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THE USE OF DAIRY COWS OF FRENCH BREEDING IN THE CONDITIONS OF UKRAINE

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Abstract

The study of milk productivity of French Holstein and Montbéliard breeds is regarded in the article, the uniformity of lactation is investigated, the lactation activity is assessed, as well as the cows are evaluated by the shape of their udder. The obtained results make it possible to affirm that the breed affects the production efficiency and the quality indicators of milk from cows of different French breeds, which are used in Ukraine. The cows of Holstein breed have a uniform course of lactation, high and constant productivity in terms of lactations and the better milk yield, but their milk quality indicators are inferior to those in the cows of Montbéliard breed. The cows of Montbéliard breed have a constant productivity and a uniform flow of lactation, they give high milk yield immediately after calving, but later they rapidly decrease productivity.

***Key words**: productivity, breed, lactation, milk yield, fat, protein, Montbéliard breed, Holstein breed.*

INTRODUCTION

The factors determining milk productivity include breed, type of livestock, feeding, keeping, milking technique, age, body weight, dry period and calving interval (Basovsky et al., 2001; Piddubna & Pelekhaty, 2012).
The cattle breed is the main factor affecting milk yield, its composition, physicochemical and technical properties of milk. Changes in the milk composition of the same breed cows are explained by hereditary factors, as well as by different housing conditions (Grymak et al., 2020). Since only the ability to produce a certain amount of milk with an approximately constant composition (milk yield) is inherited, the conditions for keeping cows are of great importance for its realization (Mashkin & Parish, 2006).
One of the main characteristics in the breeding of dairy cows is their dairy productivity, exterior constitutional features and reproductive qualities. The breeding work should be carried out on the selection of cows of a strong type of constitution, which, according to the main characteristics, is the most consistent with the desired. This will increase the milk productivity of livestock and will not lead to a decrease in their reproductive ability (Mashkin & Parish, 2006; Oltenacu & Broom, 2010).
Modern breeding programs should be aimed at the genetic improvement of production characteristics such as milk yield, growth rate, live weight and reproductive function. At the same time, an increase in milk yield should not be accompanied by a decrease in fertility, an increase in limb diseases, metabolism and a decrease in life expectancy. Therefore, these programs are often developed on the basis of the breeds of the world's best gene pool: Holstein, Simmental, Montbéliard, Charolais and others (Oltenacu, & Broom, 2010; VanRaden & Cole, 2000; Uzun & Koç, 2019).
Tellah et al. (2019) investigated the influence of the genotype of breeding bulls of Holstein, Montbeliard and Jersey (Holstein, Montbéliard and Jersey) breeds on improving the milk productivity of local breeds (Kuri and Bokolodji). The analysis of productivity of the dairy herd showed that the amount of produced milk varied depending on the genotype of the crossbred cows. Crossbreeds of Holstein, Montbéliard and Jersey bulls with local breeds (Kuri and Bokolodji) are more favorable for increasing milk yield, but reproductive

indicators (age of first calving and calving interval) must be taken into account.

Getu et al. (2016) dealt with the problems of crossing and its impact on the productivity of native dairy cattle. The studies have shown that when using bulls of the Holstein breed, the indicators of milk productivity (both in quantity and quality), as well as functional conformational signs of the exterior have been significantly improved; the type of body structure has become more consistent with the dairy type.

Holstein, Dutch, Montbéliard cattle, Jersey, Charolais and other breeds are promising for improving milk productivity, body structure, lactation characteristics, milk quality, morphological and functional characteristics of the udder, milk yield depending on the cow's level of development and live weight, as well as the age of its first insemination and calving (Mirulugovna, 2020; Bensaha & Arbouche, 2014; Vallée-Dassonneville, 2017; Vitorino and others, 2017; Tawah et al., 1999).

