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PRODUCTIVITY DYNAMICS AND RELATIONSHIP BETWEEN QUANTITATIVE AND QUALITATIVE INDICATORS IN COWS OF THE HOLSTEIN BREED

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ABSTRACT

The article presents the results of a study of the milk productivity of Holstein cows in the dynamics of lactations, correlation between the level of milk yield, fat content, and the amount of milk fat, live weight and milk ratio. The studies were carried out in the herd of the breeding farm of SLL (Society of limited liability), „Doksancom" on Holstein cows in the dynamics of 4 lactations. A comparative analysis of the yield of cows in the dynamics of lactations showed that during the second lactation, milk productivity was 934 kg of milk, the third - 959 kg of milk, the fourth - 1527 kg of milk more than in the first lactation, the difference being significant at $P < 0.01$, $P < 0.05$ and $P < 0.001$, respectively. The lactation curve of all analyzed cows of the Holstein breed of the herd of SLL „Doksancom" changed with a certain regularity and had a leveled character, characterized by a high stable type. The relationship between milk yield and the percentage of fat in milk of cows of first-fourth lactation was in negative correlation from weak (-0.187, second lactation), moderate (-0.338 – -0.486, first-fourth lactation) to noticeable (-0.557, third lactation). A negative correlation in the entire analyzed animal population was found between milk ratio and live weight, ranging from mild -0.018 to moderate -0.334. This will allow further selection of highly productive cows in the herd with an optimal live weight for the Holstein breed.

Key words: *milk productivity, fat content, lactation, live weight, correlation*.

INTRODUCTION

In modern conditions, one of the priorities is to increase the productivity of cattle, and not the increase of their number. Industrial production of milk requires a certain concentration of animals on farms, its narrow specialization, a high level of mechanization and automation of animal services. At the same time, a great attention is paid not only to production technology, but also to the quality of the livestock used for production (Gorelik *et al.*, 2014). In the dairy cattle breeding of

the developed countries of the world, the leading place is occupied by the highly productive Holstein breed. The determining factor in the qualitative transformation of cattle breeding in the Republic of Moldova is the further development of livestock breeding, the presence of highly productive dairy cattle, adapted to modern technologies, climatic and feed conditions of the republic, as well as improving the food supply and the creation of advanced technologies for keeping animals. For the last ten years, the Holstein breed of cattle began to be imported into the republic of the Dutch, German, French and other breeding, as well as cattle of a double direction of productivity - Simmental breed. As it is known, the milk productivity of cows is an important economically useful sign, one of the main indicators of animal husbandry. As a biological feature, it fluctuates depending on a number of factors, such as: season of the year, lactation in a row, membership in genealogical lines, generation and types. When breeding cows of dairy breeds and especially Holstein breed, it is taken into account the complex of economically useful traits, it is paid attention to the productivity and quality of milk - milk fat and protein milk. Thus, under optimal feeding and keeping conditions, milk yield of Holstein cows in the breeding herd of SLL "Doksancom" amounted to 8980 kg of milk (first lactation), 10082 kg (second lactation) and 10530 kg (third lactation) milk per lactation (Foksha and Konstandoglo, 2019). The realization of the genetic potential for milk production was higher for the third lactation and amounted to 108.3%, which is on average by 7.1% more than at the animals of the first two lactations. Milk productivity of cows is the result of the interaction of a complex of physiological processes of the body, which are controlled by many gene systems and determine the hereditary status of the breed. The study of the relationship between economic and useful traits has a great importance for breeding and pedigree work, as these dependencies can be used in the selection of animals of the desired types in the process of creation (Nicoro *et al*., 1968). In most cases, according to Belyaev (1966), correlations between characters arise on the basis of the pleiotropic effect of not one, but many genes that make up the gene systems that have developed during the evolution of animal species and breeds. Therefore, depending on the genotypes of individuals, the selection of pairs, changes are observed in the correlation between the characters. Correlations due to the pleiotropic effects of genes are called genetic correlations, and all other cases of correlations are called phenotypic correlations. The relationship between the signs is measured by the correlation coefficient, while the correlation is observed between both quantitative and qualitative signs (Stenkin and Mulyanov, 2014; Abrompolsky and Abylkasymov, 2005; Gaidukova and Tyutyunikov, 2013). In dairy cattle breeding, the most important is the identification of the nature and magnitude of correlation between the level of milk yield and the mass fraction of fat in milk. The correlation between milk yield and the mass fraction of fat and protein in milk is usually negative (Ruzsky, 1982; Osipenko *et al*., 1985; Yeghiazaryan and Braginets, 2010; Smith and Omoas, 1984; Sonderegger, 1986; Vleck, 1985; Abrompolsky and Abylkasymov, 2005). Therefore, in each individual case, it is necessary to determine the form, direction and degree of correlation

(Dautbaev, 1995; Egiazaryan and Braginets, 2010; Stenkin and Mulyanov, 2014). The data of many scientists confirm the positive relationship between milk productivity and live weight, and the fact that bigger animals have greater milk productivity (Kutrovsky, 2006, 2007; Brilling, 1985; Ratheises, 1972). According to many scientists and practitioners of livestock science, the relationship between milk yield, qualitative indicators of milk with age is positive (Shmeleva and Basonov, 2014; Wilver, 2015).

