

PRODUCTIVITY OF FIRST-HEIFER COWS OF LOCAL BREEDING OF THE HOLSTEIN BREED

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Abstract

There are presented the results of a comparative assessment of milk productivity for 305 days of the first lactation of daughters of the local generation of the Holstein breed of various origins and their mothers, as well as a study of the variability and heritability of milk productivity traits. The studies were carried out in 2020-2021 in the herd of Joint-Stock Company "Aydn", Comrat, Administrative and Territorial Unit Gagauzia, Republic of Moldova. There was established a significant advantage in milk yield of daughters on average for the first lactation over mothers by 530 and 1240 kg of milk, respectively, of Dutch and German breeding, with $P < 0.001$. A weak positive relationship was established between the milk yield and the fat content in milk at the offspring of the local generation of various origins ($r = +0.069$) at first-calf heifers of German breeding also have a weak negative relationship ($r = -0.186$) - first-calf heifers of Dutch breeding. The relationship between milk yield and the amount of milk fat at the descendants of German breeding is positive, the tightness of the relationship is high ($r = +0.768$), which is significantly greater at $P < 0.001$ than at the descendants of the Dutch breeding - the tightness of the relationship is moderate ($r = +0.366$). It should be noted the high degree of heritability in milk yield for the first lactation (mother-daughter) of German breeding - 93.0%, Dutch breeding - this indicator is two times lower - 44.8%.

Key words: correlation, daughters of local generation, heritability, productivity, variability.

INTRODUCTION

Modern cattle breeding in the leading countries of the world is characterized by dynamic development, assimilation of intensive technologies, an increase in the productivity of animals, which ensures a steady increase in production. Dairy farming in these countries is developing through the accelerated increase of the genetic potential of livestock, intensive rearing of reproductive heifers, reproduction of the herd with first- heifers tested for their own productivity and intensive use of improvers in the selection of bulls, as well as balanced feeding of cows and reproductive calves.

The increase in milk yield and other indicators of milk productivity depends on the correct balanced feeding, climatic conditions of the environment, features of the exterior of cows, etc. The use in breeding work of highly productive cows contributes to the accumulation of the most valuable genetic potential of animals, increases the possibility of obtaining more highly productive breeding herds (Chechenkhina et al., 2018; Zernina, 2019; Zyryanova, 2108; Nemtseva, 2019; Stepanov et al., 2019; Fedoseeva et al., 2018).

Economically useful traits, to a certain extent, are genetically related to each other, that is, they are correlated. The study of correlations between economically useful traits in breeding work with dairy cattle is of particular importance. One-sided breeding for any one trait is impossible without considering the indirect effect that can be obtained from other traits (Dechow et al., 2002; Perez-Cabal & Alenda, 2002; Veerkamp et al., 2001).

Analysis of numerous materials on some breeds of dairy cattle showed that in the selection process, the variability of one of the phenotypic indicators depends on the variability of other economically useful traits. Thus, the variability of the fat content in milk depends on the level of milk yield of cows and, to a large extent, on their live weight. An increase in live weight to an optimal value is accompanied by an increase in milk yield. However, the correlation between these features is curvilinear. Analysis of the relationship between milk yield and live weight of black-motley cattle, carried out on a large livestock (Fenchenko & Nazarchenko, 2003), shows that the highest milk yield is observed at cows with a live weight of 550-600 kg. Further increase of body weight did not affect the

increase in milk yield and reduced the value of the milk yield coefficient.

The modern use of the Holstein breed requires additional study of the breeding and genetic parameters of the population, with the help of which it is possible to establish the degree of constancy of economic traits, correlations between traits and their heritability (Adzhibekov, 1995; Nazarchenko, 2007; Nazarchenko, 2011; Ovchinnikova & Rumyantseva, 2012; Fenchenko & Nazarchenko, 2003; Fenchenko et al., 2009; Ernst & Zinovieva, 2008). When assessing the effectiveness of breeding by traits, there are many opinions about the role of the coefficient of heritability. So, the researchers Beguche et al. (1969) noted that the study of the degree of influence of the coefficient of heritability has a certain value for predicting selection and breeding work for relatively large populations of livestock.