The Holstein-Friesian breed dominates in the dairy sector, although there is a general concern that these cows may not be well adapted to certain climatic conditions and livestock farming technologies. Rodríguez Bermúdez et al. (2019) compared the reproductive ability of the Holstein-Friesian breed in different livestock management systems, as well as with other breeds and crosses having been used. The obtained results give grounds to assert that the reproductive ability of the Holstein-Friesian breed is limited not by the technology of management, but by the manifestation of estrus, which is less pronounced in Holstein than in other breeds. Therefore, the reproductive breeding and proper management of estrus detection will improve the reproductive indicators in the cows of Holstein-Friesian breed.

The Montbéliard breed is a part of the Simmental breed and is very widely used to improve the productive, reproductive and technological qualities, as well as the harmonious body structure of cows. The Montbéliard breed spread from France to other European countries, especially Switzerland, Romania, Bulgaria, Moldova and Poland (Vidu et al., 2011; Ponsart et al., 2014).

Over the past 40 years, the milk productivity of cows has significantly increased due to the use of breeds of world leaders in the milk production. Different foreign breeds are also widely used for intensive livestock farming in Ukraine. Therefore, the aim of our study is to analyze the main indicators of milk productivity in the cows of different French breeds, which are used in Ukraine.

MATERIALS AND METHODS

The production facilities of the enterprise are located in the village of Mukhovtsy of Nemirov district, Vinnytsia region. The enterprise has a fully completed production cycle of dairy products: its own arable land for growing feed, the specialized equipment for harvesting a forage base, modern premises for keeping cows, a milking parlor equipped with a milking complex, as well as the modern equipment for storing, cooling and processing milk.

All equipment for the farm and dairy plant was purchased in Germany and Israel; the genetic material for breeding dairy cows was imported from France. The cows on the farm are kept unleashed, with free access to feed, water, and walking areas.

In order to conduct the research, experimental groups from Holstein cows (n = 40) and Montbéliard cows (n = 34) were formed.

The data on milk productivity of cows, including milk yield per lactation, the average daily milk yield, the fat content in milk, the amount of milk fat, the protein content, the amount of milk protein and live weight were used as the material for the study.

The research used methods generally accepted in zootechnics, while the methods of variation statistics were used for biometric data processing (Basovsky et al., 2001; Lakin, 1990).

In order to assess the lactation curve, the following indices were determined: (Orikhivskyi et al., 2019).

The first way - according to the formula of H. Turner:

$$ILC_1 = \frac{C}{D},$$

where:

ILC_1 is the index of lactation constancy;

C - milk yield per lactation, kg;

D - the highest milk yield per month, kg.

The second way - according to the formula of I. Johansen and A. Hansson:

$$ILC_2 = \frac{a \times 100}{в},$$

where:

ILC2 is the index of lactation constancy;

a - milk yield from the 101st to the 200th day of lactation, kg;

c - milk yield from the 1st to the 100th day of lactation, kg.

The third way is the index of milk yield decline up to 7 months:

$$IYD = \frac{a}{B} \times 100,$$

where:

IYD is the index of milk yield decline up to 7 months;

a - actual milk yield for the first 7 months, kg;

B - total milk yield per lactation.

RESULTS AND DISCUSSIONS

In an unstable economic environment, when restructuring dairy farms, the choice of cattle for breeding can determine the economic effect of running the industry and become a big problem. Since each breed reacts in its own way to the process of adaptation to certain environmental conditions, fodder resources and the technology of animal husbandry.

The Holstein cows of various breeding occupy the main segment for milk production in Ukraine, but French breeding cows have been studied rather poorly. In recent years, other foreign breeds of dairy production have also begun to be used. There is practically no data on the use of Montbéliard breed in Ukraine, which aroused our interest in this study.

Milk productivity in the cows of different French breeds. Studies have determined that the average milk yield per lactation in the herd of Holstein cows was 7662 kg, which significantly (P<0.001) exceeded the milk yield of Montbéliard cows by 13.2% (Table 1).