The aim of our research is to study the milk productivity of Holstein cows in the dynamics of lactation, the correlation between the level of milk yield, fat content, and the amount of milk fat, live weight and milk ratio.

MATERIAL AND METHODS

The studies were carried out in the herd of the SLL "Doksancom" breeding farm on Holstein cows imported from Holland. The main data on the milk production of animals were taken from forms of zootechnical and pedigree accounting. All the analyzed number of cows was kept in optimal conditions of feeding and keeping in accordance with the basic zootechnical and hygiene requirements. Were used zootechnical research methods with biometric processing of materials by the method of variation statistics according to Plohinsky (1978) and Merkurieva (1983): arithmetic mean (X), arithmetic mean error (Sx), coefficient of variability (Cv), correlation coefficient (r) and correlation coefficient error (m). Lactation curves of cows were constructed, and was calculated the milk coefficient (MC) proposed by Startsev (1965) using the formula: MC = MY / LW, where MC is the milk coefficient, kg; Y- milk yield for 305 days of lactation, kg; LW - live weight, kg. The relationship between milk productivity indicators and milk quality, live weight was determined by calculating the correlation coefficient using Microsoft Excel, the reliability of the indicators was determined by Student.

RESULTS AND DISCUSSION

Indicators of milk productivity, fat content in the milk of cows of the breeding farm of SLL "Doksancom" in the dynamics of four lactations are presented in Table 1.

Table 1. The dynamics of milk production of cows' of SLL "Doksancom" (X ± Sx)

Indicators	Lactation			
	first	second	third	fourth
The number of cows, n	117	65	38	26
Live weight, kg	632±3.4	667±3.6	692±2.9	685±2.8***
Milk yield, kg	10159±142	11093±302.6**	11118±378*	11686±425***
Cv	15.2	21.9	20.9	18.6
Fat, %	3.90±0.01	3.9±0.01	3.85±0.02	3.85±0.02
Fat, kg	393±5.5	429.4±11.5	426.5±13.2	432±22.3
Cv	15,2	21.5	19.2	26.3
Milking ratio, kg	1612±24	1665±45.2	1593±56.2	1705±61.7
Cv	16.0	21.9	21.7	18.5

Note: * P <0.05; ** P <0.01; *** P <0.001

It was established that cows in the first lactation had milk productivity at the level of 90.5% of full-aged cows (at a rate of 70-75%), which averaged 11217 kg of milk with a fat content of 3.87%. A comparative analysis of the yield of cows in the dynamics of lactations showed that during the second lactation, milk productivity was by 934 kg of milk, the third - by 959 kg of milk, the fourth - by 1527 kg of milk more than in the first lactation, the difference is significant at P <0.01, P <0.05 and P <0.001, respectively, second - fourth lactations. Studies have shown that cow yields increase with increasing live weight and a maximum milk yield - 11686 kg or 109% of the average is obtained with a live weight of 685 kg. Cows of fourth lactation in live weight exceeded the data obtained on average (657 kg) for the analyzed animal population by 28 kg, the difference was significant (P <0.001). The number of kilograms of milk received per 100 kg of live weight (milk yield coefficient) in the entire analyzed number of cows exceeds the norm, (the norm is up to 1000 kg). The highest milk ratios have the cows of the fourth lactation – 1705 kg of milk, the average for the sample - 1632 kg of milk. Relatively high indicators of milk ratio indicate the level of their productivity and express of the milk type. By the analysis of the variability of signs was established that the greatest variability at a positive correlation is observed between milk yield and the amount of milk fat, live weight and the amount of milk fat (Cv = 26.3; fourth lactation), also at a high positive correlation between milk yield and milk coefficient, between the amount of milk fat and milk coefficient (Cv from 16.0 to 21.9). Consequently, the highest coefficients of variability are noted for milk yield, milk fat and live weight. As it is known, the milk productivity of cows during lactation is subjected to significant fluctuations. After calving, the daily milk yield of cows' increases, reaching a maximum at 2–3 months of lactation, then gradually decreases (Katmakov, 2004), this process is graphically reflected by the lactation curve. The nature of the lactation curve depends on the maximum daily milk yield, the subsequent degree of its decrease and the duration of lactation. High yielding cows within each breed are characterized by a large increase in productivity in the second or third month of lactation and its slow decrease in the subsequent. The change in milk yield at highly productive cows of the herd of the SLL "Doksancom" is shown in the following figures of the lactation curves, Figures 1-4.

