Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(3), 353-359, doi: 10.15421/2021_183

ORIGINAL ARTICLE

Influence of the fixed "father" factor on the protein content in milk and the yield of milk protein in cattle

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Received: 29.05.2021. Accepted: 01.07.2021.

Increased productivity in cattle is performed by using the methods of genetics and breeding. Currently, one of the promising directions for increasing the milk productivity and manufacturability of domesticated cattle is the use of the genetic potential of breeding bulls. During the research, the results of a one-way analysis of variance of the influence of the "father" factor on productive indicators were analyzed. The factor "father" was used as the analyzed factor, and the content of protein in milk and the yield of milk protein were used as dependent factors. For each fixed factor, standard indicators of protein content in milk and milk protein yield have been determined. 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 the yield of milk protein was determined. The determination of the simultaneous influence of several factors on the effective indicator was carried out using a two-way analysis of variance. It was found that the degree of influence of bulls on the protein content in daughters' milk was 7.9%, on the yield of milk protein-19.6% with high confidence levels (P>0.999). Among the factors studied, the most strongly influencing pair was "calving number-father". This combination of factors also turned out to be one of the most significant against the background of the final comparative assessment of all investigated ones in the work. It is essential that the "father" factor, as an independent factor, has a lower power of influence on the protein content in milk than when interacting with the "calving number" factor. Thus, the factor "father" causes 7.9% of the protein content in the milk of daughters, and in combination with the factor "calving number" the influence is 5.4% greater. At the same time, such a pattern is not observed in the yield of milk protein. In this case, the opposite trend is observed: the "father" as an independent factor has a higher influence compared to the options of its interaction with other studied factors. Thus, the value of the bull-producer is one of the main factors that determine the protein content in milk and milk protein yield, and one of the most important evaluation criteria.

Keywords: Cattle, milk, protein, milk protein, lactation, degree of influence, confidence level, bull-producer.

Introduction

At this time in dairy cattle breeding, there are still many problems, among which the following are the main ones: obtaining high milk yield; providing livestock with appropriate conditions in which their genetic potential can manifest; rearing stock with live weight by the breed standard (Krugliak & Krugliak, 2020; Paliy, 2016). The high level of industrial use of animals is the most important selection and genetic trait, which has a hereditary basis and depends on both the mother and the father. It has been established that even within the same herd, there is a significant number of bull daughters, which with a high degree of reliability differ in terms of use in the herd (Palii et al., 2021a).

Increasing the productivity of cattle is carried out using the methods of genetics and selection. Currently, one of the promising directions for increasing the milk productivity and manufacturability of domesticated cattle is the use of the genetic potential of breeding bulls in selection (Prudov & Dunin, 2005). Also, for any breed, it has been determined that their potential is increased mainly through the use of breeding bulls. At the same time, the phenotypic specificities of the half-sisters groups after the father and animals of different linear affiliation to a certain degree (sometimes significantly) change in the chronology of different years of economic use in different herds and climatic conditions (Polupan & Gavrilenko, 2008).

In this regard, in dairy farming, special attention is paid to the assessment and selection of bulls by the quality of the offspring. Most authors have found that genetic improvement in dairy cattle depends on the heredity of the breed leader bull (Kuznetsov, 2002; Selionova & Kovaleva, 2015; Zubets et al., 1997). Several methods are used to evaluate the bull by the quality of the offspring: comparison of the performance of daughters with peers, the average productivity of the herd or breed, the current breed standard, the best linear unbiased forecast (BLUP), "father's model", "animal model", breeding indices are calculated (Danshin, 2008; Krasota et al., 2006). In Ukraine, the assessment of producers involves the use of the method of comparing daughters with peers, as well as determining the estimated breeding value. Scientists have found that only a small part of Holstein bulls simultaneously combine breeding value by two characteristics (milk yield - fat content in milk, milk yield - protein content in milk) and even less - by three traits (milk yield-fat-protein).