The cows of Holstein breed also reliably (P<0.05-0.001) dominated the animals of Montbéliard breed in terms of milk yield for the first, second, third and older lactations by 10.4-15.9%; in terms of the average daily milk yield - by 8.2-23.0%.

The quality indicators of milk in the cows of Montbéliard breed reliably (P<0.05-0.001) dominated those of Holstein breed in terms of the fat content in milk by 0.4% (P<0.001), of the amount of milk fat - by 16.3% (P<0.05-0.001), of the protein content - by 0.1% (P <0.05-0.001) and the milk protein content - by 17.8% (P <0.001).

It was also determined a significant difference between the qualitative indicators of Holstein and Montbéliard cows (P<0.05-0.001) in the first, second, third and older lactations. The difference varied in the fat content within the range of 0.32-0.41%, in the amount of milk fat - 9.0-21.7%, in the protein content - 0.06-0.15% and the amount of milk protein - 16.3-19.9%.

There was no significant difference between the live weight of cows in terms of the average indicator by the herd, except for the indicator of cows of the third lactation and older.

N. Balandraud, C. Mosnier, L. Delaby, F. Dubief et al. (2018) studied the phenotypic differences between Montbéliard and Holstein breeds. In the similar production environment, the Montbéliard cows were found to produce by about 12% less milk than the Holstein cows, but the fat and protein content in their milk was higher.

The age of the first calving in Holstein cows was, on average, by 3 months earlier than in Montbéliard cows, but with a lower reproductive function (the interval between calving was by 25 days longer) and more frequent mastitis.

When analyzing the indicators of characteristics variability (Table 2), it was found that the variation coefficient of milk yield in Holstein cows was 15.8% (high characteristics variability); the coefficient of the average daily milk yield was 16.8% (high characteristics variability); the coefficient of fat content in milk was 3.9% (low characteristics variability); the coefficient of the amount of milk fat was 15.5% (high characteristics variability); the coefficient of protein content was 2.1% (low characteristics variability); the coefficient of the amount of milk protein was 18.9% (high characteristics variability); the coefficient of live weight was 5.2% (medium characteristics variability).

Table 1. Milk productivity in the cows of French breeding, $\overline{X} \pm S\overline{x}$

Indicators	Lactation			
	I	II	III and older	$\overline{X}$ for herd
Holstein breed				
n	9	12	29	40
Milk yield per lactation, kg	6948±185.4	7689±190.5	8350±124.7	7662±163.9
Average daily milk yield, kg	27.8±0.55	39.4±0.89	48.0±0.44	38.3±0.83
Fat content, %	3.69±0.01	3.72±0.01	3.78±0.02	3.73±0.02
Amount of milk fat, kg	265.2±5.45	2.0,8±6.78	325.1±7.65	293.7±7.84
Protein content, %	3.14±0.02	3.24±0.01	3.28±0.01	3.22±0.01
Amount of milk protein, kg	213.1±5.74	229.1±5.99	254.0±6.32	232.1±5.24
Live weight, kg	536±6.78	585±5.90	612±7.23	577.7±6.89
Montbéliard breed				
n	7	6	21	34
Milk yield per lactation, kg	5840±145.8***	6641±173.6***	7479±128.1***	6653±154.7***
Average daily milk yield, kg	25.5±0.63*	32.9±0.78***	39.0±0,80***	32.5±0.78***
Fat content, %	4.01±0.01***	4.13±0.01***	4.16±0.03***	4.10±0.02***
Amount of milk fat, kg	289.1±6.52*	354.0±7.30***	382.0±7.42***	341.7±6.94***
Protein content, %	3.20±0.01*	3.35±0.01***	3.43±0.02***	3.32±0.01***
Amount of milk protein, kg	255.6±6.60***	267.4±6.32***	295.3±5.45***	273.5±6.34***
Live weight, kg	545±5.80	588±4.09	634±6.14*	589±5.35