Assessment of the influence of mothers' cows on milk yield and the qualitative composition of daughters' milk is one of the fragments in the breeding of cattle, which meets the modern requirements of intensive dairy farming (Damarov & Shishin, 2018; Kozlov, 2019; Kulikova & Eremin, 2016; Piotrovskaya & Damarov, 2018; Titova, 2019). In the literature, there are completely different data on the heritability of productivity indicators. As a result of the research by Sklyarenko et al., (2017), it was established the dependence of the milk production of cows on the productivity of their female ancestors in a herd of dairy cows. According to Novak (2012) and Piddubna (2014), the heritability coefficients (h^2) between milk yield and the amount of milk fat of daughters and their mothers ranged from 0.264 to 0.356. At the same time, the authors found that the share of the influence of the milk yield of mothers on the milk yield of daughters is in the range of 19.3-46.8%.

In the zootechnical literature there are many reports on the range of variation in the coefficient of heritability of the traits of milk production. So, in terms of milk yield, the heritability coefficient varies from 0.10 to 0.60, in terms of the fat content in milk - from 0.01 to 0.78 (Adzhibekov, 1995; Katmakov and Anfimova, 2013; Kakhikalo et al., 2007; Kuznetsov, 2002; Lyubimov & Martynova,

1995; Mymrin, 1998). An important conclusion follows from the results of the work of these researchers: if a single lactation, for which it is known that it has a relatively small coefficient of heritability, then information about its milk yield, generalized for five lactations, already gives a sufficiently complete picture for judging its breeding value. When calculating the coefficient of heritability of milk production, it is important that there are no sharp differences in the conditions of keeping and feeding mothers and daughters. Therefore, the coefficients may be different not only in different farms, but in the same farm in different feeding years. In good housing conditions and adequate feeding, in most cases they are higher, and lower in bad conditions. At the same time, the higher is the coefficient of heritability of a trait, the higher is the effect of selection of animals by phenotype. A higher value of the heritability coefficient indicates that mass selection for this trait will be effective, and its low indicators indicate a large influence of environmental factors that reduce the selection effect (Rokitsky, 1964; Ruzsky, 1972; Strekozov & Krylova, 1987; Eisner, 1986).

The aim of the study was to assess the milk productivity of first-heifer cows of the local generation and their mothers - Holstein cows of various breeds, to study the correlation of milk productivity traits and their heritability.

MATERIALS AND METHODS

The material for research was Holstein cattle of various origins in the herd of J-SC "Aydm" (Joint-Stock Company), t. Komrat in 2020-2021. The milk productivity of first- heifers of local generation was assessed at the end of their first lactation. Holstein cows with family ties (mother and daughter) were selected to study the variability and heritability of milk productivity traits for the first lactation. Each sample consists of 20 cows and 20 offspring of local breeding (Dutch breeding) and 23 cows - 23 offspring of local breeding (German breeding). The milk yield for 305 days of lactation, the fat content in milk and the amount of milk fat were studied, and the variability of these parameters (C_v) was determined. It was done a study of the correlative links of cows and primiparous local organic generation with milk production, fat

content and overall amount of fat, body mass. The correlation coefficient (r) was calculated on a computer using the CORREL function in the Excel program environment. The heritability coefficient was found to be equal to twice the correlation coefficient between mothers and daughters ($h^2 = 2rM/F$). To determine the significant difference in the data, the Student's test (t -test) was used. Statistical data processing

was carried out in a computer application Microsoft Office Excel 2010.

RESULTS AND DISCUSSIONS

The results of assessing milk productivity and quality indicators of milk of mothers and their daughters - first-heifer cows of local breeding, depending on their origin, are shown in Table 1.

Table 1. Comparative assessment of milk productivity for 305 days of the 1st lactation of daughters and their mothers, depending on the origin, ($X \pm Sx$)

Mothers			Daughters			\pm in% to mothers		
Milk yield kg	Fat		Milk yield, kg	Fat		Milk yield, kg	Fat	
	%	kg		%	kg		%	kg
German breeding								
7239 \pm 195.5	3.73 \pm 0.04	273 \pm 6.7	8479 \pm 98.8***	3.84 \pm 0.03	323 \pm 5.5***	+1240	+0.11	+50
Dutch breeding								
7842 \pm 212.7	3.62 \pm 0.05	284 \pm 8.2	8372 \pm 69.5*	3.82 \pm 0.02	314 \pm 3.6**	+530	+0.2	+30

Note: * - $P < 0.005$; ** - $P < 0.01$; *** - $P < 0.001$

The analysis of the obtained results showed a significant advantage in milk yield of daughters on average for the first lactation over mothers. The milk yield of daughters, on average, exceeded the milk yield of mothers for 305 days of lactation by 530 and 1240 kg of milk of Dutch and German breeding respectively, with $P < 0.001$. The data obtained by us are confirmed in the studies of Bakai & Lepekhina (2016), Latysheva (2018), Tekeev (2014), where cows-daughters exceeded cows-mothers in milk yield for the first lactation. The results of the studies by Poslavskaya (2016) showed a significant superiority of daughters over mothers in terms of the amount of milk produced and the amount of milk fat.