In the works of Korshun & Klimov (2016) and Palii et al., (2020a), it has been found that when studying the influence of various factors on the longevity indicators of dairy cattle, among genetic factors, the factor of father's heredity has the greatest influence on productive longevity. Also, the researcher Titova (2017) has found that the father's genotype had a significant effect on productive longevity and life-long milk yield of cows-37.7% and 30.3%, respectively. The longest period of productive use and the highest lifetime milk yield were characteristic of the descendants of purebred black-and-white bulls in comparison with hybrid bulls - producers of the Holstein breed. Until now, in the selection of dairy cattle, information on the milk productivity of their female ancestors has been used as the main criterion for the selection of sire bulls (Titova, 2016). The identification of producers that increase the mass fraction of protein in daughters' milk and their widespread use largely determines the intensity of improving domestic cattle in terms of protein-milk content (Lazarenko et al., 2004; Osipenko et al., 2018).

An important selection method for improving the herd is the use of the best breeding bulls, whose daughters, according to the blocks of milk productivity and reproductive ability, should be as close as possible to the parameters of animals of the desired type. The smaller the difference between the two, the more profitable the use of one or another producer on the farm will be (Kochuk-Yashchenko & Kucher, 2020; Palii et al., 2020b).

In studies by Shulyar et al. (2020), it has been found that when analyzing three factors of influence (the conditional part of blood by the Holstein breed, father, line), in cows-first-calf heifers of the Ukrainian black-and-white dairy breed, it was of paternal origin and was: milk yield for 305 days of lactation (19.0%, $P<0.001$), fat content in milk (2.5%, $P<0.001$), amount of milk fat (13.0%, $P<0.001$), protein content in milk (6.5%, $P<0.001$), the amount of milk protein (20.8%, $P<0.001$), and the total production of milk fat and protein (16.4%, $P<0.001$).

Valuable are bulls whose daughters have a positive and slightly negative correlation between milk yield and fat, milk yield and protein, as well as bulls, in whose offspring high positive values of the correlation coefficient between fat and protein are revealed. Thus, the selection and widespread use of sires, in the offspring of which a positive correlation between milk yield and fat content, between milk yield and protein content, will help to quickly overcome the undesirable negative relationship between these traits.

Materials and Methods

During the research, the results of a one-way analysis of variance of the influence of the "father" factor on productive indicators were analyzed. The factor "father" was used as the analyzed factor, and the content of protein in milk and the yield of milk protein were used as dependent factors. The analysis was carried out using the procedure of the general linear model (General Linear- GLM General Factorial) of the computer standard package of statistical programs SPSS 16.0. For each fixed factor studied by us, the standard indicators of the protein content in milk and the yield of milk protein were determined.

These indicators were: the number of lactations (n), arithmetic means ($\overline{X}$), arithmetic mean error ($S_{\bar{x}}$), 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 the yield of milk protein was determined.

The determination of the simultaneous influence of several factors on the effective indicator was carried out using a two-way analysis of variance.

Results and Discussion

To identify bulls by the protein content in milk and the yield of milk protein in daughters, the results of their assessment by these productive traits were analyzed. The average values by the protein content in milk and the yield of milk protein are given for all lactations, regardless of the age of the animals. Table 1 presents the results of the evaluation of the daughters of the bulls most frequently used at the farms.