Note: * P≤0.05, ** P<0.01, *** P<0.001 compared to Holstein breed

Table 2. Indicators of characteristics variability in the dairy cows of French breeding, C_v, %

Indicators	Lactation			
	I	II	III and older	$\overline{X}$ for herd
Holstein breed				
n	9	12	29	40
Milk yield per lactation, kg	12.8	16.4	18.3	17.8
Average daily milk yield, kg	8.2	90.1	12.1	9.6
Fat content, %	2.4	5.5	3.8	3.9
Amount of milk fat, kg	15.0	14.7	16.9	15.5
Protein content, %	1.9	2.8	1,6	2.1
Amount of milk protein, kg	17.3	20.4	18.9	18.9
Live weight, kg	6.0	4.5	5.2	5.2
Montbéliard breed				
n	7	6	21	34
Milk yield per lactation, kg	16,.2	18.6	13.8	16.2
Average daily milk yield, kg	6.6	9.7	8.9	8.4
Fat content, %	1.9	3.4	5.9	3.7.
Amount of milk fat, kg	18.1	12.7	10.1	13.6
Protein content, %	1.8	2.6	4.0	2.8
Amount of milk protein, kg	16.6	17.9	20.5	18.3
Live weight, kg	3.2	5.9	8.0	5.7

The indicator of the variation coefficient of milk yield in the cows of Montbéliard breed was 16.2% (high characteristics variability); the coefficient of the average daily milk yield was 8.4% (medium characteristics variability); the coefficient of fat content in milk was 3.7% (low characteristics variability); the coefficient of the amount of milk fat was 13.6% (medium characteristics variability), the coefficient of protein content was 2.8% (low characteristics variability); the coefficient of the amount of milk protein was 18.3% (high characteristics variability); the coefficient of live weight was 5.7% (medium characteristics variability).

Consequently, the coefficient of variability of milk yield, fat and protein content in milk is not constant and is corrected by the influence of environmental factors, the intensity and type of breeding, as well as by the genetic structure of the herd.

It has been found that the indicators of milk productivity of Holstein cows versus those of Montbéliard cows are characterized by a high degree of phenotypic variability.

The uniformity of lactation in the cows of French breeding. Milk productivity largely depends on the nature of the formation of cows' lactation, the value of the maximum milk yield and the ability to maintain milk yield at a certain level for a long time. The uniformity of lactation is characterized by a coefficient of constancy, which can be determined in various ways (Karateeva & Polishchuk, 2018).

Under the optimal conditions of feeding and keeping cows, daily milk yield in the first months of lactation, as a rule, increases and reaches a maximum in the second month of lactation. Subsequently, milk yield for lactation decreases and the lactation curve falls. But our studies have defined a different intensity of lactation decline and the level of milk yield depends on the breed characteristics of dairy cows (Orikhivskyi et al., 2019).

The studies have determined that the milk yield of Holstein cows was significantly higher (Table 3).

Table 3. Indicators of lactation constancy in the dairy cows of French breeding, $\overline{X} \pm S\overline{x}$

Indicators	Lactation			
	I	II	III and older	$\overline{X}$ for herd
Holstein breed				
n	9	12	29	40
Milk yield per lactation, kg	6948±185.4	7689±190.5	8350±124.7	7662±163.9
Index of lactation constancy according to I. Johansen and A. Hansson, %	91.9±0.95	90.4±1.54	96.3±0.83	90.1±1.84
Index of lactation constancy according to H. Turner, %	7.7±0.25	7.9±0.41	8.2±1.10	7.9±0.83
Index of milk yield decline up to 7 months, %	80.5±1.67	83.4±2.14	88.1±1.85	84.0±1.94
Montbéliard breed				
n	7	6	21	34
Milk yield per lactation, kg	5840±145.8***	6641±173.6***	7479±128.1***	6653±154.7***
Index of lactation constancy according to I. Johansen and A. Hansson, %	92.4±1.12	95.6±1.39*	94.3±1.84	94.1±2.14
Index of lactation constancy according to H. Turner, %	7.5±1.10	7.6±1.82	7.9±0.93	7.7±1.64
Index of milk yield decline up to 7 months, %	82.8±2.51	84.9±1.74	85.9±1.65	84.5±2.10

Note: * P≤0.05, ** P<0.01, *** P<0.001 compared to Holstein breed

There was no significant difference in the groups between the indices of lactation constancy and the decline in milk yield, except for the indicator of the second lactation of Holstein cows.

