Influence of cattle breed combinations on milk production: results of the Analysis of Variance

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One of the main factors in increasing the efficiency of milk production is the breed. No breed in the world would be ideal for a variety of conditions and technological processes. Besides, like any biological system, the breed is in continuous change. The breed of cattle largely determines both the level of milk production and the quality of milk. Therefore, to improve the quality of milk, it is necessary to establish the degree of influence of zootechnical and technological factors on the condition of milk components. Among genetic factors, the breed of animals and the breed combination have a significant influence. During the research, a one-way analysis of variance of the breed's influence and breed combinations on productive indicators has been analyzed. The factor "breed" and "breed combination" were used as the analyzed factor, and the protein content in milk and the yield of milk protein was used as the dependent factor. Based on one-way and multi-way ANOVA, the degree of influence of the factors under study was assessed. It has been established that the breed has a significant, both direct and combined with other factors, influence on the protein content in milk and the yield of milk protein. The level of the breed's direct influence on the protein content is 1.0%, on the milk protein yield - 1.7%. The factors "father" and "calving number" have the most substantial combined effect. Their influence levels are 1.8%, 1.4%, respectively, with a high level of reliability (P>0.999). The same factors most influence the milk protein yield as the protein content (the levels of influence are 1.9%, 1.3%, respectively) with a high level of reliability (P>0.999). As a result of analyzing the data on changes in protein content and milk protein yield in cows of different breed combinations, it can be concluded that this factor can describe 4.5% of the variability in protein content and 11.4% of milk protein yield (P>0.999). The degree of joint influence of breed combinations with other studied factors was up to 6.6%.

Keywords: cattle; breed; milk; protein content; milk protein yield; breed combination

Introduction

The main impetus in the breed formation process is society's order for products, quantity, and quality. Based on this, breeders create animal breeds adapted to industrial technologies and are resistant to diseases, which use feed effectively, and give products of high quality. These requirements form the basis for the development of a standard and the formation of the desired type of animals, the selection and selection of pairs, and crossed breeds. Specific tasks require appropriate breeding methods when creating new and improving existing breeds, types, and lines (Kozlova & Nazarenko, 2002; Palii & Palii, 2019).

Cattle breed mostly determines milk production and milk quality (Zubets & Burkat, 1997; Palii et al., 2020b). The world is continuously developing new breeds of animals. At the same time, breeds of different productivity directions are created, meeting human needs and ensuring complete satisfaction of society's food needs (Rodríguez-Bermúdez et al., 2019). Any breed carries a complex of features and characteristics inherent to it due to heredity and fixed by long-term selection. The most common Ukrainian black pied dairy breed, Ukrainian red pied dairy breed, Ukrainian red dairy breed, and Simmental breed in Ukraine are characterized by average protein content (Pendyuk et al., 2019).

Different herds within the same breed, depending on the origin and area of distribution, differ in terms of milk quality. According to the average statistical data, cows of various breeds, characterized by a high fat and protein content, make up 25-30% of the herd, and only 15% of cows have a high milk yield, high fat, and protein content of milk. Such animals are valuable and should be used to breeding intensively (Palii et al., 2020c; Seidel et al., 2020).

Black-and-white cattle are among the best and most popular dairy breeds in our country. Black-and-white Holstein cattle are characterized by exceptionally high milk productivity, which is widely used as an improvement breed in the improvement of many breeds, especially in countries with developed livestock production (Gerasimchuk et al., 2003; Kuziv, 2017).

Protein production has been studied on cows of the Slovak spotted breed (Bujko et al., 2019) during 300 days of lactation; milk contained an average of 3.408% protein, 2.788% casein, and 0.619% whey protein. Protein production was 174.76 kg, casein - 143.04 kg, whey protein - 31.53 kg per 1 dairy cow. During lactation, protein production changed as follows. The average protein content in milk was minimal up to 2 months of lactation (3.04%) and then increased to 10 months (3.84%). The whey protein content increased from the first (0.50%) up to the last month of lactation (0.75%). Studies carried out on cows of the Slovak spotted breed are consistent with the work carried out by scientists (Dubin, 2002) to study the change in milk yield and quality indicators in the milk of red-spotted cows.