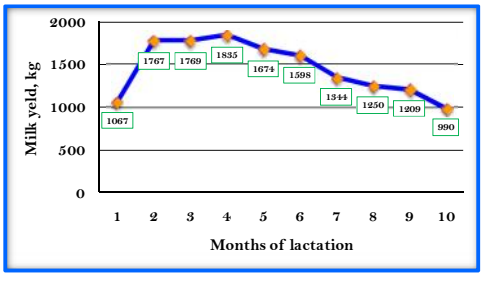

Figure 1. Lactation curve of the cow no 7320, fourth lactation, milk yield 14513 kg of milk

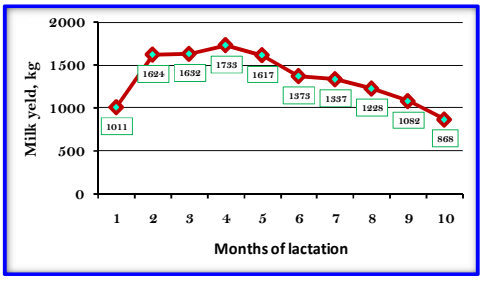

Figure 2. Lactation curve cow no 7582, third lactation, milk yield 13422 kg of milk

As it is seen from the figures, at cows no 7320 and no 7582 the lactation curve rises by the 2nd month of lactation and within 2-3 months of lactation stabilizes, by the fourth month rises to the peak of lactation. Then it gradually decreases until the end of lactation by an average of 9.6% with fluctuations from 4.5 to 18.1% (no. 7320) and by 10.6% with fluctuations from 6.6 to 19.8% (no 7582).

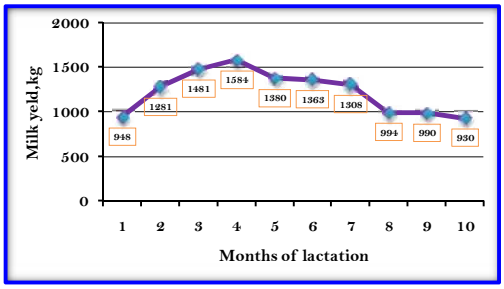

Figure 3. Lactation curve cow no 1667, fourth lactation, milk yield 12556 kg of milk

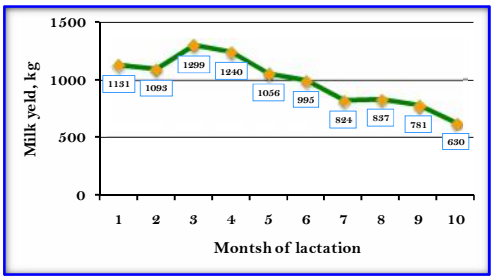

Figure 4. Lactation curve cow no 2967, first lactation, milk yield 9886 kg of milk

At cow no 1667 from the first to 4 months lactation takes place a gradual increase in the average monthly milk yield, the peak of the lactation curve falls on 4 month of lactation, then over the next months the curve gradually and smoothly decreases until the end of lactation. The lactation curve of cow no 2967 is somewhat different from the rest in that the average monthly milk yield for the second month of lactation is slightly less (by 38 kg) of the first month of lactation. The peak lactation occurs in the third month, followed by a gradual decrease until the end of lactation. It should be noted that the results of our studies are consistent with the data (Nekrasov *et al*., 2011), which also recorded the maximum average monthly milk yield for 2-3-4 months of lactation and the conclusion (Devyatov, 1983; Aldrich, 1987) that the lactation curve, regardless of productivity, has a certain optimal form with balanced feeding.

Thus, the lactation curve at all analyzed cows of the Holstein breed of the herd of SLL "Doksancom" changes with a certain regularity and has a leveled character, characterized by a high stable type, which is characteristic to animals with a strong constitution, having high milk productivity.

Of great importance in breeding work with dairy cattle has the correlation between economically useful signs. For example, the variability of the mass fraction and amount of fat in milk, as well as live weight, depend on the variability of cows' milk yield per lactation. The results of studying of the correlation between productivity indicators in herd of SLL "Doksancom" are shown in Table. 2.

The relationship between milk yield and the percentage of fat in milk of cows of the first-fourth lactation was in negative correlation from weak (-0.187, second lactation), moderate (-0.338 – -0.486, first-fourth lactation), to a noticeable one (-0.557, third lactation).