Regarding the fat content of the compared animals, it should be noted that all daughters in

terms of fat content in milk exceeded the requirements of the standard by + 0.24% (German breeding) and + 0.22% (Dutch breeding). In terms of the amount of milk fat, the daughters of German breeding exceeded mothers by 50 kg ($P < 0.001$), daughters of the Dutch breeding by - 30 kg ($P < 0.01$).

An analysis of the selection and genetic parameters of economically useful traits of mothers and daughters of various origins showed that the highest coefficient of variability in milk yield for the first lactation was at mothers and daughters of German breeding, which is by 0.3 and 1.7 percent more, respectively, than at mothers and daughters of Dutch breeding (Table 2).

Table 2. Comparative assessment of the coefficient of variability of indicators of milk production mother-daughter (%)

Indicators		Milk yield	Fat content	Fat amount
German breeding	mothers	13.0	4.7	11.7
	daughters	5.6	3.5	8.2
Dutch breeding	mothers	12.7	5.7	12.9
	daughters	3.9	2.4	5.3

The coefficient of variability in terms of the content and amount of fat was higher at the daughters of German breeding, respectively, by 1.1 and 2.9 percent.

On average for the sample, the coefficients of variability for all analyzed indicators are lower

compared to the literature data, with the exception of the coefficient of variability of mothers of Dutch breeding in terms of fat content (5.7%).

Thus, the low value of the coefficient of variability for all analysed characteristics of

mothers and daughters of different origins indicates a small range of variability and a decrease in the genetic diversity of this livestock population. The results of the realization of the genetic potential in terms of milk production

indicators by first- heifers - daughters of local breeding are shown in Table 3, for which the parental index of mothers cows (PIC) was calculated.

Table 3. Realization of genetic potential by daughters of local breeding of various origins

Indicators		Dutch breeding	German breeding
Parental index of mothers cows (PIC)	Milk yield, kg	9154±121.3	9203±116.4
	fat, %	4.06±0.03	3.92±0.04
Daughters Own productivity	Milk yield, kg	8372±69.5	8479±98.8
	fat, %	3.82±0.02	3.84±0.03
Realization of genetic potential (RGP), %	Milk yield	91.4	92.1
	fat	94.1	97.9

As it can be seen from the data in Table 3, the parental index of mothers (PIC) in terms of milk yield was the highest at German-bred mothers - 9203 kg, which is by 49 kg of milk more than the parental index of Dutch-bred mothers, the difference is insignificant.

Realization of the genetic potential (RGP) of first- heifers - daughters of both breeding was quite high - 91.4% (Dutch breeding) and 92.1% (German breeding), in general, according to the analysed traits, it is observed some superiority of the daughters of German breeding over their peers of the Dutch breeding.

The quality of animal evaluation and selection is influenced by the relationship between traits of milk production. It is known that the correlation between the milk yield and the fat content in milk depends on many factors, including the breed or belonging of animals to a particular breeding. As a result of studying the relationship between milk yield and fat content in milk at the offspring of local generation of various origins, a weak positive relationship ($r = +0.069$) was found at first- heifers of German breeding and a weak negative relationship ($r = -0.186$) at first- heifers of Dutch breeding (Table 4).

Table 4. Correlations between the main characteristics of the productivity of daughters - descendants of the local generation of various origins, $r \pm \text{mr}$

Origin of first- heifers	Indicators				
	Milk yield - Fat content	Milk yield - the amount of fat	Milk yield - Live weight	Live weight - Fat content	Live weight - amount of Fat
German breeding	+0.069±0.22	+0.768±0.14***	-0.161±0.21	-0.437±0.20	-0.396±0.20
Dutch breeding	-0.186±0.22	+0.366±0.21	+0.043±0.22	-0.267±0.21	-0.108±0.22

Note *** - $P < 0.001$

The relationship between milk yield and the amount of milk fat at the descendants of German breeding is positive, the tightness of the relationship is high ($r = +0.768$), which is significantly greater at $P < 0.001$ than at the descendants of the Dutch breeding - the tightness of the relationship is moderate ($r = +0.366$).