In Gavrilenko's (2002) work, intrabreed differences in the protein content in cows' milk were established, and it was proved that, according to this trait, they are more significant than interbreeding ones. Other researchers (Shelyov et al., 2018) proved that with the same milk productivity and fatness, the protein content in the milk of black-and-white cows is 0.12-0.27% higher than that of Holstein cows and its crosses. With the help of selection, this indicates the possibility of improving cattle breeds in terms of protein content.

Domestic and foreign cattle breeds differ in protein-milk content. The difference in the protein content in the milk of cows of certain breeds reaches 1.0% (for example, in the Jersey breed - 4.2%, the Ayrshire breed - 3.7%, the black-and-white breed - 3.2%), while the intra-breed fluctuations of this trait are even more significant (Malynovska et al., 2019).

Thus, one of the main factors in increasing the efficiency of milk production is the breed. Any breed has a complex of features and characteristics inherent to it due to heredity and fixed by long-term selection. When characterizing the milk of cows of different breeds, one should consider the climatic, fodder, and other farm conditions. The effectiveness of breeding work largely depends on how accurately and reliably the breeder can assess the selected animals' genetic inclinations. Determining the breeding value of an animal means evaluating its genotype, which, in interaction with the environment, forms the phenotype (Palii et al., 2020d; Hinrichs & Meuwissen, 2011).

The genes determine an animal's breeding value it can pass on to its offspring, with each offspring receiving a random set of paternal and maternal genes (Hozé et al., 2014). High protein content in some breeds can be used to improve this trait in others (Pryce & Daetwyler, 2012). In purebred breeding, the heritability of the relative content of protein fractions in milk is characterized by a low value and does not exceed 0.498 (Macedo Mota et al., 2020). Therefore, changes in the structure of milk protein can be achieved only by genetic selection. Interbreeding contributes to an increase in genetic variability in milk proteins' relative content (Puppel et al., 2018).

The classics of zootechnical science used the crossing method to improve and perfect domestic breeds of livestock. Like all quantitative traits, the protein content during the crossing is inherited intermediately. However, the increase in the range of variability of the trait enables breeders to use individual selection methods to obtain a positive effect in the next generation (Amalfitano et al., 2020). In the experiment conducted by Shkurko (2005), it was determined that all groups had a high percentage of fat and relatively low protein content. Compared with the purebred Holstein breed, the studied crosses had a protein content higher by 0.02 and 0.09%. The effectiveness of interbreeding to increase the protein content in milk does not exclude the need for intrabreed improvement of cows by this trait. Crossbreeding does not replace purebred breeding but complements it and allows breeders' achievements to improve each breed. The same patterns that are observed during crossing are also noted during purebred breeding, that is, when mating animals with contrasting protein content in milk. As a rule, their offspring has an intermediate expression of this trait, on average (Gandini et al., 2014).

Thus, high indicators of protein content in some breeds can be used to improve this trait in others with crossbreeding. Since the researchers obtained different results when breeding for protein, it is necessary to take into account, in addition to the individual characteristics of the crossed breeds, also the conditions of feeding and maintenance.

Materials and Methods

During the research, the results of one-way ANOVA of the breed's influence and breed combinations on productive indicators have been analyzed. The factor "breed" and "breed combination" were used as the analyzed factor, and the protein content in milk and the yield of milk protein was used as the dependent factor. The analysis was performed using the General Linear - GLM General Factorial procedure of the SPSS 16.0 computer standard statistical software package. The analyzed factors' gradations were used to determine the standard indicators of protein content in milk and the yield of milk protein. These indicators were the number of lactations (n), arithmetic means (M), error of the arithmetic mean (m), standard deviation (σ). Also, the degree of influence of the investigated factors under their action, both independently and together with other conditioning factors, on the protein content and milk protein yield was determined following M.A. Plochinskiy (1970) method. The simultaneous influence of several factors on the effective indicator was determined using two-way ANOVA.

Results and Discussion

The effectiveness of breeding work largely depends on how accurately and reliably the breeder can assess the selected animals' genetic inclinations. Hereditary factors and different keeping conditions explain fluctuations in the milk of cows of the same

breed. Thus only the ability to form a certain amount of milk with an approximately constant composition (milk productivity) is inherited; the conditions for keeping cows are of great importance for its implementation.

We considered that complex quantitative traits, including milk protein, are due to many genes that can simultaneously influence several traits. The study of quantitative features is much complicated by influencing a whole complex of environmental factors on their variability. Therefore, some factors were analyzed to determine how strongly they affect the protein content and milk protein yield of animals. To one degree or another, the studied factors are conditional since some of them (mother's productivity) have both genetic and environmental components.