The data in the Table show that lactation of experimental cows of both breeds is characterized by a high indicator of lactation constancy according to I. Johansen and A. Hanson and H. Turner (90.1 and 94.1%; 7.7 and 7.9%). The index of milk yield decline in Holstein and Montbéliard cows was at the same level.

So, the main indicator characterizing the lactation activity of dairy cattle is the amount of milk received during lactation, and the latter one is due to high milk yields per month and the stability of lactation. The lactation in the cows of Holstein and Montbéliard breeds is characterized by constancy, since the higher are the indices, the more stable is the lactation curve of the cows under study.

Assessment of the cows' lactation activity

Milk productivity of a dairy herd is one of the main indicators characterizing the efficiency of dairy cattle breeding. The optimal internal and external factors of cow productivity directly depend on the dynamics of milk yield during lactation, displayed by the lactation curve. In the production conditions, preference is given to the cows, the yield curve of which gradually increases and decreases evenly, which means that such animals have a high lactation activity. The high and stable lactation curve indicates the cow's ability to withstand a prolonged physiological stress for a long time (Orikhivskyi et al., 2019; Karateeva & Polishchuk, 2018).

But even if these conditions are optimal, the productivity is uneven during lactation. The highest milk yield occurs in the first 2-3 months after the calving of cows, and then begins to gradually decrease until the end of lactation. The period of calving has a significant effect on reducing milk yield.

There are several ways to assess the course of lactation activity, among which the simplest is to graphically depict changes in daily or monthly milk yield.

The study of the lactation curves of Holstein cows shows that the animals had the maximum productivity during the 2nd month of lactation, and then the lactation curve passed with different intensities (Figure 1).