On the high indices of correlation between milk yield and the amount of fat in milk ($r = +0.94$) and ($r = +0.91$), when studying the milk productivity of the Holstein breed, was also indicated in the work of Carabano et al., (1989). With a high live weight of the offspring of both German breeding (606 kg) and Dutch breeding (611 kg), a weak negative relationship ($r = -0.161$)

and a weak positive ($r = +0.043$), respectively, was established. This indicates that a further increase in the live weight of cows can lead to a decrease in their milk yield. Therefore, the main attention in the selection should be paid to the amount of milk yield while maintaining sufficient parameters for live weight.

Correlation relationships between live weight and fat content in milk and live weight and milk fat are negative at the entire analysed livestock of first- heifers of both breeds, however, the closeness of the relationship for animals of Dutch breeding is weak, for animals of German breeding - moderate.

Assessment of the genotype for productive qualities is inextricably linked with the

determination of the heritability of traits. Therefore, to assess the indicators of heritability of traits, it was used the method of heritability of

traits, it was used the method of correlating traits of daughters (descendants of local breeding) with their mothers (Table 5).

Table 5. Correlations between the main features of productivity of daughters and mothers of different origins, $r \pm mr$

Indicators	Number of animals: mothers - daughters, n	Milk yield, kg	Fat content, %	Fat amount, kg
Mothers- daughters (NL)	20-22	+0.224±0.15	+0.066±0.15	-0.036±0.15
Mothers- daughters (DE)	23-23	-0.465±0.14***	+0.057±0.16	-0.087±0.16

Note: *** - $P < 0.001$

A positive correlation coefficient of milk yield for 305 days of lactation was revealed between mothers and daughters of the Dutch breeding, the tightness of the relationship is weak (+0.224). A negative correlation in milk yield for 305 days of lactation (-0.465) was found between mothers and daughters of German breeding, the closeness of the relationship is moderate, which confirms the superiority of daughters in milk yield for the first lactation. A weak positive correlation was found for the fat content in milk between mothers and daughters of both breeds. It should be noted that there is a

negative correlation in the amount of milk fat at mothers-daughters of both breeds, the tightness of the relationship is weak.

As a comparative analysis between mothers and daughters of Dutch and German breeding in terms of the correlation coefficient (milk yield per 305 days of lactation) is revealed a significant difference (-0.241) at $P < 0.001$.

Heritability indicator was studied by us by the double correlation method (mother-daughter), that is, the degree of inheritance of traits from the mother (Table 6).

Table 6. Heritability (h^2) of productivity traits (mother-daughter) of the Holstein breed of different breeding for 305 days of lactation, %

Indicators	Dutch breeding		German breeding	
	Number of animals: mothers - daughter, n	$h^2=2r_{m/d}$	Number of animals: mothers - daughter, n	$h^2=2r_{m/d}$
By milk yield	42	44.8	46	93.0
By fat content in milk	42	13.2	46	11.4
By the amount of milk fat	42	7.2	46	17.4

It should be noted that a high degree of heritability was revealed in terms of milk yield for the first lactation (mother-daughter) of German breeding, which amounted to 93.0%. To our opinion this is due to the fact that over the past few decades in Germany, breeding work has been carried out to combine high milk yield and high fat and protein content in milk.

As for the Dutch breeding cows, this index is two times lower - within 44.8%. Heritability coefficients (h^2) of fat in milk and the amount of milk fat are lower than the literature data. According to the literature (Ruzsky, 1977), in different populations, the coefficient of heritability (h^2) of the fat content in milk and the amount of milk fat are higher and vary between 17-70 and 45-70.

Thus, the results obtained testify to the observance of the technology of growing, feeding and keeping cattle on the JSC farm "Aydın" in all

age periods of animals. Further study of the degree of influence of the heritability coefficient will be continued after the daughters finish the second and subsequent lactations, which is of certain importance for predicting selection and breeding work for a relatively large population of livestock.

CONCLUSIONS

The established negative relationship between the fat content in milk and the milk yield of mothers and daughters (descendants of the first local generation) indicates that further selection for milk yield in the J-SC "Aydın" must be carried out taking into account the fat content of milk.

Low correlation coefficients between milk yield and live weight (positive - German breeding and offspring of the first generation) and (negative -

Dutch breeding) indicate a non-linear nature of the relationship between them, and characterize the homogeneity of the herd of J-SC "Aydn" by live weight.

The study of the relationship between milk productivity, fat content in milk, amount of milk fat, milk yield and live weight at first- heifers of local generation made it possible to establish correlation coefficients of positive and negative directions of different strength.

The obtained results of studies of the coefficients of correlation and heritability of the main breeding traits, the correlation between the milk production of daughters and their mothers of the Holstein breed of various origins, should be used in the selection and assortment of animals and in the long-term planning of breeding programs of the herd of J-SC "Aydn".

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