Breed differences in protein content in milk of cows

Any breed carries a complex of features and characteristics inherent to it due to heredity and fixed by long-term selection. Breeding methods improve existing and create new breeds and their structural units. The active breed-forming process in Ukraine in the last four decades, and the creation of new breeds in this regard, lead to the need to study this issue in the current conditions. To determine the breed's influence on the protein content in milk and the yield of milk protein, the protein indicators in cows of different breeds were analyzed (Table 1).

Table 1. Milk protein content and milk protein yield depending on the breed factor

Breed	Number of lactations	Protein content, %		The yield of milk protein, kg	
		M±m	σ	M±m	σ
Ayrshire	707	3.17±0.006	0.099	171.63±1.75	49.15
Red Steppe	2294	3.17±0.004	0.107	161.10±0.97	50.13
Lebedyn	777	3.18±0.006	0.116	145.94±1.67	47.36
Simmental	3653	3.21±0.003	0.173	161.99±0.77	48.78
Ukrainian Red Pied Dairy	10443	3.22±0.002	0.195	161.38±0.45	47.40
Ukrainian Black Pied Dairy	2192	3.19±0.004	0.089	145.84±0.99	32.00
Mean	20066	3.20±0.004	0.169	159.49±1.10	46.99

The highest protein content was in the milk of Ukrainian red pied dairy cows. The next, according to this indicator, is the Simmental breed. The difference in the protein content in the milk of these breeds is insignificant - 0.01%, the level of reliability is (P>0.99), and the yield of milk protein is practically the same; the difference is 0.61% (P<0.95). The lowest protein content is in Ayrshire and Red Steppe cows (P<0.95). The yield of milk protein in these breeds differs slightly, and the difference is 10.53 kg of milk with a high level of reliability (P>0.999). The Ukrainian black pied dairy breed is intermediate in protein content in milk. The same cannot be said for the yield of milk protein, which turned out to be the lowest among all studied breeds.

The data presented show an insufficiently wide amplitude of fluctuations in the protein content in cow's milk and milk protein yield. Simultaneously, the Ukrainian red pied dairy breed (σ = 0.195, Cv = 6.05) was characterized by the most significant variability in the protein content, which we explain by using a wide range of breeds in its breeding. When improving the Ukrainian red pied breed with Holstein animals' help, the Ukrainian Holsteinized type of red dairy breed was created. The protein content in these animals was 3.3%, and the milk protein yield was 180 kg (Kozyr et al., 2003; Pabat et al., 2000), which is 0.13% and 20 kg, respectively, higher in comparison with our data. Such differences are related to the Red Steppe breed's initial population, which was improved in different regions by the Danish and other breeds producers.

The factor "breed" as an independent one, is characterized by the degree of influence on the protein content in milk - 1.0%, on the milk protein yield - 1.7%. The influence of the factor "breed" on the protein content and yield of milk protein together with other conditioning parameters can be judged by the results of a series of analysis of variance (Table 2).

Table 2. The joint influence of the factor "breed" with the studied genetic and non-genetic factors

Factors, complex of factors	Protein content		Milk protein yield	
	level of influence, %	reliability level	level of influence, %	reliability level
Breed	1.0	>0.999	1.7	>0.999
Father - breed	1.8	>0.999	1.9	>0.999
Calving number - breed	1.4	>0.999	1.3	>0.999
Breed combination - breed	0.8	>0.999	0.8	>0.999
Calving month - breed	0.7	>0.999	0.7	>0.999
Feeding level - breed	0.7	>0.950	0.8	>0.999
Diet concentrate level - breed	0.4	<0.950	1.0	>0.999
Mother productivity - breed	0.4	>0.999	1.6	>0.999

The factors "father" and "calving number" have the most substantial combined effect on the protein content in cow's milk and the yield of milk protein at a high level of reliability (P>0.999). Thus, we found that the breed has a significant, both direct and combined with other factors, influence on the protein content in milk and the yield of milk protein. The degree of the breed's direct influence on the protein content is 1.0%, on the milk protein yield - 1.7%. The factors "father" and "calving number" have the most potent combined effect.