Bull's nickname and identification number	**Number of lactations**	**Protein content,%**		**Milk protein yield, kg**	
		M ± m	**σ**	**M ± m**	**σ**
Shturm 4622	118	3.36 ± 0.015	0.12	180.91 ± 3.78	32.82
Titus 3257	121	3.34 ± 0.015	0.14	183.38 ± 3.75	38.55
Tekhal' 1726	166	3.31 ± 0.013	0.19	201.83 ± 3.18	52.73
Surik 8655	133	3.30 ± 0.014	0.17	176.41 ± 3.52	35.81
Limit 6730	187	3.28 ± 0.012	0.21	138.51 ± 2.97	28.77
Vud 1703	200	3.26 ± 0.011	0.20	203.32 ± 2.87	48.79
Bilet 6437	169	3.25 ± 0.012	0.23	132.09 ± 3.12	29.29
V.V. Jackson 9955	155	3.23 ± 0.013	0.22	140.01 ± 3.26	35.15
Karlo 1599	409	3.22 ± 0.008	0.20	173.45 ± 2.01	34.76
Aleut 6619	112	3.21 ± 0.015	0.25	124.04 ± 3.84	27.75
Colt 69	370	3.21 ± 0.008	0.17	142.91 ± 2.11	28.63
Ridzhes 1743	427	3.21 ± 0.008	0.14	185.83 ± 1.97	52.49
Caliber 9707	125	3.19 ± 0.014	0.14	180.73 ± 3.63	52.82
Ridbul 2771	191	3.18 ± 0.012	0.08	165.38 ± 2.94	36.54
Sofist 2139	230	3.18 ± 0.011	0.09	176.78 ± 2.68	35.24
Dar'yus 1029	172	3.16 ± 0.012	0.12	167.43 ± 3.09	46.96
President 1875	566	3.15 ± 0.007	0.16	186.02 ± 1.73	45.42
Kavaler 2235	149	3.14 ± 0.013	0.21	154.46 ± 3.32	30.66
Nickel 7680	246	3.13 ± 0.010	0.21	165.42 ± 2.59	32.49
Pilmor 1646	133	3.13 ± 0.014	0.18	159.23 ± 3.52	32.41
Red 1713	110	3.12 ± 0.015	0.11	188.60 ± 3.92	52.99
Average		3.22 ± 0.012	0.17	167.94 ± 3.04	38.62

Table 1. Parameters of protein content and variability in milk and milk protein yield of daughters of the most commonly used sires.

From the bulls with at least 100 daughters' lactations in the database, the daughters of the bull Shturm 4622 were the best by the studied indicator, and the bull Red 1713 was the worst. The difference between their daughters in terms of protein content in milk was 0.24% and was highly reliable (P>0.999). Improvers in terms of protein content in milk include bulls: Shturm 4622, Titus 3257, Tekhal' 1726, etc. Degrading bulls are the bulls Red 1713, Pilmor 1646, Nickel 7680, etc. Aleut 6619, Ridbul 2771, Caliber 9707 and some others are rated as neutral.

The difference in protein content in milk (Table 2) in the daughters of bulls - improvers is 0.02-0.05% with reliability (P>0.95). In the daughters of neutral bulls - 0.02-0.03% and it is unreliable (P<0.95). Degrading bulls have an insignificant effect on the protein content in daughters' milk.

Nickname, inv. No.		**Difference between averages,%**	**Difference error, %**	**Reliability level**	**95%-confidence interval**	
bull-fathers					**lower border, %**	**upper border,%**
Shturm_4622	Tragik_5465	0.20	0.022	0.999	0.16	0.24
Shturm_4622	Dar'yus_1029	0.20	0.019	0.999	0.16	0.24
Shturm_4622	Karniz_706	0.20	0.02	0.999	0.16	0.24
Shturm_4622	O.Robin Et Red_4567	0.20	0.02	0.999	0.16	0.24
Shturm_4622	Kesci_38	0.20	0.021	0.999	0.16	0.25
Shturm_4622	Security_3597	0.20	0.021	0.999	0.16	0.25
Shturm_4622	Pavlin_2085	0.21	0.019	0.999	0.17	0.24
Shturm_4622	Rokik Red_9599	0.21	0.02	0.999	0.17	0.25
Shturm_4622	Antaeus_7237	0.22	0.021	0.999	0.17	0.26
Shturm_4622	President_1875	0.22	0.016	0.999	0.18	0.25
Shturm_4622	Reps_20	0.22	0.019	0.999	0.18	0.25
Shturm_4622	Kavaler_2235	0.22	0.02	0.999	0.18	0.26
Shturm_4622	Shevron_531	0.22	0.018	0.999	0.19	0.26
Shturm_4622	Byunas_55	0.23	0.019	0.999	0.19	0.26
Shturm_4622	Nickel_7680	0.23	0.018	0.999	0.20	0.27
Shturm_4622	Pilmor_1646	0.24	0.02	0.999	0.19	0.27
Titus_3257	Kavaler_2235	0.20	0.02	0.999	0.16	0.24
Titus_3257	Byunas_55	0.20	0.019	0.999	0.17	0.24
Titus_3257	Shevron_531	0.20	0.018	0.999	0.17	0.24
Titus_3257	Nickel_7680	0.21	0.018	0.999	0.18	0.25
Titus_3257	Red_1713	0.22	0.021	0.999	0.18	0.24
Titus_3257	Pilmor_1646	0.21	0.02	0.999	0.17	0.25