Table 2. Correlation between productivity indicators, live weight, r ± m

No	Correlated sign	first lactation	second lactation	third lactation	fourth lactation
1.	milk yield – fat, %	-0,338±0,08	-0,187±0,12	-0,557±0,14	-0,486±0,14
2.	milk yield – fat, kg	+0,891±0,02	+0,981±0,02***	+0,982±0,03*	0,721±0,02
3.	live weight – milk yield	+0,044±0,09	+0,049±0,12	-0,093±0,16	+0,089±0,2
4.	live weight – fat, %	+0,06±0,09	-0,197±0,12	+0,156±0,16	+0,109±0,2
5.	live weight – fat, kg	+0,03±0,09	+0,020±0,12	-0,065±0,16	+0,071±0,2

Note: *** P <0.001

As it is seen, unilateral selection by the level of milk yield led to an increase of the negative relationship between these signs. The presence of a negative relationship between the level of milk yield and fat content in milk makes it difficult to conduct a successful selection and indicates the need for simultaneous selection for milk yield and fat content in milk. It should be noted a high correlation between the signs of milk yield - the amount of milk fat, which in the first lactation is +0.891, second – +0.981, third – +0.982 and the fourth lactation – +0.721. By a comparative analysis of the results of the relationship between milk yield and the amount of milk fat is established a high reliable positive relationship between the second and the first (P <0.001), between the third and first lactations (P <0.05). As a result of studying the correlation between the live weight of cows and their milk productivity, a weak positive relationship was revealed for the first (+0.044), second (+0.049) and fourth (+0.089) lactations, and a weak negative (-0.093) – for the third lactation. Low correlation coefficients between milk yield for all lactations and live weight indicate the non-linear nature of the relationships between them, which characterizes the herd's uniformity in live weight. The correlation between live weight and percentage of fat, as well as the amount of milk fat was mainly positive, weakly expressed. An exception is the revealed negative relationship between live weight and the percentage of fat (-0.197) at cows of second lactation and between live weight and the amount of milk fat (-0.065) – cows of third lactation. The data of the results of studying the correlation between the milk coefficient and productivity indicators are given in Table 3. As it can be seen, the correlation between milk yield and milk ratio was positive and very high with fluctuations in lactation from 0.905 to 0.994.

Table 3. The correlation between the coefficient of milk and productivity indicators, r ± m

No	Correlated sign	first lactation	second lactation	third lactation	fourth lactation
1.	milk ratio – milk yield	+0,905±0,01	+0,980±0,01	+0,963±0,04	+0,994±0,02
2.	milk ratio – fat, %	-0,149±0,09	-0,145±0,12	-0,598±0,13**	-0,502±0,17
3.	milk ratio – fat, кg	+0,812±0,03	+0,972±0,03	+0,932±0,06	0,717±0,14
4.	milk ratio – live weight	-0,334 ±0,03	-0,148±0,12	-0,194±0,16	-0,018±0,2

Note: ** P <0.01

As it can be seen, the correlation between the mass fraction of fat and the milk ratio is negative: weak (-0.149; -0.145) – first and second, noticeable (-0.598; -0.502) - third and fourth lactations, respectively. It is noticed a significant difference between the third and the second (-0.598), third and first lactations (-0.598) at P <0.01. Therefore, selection aimed at creating a highly productive herd of Holstein cattle at SLL "Doksancom" has led to a decrease in the milk fat content of cows. The correlation between the amount of milk fat and the milk ratio is high positive (+0.717, +0.812) – fourth and first lactations and very high - (+0972, +0.932) - second and third lactations, respectively. A negative correlation was found between the coefficient of milk yield and live weight in the entire analyzed animal population, which varies from weak -0.018 (fourth lactation) – -0.194 (third lactation), to moderate – -0.334 (first lactation). This will allow further selection of highly productive cows in the herd with the optimal live weight for the Holstein breed. Thus, the established negative relationship between the mass fraction of fat and milk yield, the mass fraction of fat and the milk ratio indicates that further selection according to one of these characteristics in the herd of SLL "Doksancom" must be carried out taking into account the other.

CONCLUSIONS

The milk productivity of the cows of the herd of SLL "Doksancom" for the second lactation was by 934 kg of milk, the third was by 959 kg of milk, the fourth was by 1527 kg of milk more than for the first lactation, the difference was significant at P <0.01, P < 0.05 and P <0.001, respectively. Relatively high indicators of milk ratio indicate the level of productivity of cows and the express of the milk type. Cows of the fourth lactation have the highest milk yield coefficient - 1704.8 kg of milk, and the average milk yield coefficient in the sample was 1632 kg of milk. The lactation curve of the Holstein cows of the herd of SLL "Doksancom" changes with a certain regularity and has a leveled character, characterized by a high stable type. Low correlation coefficients between milk yield for all lactations and live weight indicate the non-linear nature of the relationships between them, which characterizes the homogeneity of the herd of SLL "Doksancom" by live weight.

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