Their influence level is 1.8%, 1.4%, respectively, with a high level of reliability (P>0.999). The same factors most influence the milk protein yield as the protein content (the level of is 1.9%, 1.3%, respectively) with a high level of reliability (P>0.999).

Comparative assessment of protein content in milk and milk protein yield of cows of different breed combinations

Increasing the productivity of livestock based on the qualitative improvement of herds provides for the most effective use of the gene pool of selected breeds of domestic and foreign selection, on the one hand, as well as the preservation and rational use of the gene pool of local breeds in the breeding process, on the other. The primary gene pool of cattle is represented by common domestic breeds (Ukrainian black pied dairy, Ukrainian red pied dairy, Ukrainian red dairy, Simmental) and some foreign breeds (Holstein, Angler, red Danish, Ayrshire). The other gene pool includes domestic local and aboriginal breeds.

For many years, animal productivity's genetic potential has been increased by breeding methods while creating optimal conditions for growing, feeding, and keeping, significantly improving existing ones, creating new breeds, and structural units (Dadousis et al., 2018; Osipenko et al., 2018). The genes determine an animal's breeding value it can pass on to its offspring, with each offspring receiving a random set of paternal and maternal genes (Semjan & Kazimir, 1984). We carried out genetic and mathematical analysis to determine breed combinations' influence on the protein content in milk and milk protein yield (Table 3).

When evaluating the animals of these groups by the content of protein and milk protein, we found that the highest protein content in milk was in hybrids with most of the blood of the Simmental breed $^{3}/_{4}$S $^{1}/_{4}$H, $^{3}/_{4}$S $^{1}/_{4}$M, and $^{1}/_{2}$S $^{1}/_{2}$H, they were reliably (P>0.999) inferior by 0.11-0.14% to crosses with a smaller part of blood in the Simmental breed ($^{1}/_{4}$S $^{3}/_{4}$M and $^{1}/_{4}$S $^{1}/_{4}$A $^{1}/_{2}$M)). Also, Simmental-Montbeliard hybrid animals are indicative. In hybrids with most of the blood of the Montbeliard (($^{1}/_{4}$S $^{3}/_{4}$M), the protein content in milk is low, and with a predominance of part of the blood of the Simmental breed ($^{3}/_{4}$S $^{1}/_{4}$M), the protein content is much higher. The difference between these groups is 0.12% protein content, with a high degree of reliability (P>0.999). As for the yield of milk protein, the mixed animals $^{3}/_{4}$S $^{1}/_{4}$A, $^{1}/_{2}$S $^{1}/_{2}$H, and $^{1}/_{4}$S $^{1}/_{4}$H $^{1}/_{2}$A were characterized by a relatively high yield. A low yield of milk protein we observed in the $^{1}/_{4}$S $^{3}/_{4}$H crossbreds and purebred Simmentals. The difference between the best and worst crossbreeds was 43.2-36.8 kg of milk protein, with a high degree of reliability (P>0.999). Regarding milk protein (kg), there is no dependence on the proportion of blood by the Simmental breed.

Table 3. Protein content and yield of milk protein of different breed combinations