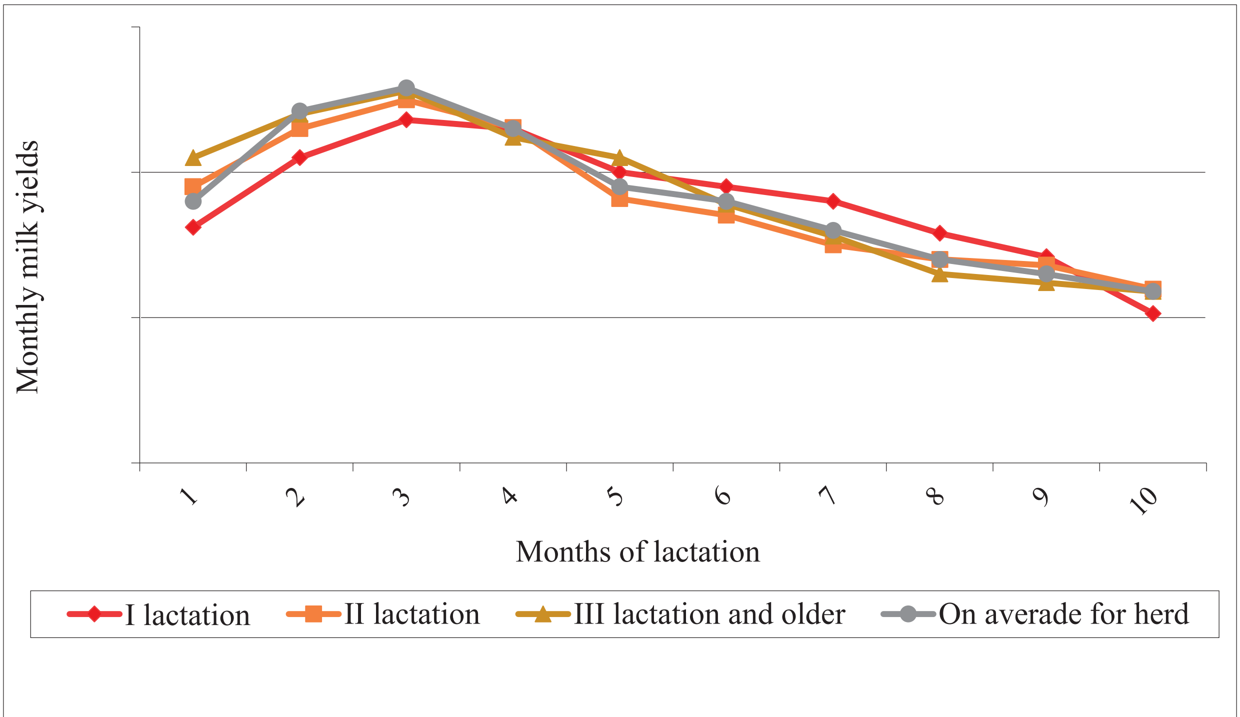

Figure 1. Lactation curves of monthly milk yield in the cows of Holstein breed

At the same time, the cows of the third and older lactations had the highest monthly milk yields; subsequently, they gradually decreased monthly with a rapid fall after the fifth month of lactation. In this case, the animals first increase milk secretion at the expense of a physiological maximum. The lactation curve is characterized by a high index of milk yield decline, which indicates that the conditions of keeping, feeding and using animals of this breed provide the highest productivity. However, in such conditions, the cows of the second lactation reduce productivity with a slightly more intense decline from the third to the fifth month of lactation. On average for a herd of Holstein cows, the curve is characterized by a similar decline from the third to the fifth month of lactation.

The lactation curve of the first lactation cows showed a high milk yield after calving in the second or third month of lactation and was characterized by a stable decrease in milk yield in the following months until the end of lactation.

The milk yield curves in Montbéliard cows were characterized by rapid growth to the peak of lactation with a decrease by certain months and a subsequent gradual decrease until its end (Figure 2).