Table 2. Evaluation of the reliability of the difference between bulls in terms of protein content in the milk of their daughters.

The milk protein yield per lactation among the daughters of the most widely used bulls also varied. A positive point for breeding opportunities is the fact that the daughters of bulls selected as the best in terms of protein content in milk, also had a fairly high yield of milk protein (from 180 to 201 kg).

At the same time, in the daughters of some bulls (Red 1713, President 1875, etc.) with low protein content, the yield of milk protein was not low (from 164 to 188 kg). That is, those bulls that were degrading in terms of protein content in milk were identified as improving the yield of milk protein due to the relatively high average milk yield of their daughters. The bulls Aleut 6619 and Bilet 6437 were rated the worst in terms of the yield of milk protein in their offspring. With a sufficiently high protein content in the milk of their daughters (3.21% and 3.25%, respectively), the average values of the yield of milk protein turned out to be the smallest-124.0 kg and 132.1 kg, with high reliability (P>0.999).

Scientists Dobryansky et al., (2004) found that a large percentage of the protein in milk and a large total weight for lactation are obtained mainly from the daughters of improving bulls. In their studies, Salute 02530 was named one of such bulls (3.30% and 98.27 kg, respectively). The indicators of the protein content (3.27-3.28%) in the milk of the daughters of the bull Zhoker 275 and Alyur 2453 are slightly lower, and the lowest (3.22-3.23%) in the offspring of the bulls Olivets 3869 and Michman 8182.

It has been determined that the degree of influence of bulls on the protein content in daughters' milk was 7.9%, on the yield of milk protein - 19.6% with high levels of reliability (P>0.999). Regular determination of the protein content in milk makes it possible to establish a rating of breeding bulls by this indicator among their daughters and take this indicator into account during selection. Thus, the value of the sire is one of the main factors that determines the protein content in milk and the yield of milk protein, and one of the most important evaluation criteria.

Some scientists engaged in dairy farming (Dubin, 2002; Palii et al., 2021b; Polkovnikova & Pidpala, 2000) consider it expedient to conduct a selection taking into account complex genetic and environmental factors. A series of analyses of variance was carried out to determine the influence of the "father" factor on the studied productive indicators together with other conditioning factors (Table 3).

Factors	**Protein content**		**Milk protein yield**	
	degree of influence, %	**confidence level**	**degree of influence, %**	**confidence level**
Father	7.9	>0.999	19.6	>0.999
Calving number-Father	13.3	>0.99	10.0	>0.999
Calving month-Father	7.4	>0.999	6.5	>0.999
Breed combination-Father	6.6	>0.999	5.5	>0.999
Diet concentrate levels-Father	6.1	>0.999	3.7	>0.999
Feeding level-Father	4.9	>0.999	2.6	>0.999
Mother's productivity-Father	4.0	>0.999	4.1	>0.999
Breed-Father	1.8	>0.999	1.9	>0.999

Table 3. Combined influence of the "father" factor with genetic and non-genetic factors.