Conditional consanguinity of crossbred animals	Number of lactations	Protein content, %		Milk protein yield, kg	
		M±m	σ	M±m	σ
$^{1}/_{2}$S $^{1}/_{2}$A	179	3.22±0.013	0.157	174.8±3.36	43.26
$^{1}/_{2}$S $^{1}/_{4}$A $^{1}/_{4}$H	16	3.22±0.042	0.154	165.8±11.25	42.29
$^{1}/_{2}$S $^{1}/_{2}$H	1591	3.29±0.004	0.173	189.5±1.13	45.38
$^{1}/_{2}$S $^{1}/_{2}$M	232	3.21±0.011	0.169	175.0±2.95	40.11
$^{1}/_{4}$S $^{1}/_{4}$A $^{1}/_{2}$H	863	3.20±0.006	0.135	158.8±1.53	48.33
$^{1}/_{4}$S $^{1}/_{4}$A $^{1}/_{2}$M	361	3.19±0.009	0.133	167.3±2.37	48.90
$^{1}/_{4}$S $^{3}/_{4}$A	12	3.23±0.049	0.145	159.8±12.99	48.59
$^{1}/_{4}$S $^{1}/_{4}$H $^{1}/_{2}$A	417	3.22±0.008	0.140	185.8±2.20	38.66
$^{1}/_{4}$S $^{1}/_{4}$H $^{1}/_{2}$M	83	3.26±0.019	0.135	175.6±4.94	39.42
$^{1}/_{4}$S $^{3}/_{4}$H	1595	3.21±0.004	0.185	152.7±1.13	37.94
$^{1}/_{4}$S $^{1}/_{4}$M $^{1}/_{2}$A	387	3.21±0.009	0.130	180.3±2.29	43.68
$^{1}/_{4}$S $^{1}/_{4}$M $^{1}/_{2}$H	675	3.23±0.006	0.171	167.9±1.73	46.51
$^{1}/_{4}$S $^{3}/_{4}$M	275	3.18±0.010	0.121	178.6±2.71	42.94
$^{3}/_{4}$S $^{1}/_{4}$A	38	3.24±0.027	0.166	186.1±7.30	51.63
$^{3}/_{4}$S $^{1}/_{4}$H	198	3.32±0.012	0.166	162.6±3.20	40.49
$^{3}/_{4}$S $^{1}/_{4}$M	47	3.30±0.025	0.202	173.1±6.57	37.86
S, purebred	1990	3.20±0.004	0.188	146.3±1.01	50.05
Mean	8962	3.22±0.026	0.172	165.4±5.26	47.77

Table 4. The joint influence of the indicator "breed combination" with genetic and non-genetic factors

Factors	Protein content		Milk protein yield	
	level of influence, %	reliability level	level of influence, %	reliability level
Breed combination	4.5	>0.999	11.4	>0.999
Father - breed combination	6.6	>0.999	5.5	>0.999
Diet concentrate level - breed combination	4.2	>0.999	1.6	>0.999
Feeding level - breed combination	3.5	>0.999	1.9	>0.999
Calving month - breed combination	2.5	>0.990	1.7	<0.950
Calving number - breed combination	2.4	>0.999	2.9	>0.999
Mother's productivity - breed combination	1.1	>0.999	1.3	>0.999
Breed - breed combination	0.8	>0.999	0.8	<0.950

The factor "breed combination" affects the studied productive indicators independently and combined with other factors taken into account, which is quite likely. To find out the degree of influence of the studied complex of factors, the analysis of the protein content and yield of milk protein was carried out when dividing into gradations simultaneously both by breed combinations and by other studied indicators. The data given in Table 4 show that such pairs of factors as "father - breed combination" and "the level of concentrates in the diet - breed combination" has a significant influence on the protein content and milk protein yield.

In Table 4, pairs of factors are presented according to the strength of their influence. In all cases, the effect on protein content is higher than on milk protein yield. The exceptions are the pairs of factors: "calving number - breed combination", "mother's productivity - breed combination", in which the degree of influence on the yield of milk protein is higher than on the protein content by 0.5%, 0.2%, respectively. In most cases, there is a high level of reliability (P>0.999). The influence of the pairs "breed - breed combination" and "month of calving - breed combination" on the yield of milk protein was unreliable (P<0.95).

One of the most influencing co-factors is the breed mix. Table 5 shows the most significant pairs of gradations that show the mechanism and direction of the joint influence of this pair of factors. As an example, the productivity of the daughters of two bulls - Antaeus 7237 and Atlant 8375, with different breed combinations, was analyzed. We proved that the average protein content in milk in the presented variants depends on both bulls and breed combinations.

Table 5. Protein and milk protein content in cow's milk of different breed combinations and different bulls

Father	Breed combination of daughters	Number of lactations	Average protein content, %	The average yield of milk protein, kg
Antaeus 7237	$^1/_4$S $^1/_4$A $^1/_2$H	9	3.11	218.8
	$^1/_4$S $^1/_4$M $^1/_2$A	90	3.15	173.6
Atlant 8375	$^1/_4$S $^1/_4$A $^1/_2$H	9	3.36	207.5
	$^1/_4$S $^1/_4$M $^1/_2$A	13	3.28	169.0

Thus, the daughters of the bull Antaeus 7237, having a breed combination of $^1/_4$S$^1/_4$A$^1/_2$H, are 0.04% inferior in protein content to the daughters of the same bull, but with a breed combination - $^1/_4$S$^1/_4$M$^1/_2$A. The opposite picture we observed in the daughters of the bull Atlant 8375. Among this bull's daughters, animals of the breed combination $^1/_4$S $^1/_4$A $^1/_2$H were characterized by higher protein content in milk (by 0.08%). Similar examples can be considered with other reliably influencing pairs of factors.