The degree of father factor co-influence with other factors such as calving number, calving month, breed mix, breed, feeding level, and dietary concentrate levels on protein content and milk protein yield is different.

Among the factors studied, the most strongly influencing pair was "calving number - father". This combination of factors turned out to be one of the most significant and against the background of the final comparative assessment of all investigated combinations. It is essential that the "father" factor, as an independent factor, has a lower influence on the protein content in milk than when interacting with the "calving number" factor. So, the factor "father" causes 7.9% of the protein content in the milk of daughters, and in combination with the factor "calving number" the effect is 5.4% more. At the same time, no such regularity is observed in the yield of milk protein. In this case, the opposite tendency is seen: the "father" as an independent factor has a higher influence in comparison with the variants of its interaction with other studied factors.

To present an illustrative example of the influence of fathers together with other factors on the studied productive traits, gradations characteristic of this influence were singled out, both according to the "father" factor and other factors. Thus, below the productivity of the most characteristic combinations of the joint action of the factors "calving number-father" are presented.

In this case, the analysis of protein content in milk and milk protein yield is shown depending on the lactation number in the context of the bulls used. Significant pairs of gradations have been identified, which show the mechanism and direction of the joint action of this pair of factors (Table 4).

Lactation number	Father	Number of lactations	Average protein content, %	Average yield of milk protein, kg
1	V.V. Jackson Et 9955	46	3.07	128.57
	Karlo 1599	149	3.31	182.94
3	V.V. Jackson Et 9955	29	3.41	151.19
	Karlo 1599	44	3.10	174.49

Table 4. Protein and milk protein content in milk of cows depending on calving number and fathers.

It follows from the table that the average protein content and milk protein yield by daughters of bulls differ depending on the number of lactation. Thus, the protein content of the daughters of the bull V.V. Jackson 9955 for the first lactation was significantly lower than for the third. The difference was 0.34%; reliability of the difference P>0.999. And the daughters of the bull Karlo 1599 have the opposite pattern. Consequently, the decisive factor in this case is the combination "bull-lactation number".

Relative to the yield of milk protein, there is a dependence on the combination "father-lactation number". Thus, the daughters of the bull V.V. Jackson 9955 the studied indicator for the third lactation exceeds by 22.6 kg of milk the same indicator for the first lactation, and for Karlo 1599 is the opposite. The significant influence of fathers is also evidenced by studies of domestic and foreign scientists (Bazyshyna, 2017; Dydykina et al., 2021; Khmelnychy, 2019; Lyubynsky & Kasprov, 2020; Savegnago et al., 2013; Shulyar, 2018; Vechorka & Mazur et al., 2018; Yovenko, 2002). They argue that the best offspring are born from the best fathers more often than from the worst ones. The greater or lesser part of the phenotypic diversity of offspring is caused by genotypic diversity, which comes from the fathers through the genetic information that is embedded in the gene complexes. The rather high influence of the genetic factor "father" and its combinations with others indicates the advisability of further studies aimed at specifying the effects of these influences.

Conclusion

It has been found that the degree of influence of the "father" factor on the protein content in milk of cows is 7.9%, on the yield of milk protein-19.6% with a high degree of reliability (P>0.999). Among the factors in the formation of which the component "father" is involved, the most strongly influencing is "calving number - father", the degree of influence of which is: by protein content 13.3%; by the yield of milk protein 10.0%, respectively, with a high degree of reliability (P>0.999).

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Citation:
Palii, A.P., Osipenko, T.L., Chigiryov, V.A., Gurko, I.Y., Petrov, R.V., Berezovsky, A.V., Khitska, O.A., Furman, S.V., Lisohurska, D.V., Lisohurska, O.V. (2021). Influence of the fixed "father" factor on the protein content in milk and the yield of milk protein in cattle. Ukrainian Journal of Ecology, 11 (3), 353-359.