As evidenced by Pabat et al. (2000), Paliy (2016), and Maurmayr et al. (2018), the genotypic diversity of cattle within the breed and individual herds determines the possibility of breeding animals in the direction of improving specific indicators of milk productivity. It is also necessary to pay attention to environmental conditions: under unfavorable environmental conditions, the level of realization of the potential genetic decreases (Osipenko et al., 2018; Fedak, 2001). Goryaev (2001) and Palii et al. (2020a) focus on the fact that of the many listed factors that influence breeding work, special attention should be paid to the accuracy of the animal genotype assessment. Thus, we found that the content and yield of milk protein to a certain extent depends on the combination of genotypes of the original breeds in hybrids.

After analyzing the data on changes in the protein content and milk protein yield in cows of different breed combinations, we concluded that this factor could describe 4.5% of the variability in protein content and 11.4% - the yield of milk protein (P>0.999). The level of joint influence of breed combinations with other studied factors was up to 6.6%. The protein content in cows' milk is also a breed characteristic. Because many breeds of dairy and combined directions of productivity are bred in the world, several researchers have studied the inter-breed differences in the protein content in milk (Berry et al., 2014).

A comparative assessment of the protein content in milk of different breeds (Saliy & Polupan, 2003) found that it is low in Holstein cows (3.15%), black pied cows (3.05-3.37%), Ost-Friesian (3.09%) cows, Ayrshire (3.27-3.34%) and red steppe cows (3.22%), high - in the milk of Jersey (3.78-4.23%), Yaroslavl (3.55-3.64%), Red Gorbatov (3.51-3.56%), Simmental (3.44-3.51%) and Swiss cows (3.42-3.50%). When comparing all of the listed breeds with the black pied cattle, the researchers revealed significant differences in minimum and maximum values. The authors conclude that increasing the protein content by breeding methods is possible and advisable, although this is a long process.

In Ukraine, the Holstein breed is increasingly spreading; this breed better meets the desired type for industrial production technology and has established itself as the most highly productive in the world (Mikitas & Demchuk, 2001). Saliy & Polupan (2003) argue that with an increased proportion of blood by the Holstein breed, animals' milk production increases. When considering the influence of the proportion of Holstein blood on the protein content, there is a tendency to decrease the studied indicator. The difference between $^3/_4$S$^1/_4$H and $^1/_4$S$^3/_4$H is 0.11% in favor of $^3/_4$S$^1/_4$H - Holstein blood.

Although Ladyka (1999) and Ovcharenko (2000) have determined that an increase in the proportion of heredity of the improving Holstein breed has a positive effect on milk's average protein content and its qualitative composition, until now, scientists have obtained the results of the influence of several factors (genetic and non-genetic) on the change in the protein content in milk of cows in previously created breeds (Palii et al., 2020f). A comparative assessment of the results of these studies indicates their diversity.

The main direction of animal husbandry is increasing productivity. It is determined both by an increase in milk yield based on rational feeding and maintenance of pedigree livestock and by improving breed resources in terms of a set of characteristics, especially milk composition. The higher the fat and protein content of milk, the more dairy products are produced from processing. In this regard, it is advisable to carry out work to improve the composition of milk, especially protein content.

Conclusion

We established that the breed has a significant, both direct and combined with other factors, influencing the protein content in milk and the yield of milk protein. The degree of the breed's direct influence on the protein content is 1.0%, on the milk protein yield - 1.7%. The factors "father" and "calving number" have the most substantial combined effect. Their influence level is 1.8% and 1.4%, respectively, with a high-reliability level ($P>0.999$). The same factors most influence the milk protein yield as the protein content (the degree of influence is 1.9%, 1.3%, respectively) with a high level of reliability ($P>0.999$).

The factor "breed combination" determines about 4.5% of the variability of the protein content and 11.4% - the yield of milk protein with a high degree of reliability ($P>0.999$). The level of joint influence of this indicator with other studied factors was up to 11%. The most influencing of them are "breed combination - father" ($\acute{\eta}^2$ = 6.6% for protein content and $\acute{\eta}^2$ = 5.5% for milk protein yield).

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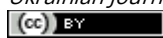
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