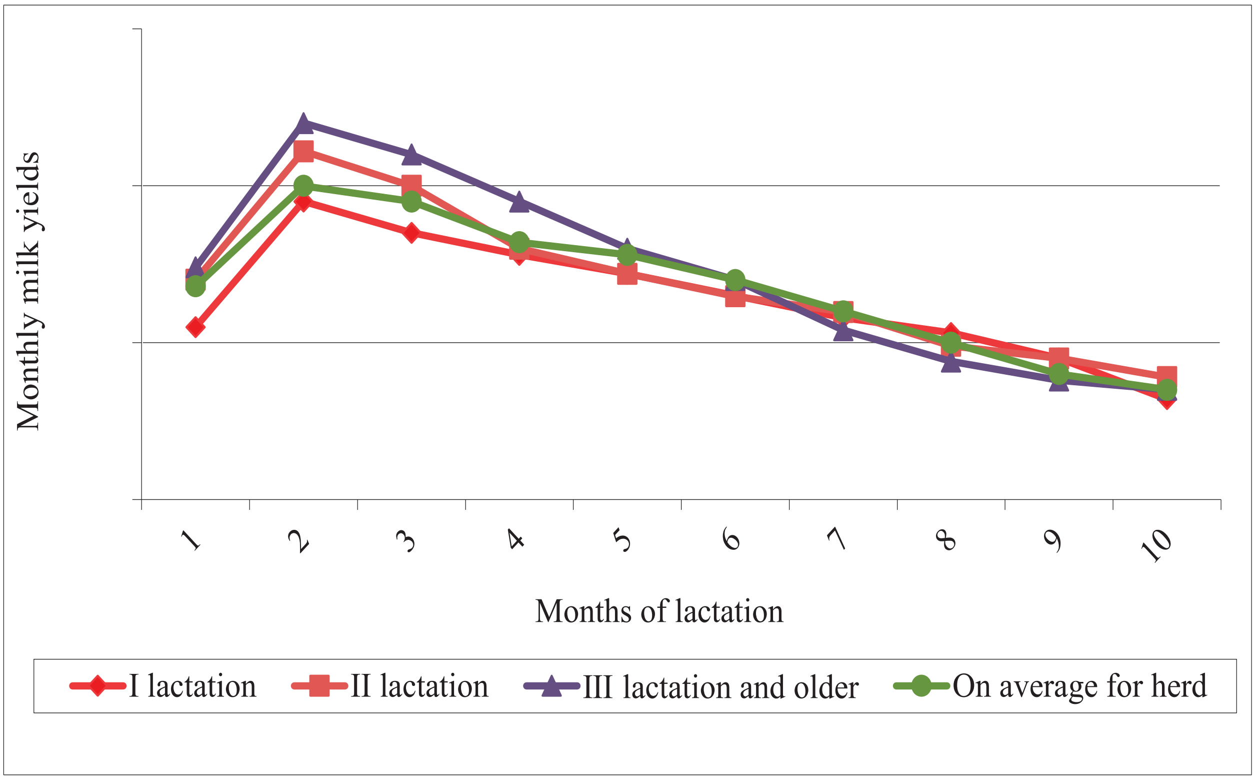

Figure 2. Lactation curves of monthly milk yield in the cows of Montbéliard breed

The lactation curve in the cows of the first lactation increased until the second month of lactation and gradually decreased until its end. The curve in the cows of the third and older lactations increased until the second month and fell rapidly until the fifth; then a gradual decrease was recorded. The second lactation of experimental cows is characterized by a rapid increase in milk yield until the second month of lactation, decreasing to the fourth month; after that a stable decrease in milk yield was observed in the following months until the end of lactation. On average, the herd of Montbéliard cows showed a rapid increase by the second month, a stable decrease until the fourth month of lactation and a gradual decrease until its end.

Consequently, the formation of lactation curves makes it possible to determine a positive or negative effect on the productivity of the breed characteristics of cows. By the course of lactation, the Holstein cows can be attributed to the type of cows with high and constant productivity and a uniform course of lactation, while the Montbéliard breed to those that immediately after calving show high productivity, which subsequently sharply decreases; the lactation curve after a short upward movement quickly decreases.

A number of foreign scientists have also been involved in identifying different forms of the lactation curve for dairy cattle using empirical mathematical models (Macciotta, et al., 2019; Congleton & Everett, 1980; Landete-Castillejos & Gallego, 2000).

The correlation between mathematical characteristics and lactation curve shapes were analyzed by N.P.P. Macciotta, D. Vicario, A. Cappio-Borlino (2005) by selecting several common functions (Wood incomplete gamma, Wilmink's exponential, Ali and Schaeffer's polynomial regression, and fifth-order Legendre polynomials). Among the studied models, the three-parameter models (Wood and Wilmink) corrected the lactation activity better and were able to identify 2 main groups of the curve shape: standard and atypical. The five-parameter models (Ali and Schaeffer's function and Legendre polynomials) were able to recognize more curve shapes. However, each group of curves can be considered as a result of a certain deformation of two main forms, standard or atypical, which become more variable due to the presence of waves in the second half of lactation.

The other authors state that the appearance of curves without peak lactation is mainly the result of a lack of recordings in the early days of lactation (Congleton & Everett, 1980).
T. Landete-Castillejos & L. Gallego (2000) also reported about differences in the ability of models to describe different forms of the lactation curve.

Assessment of dairy cows of French breeding according to the udder shape. The assessment of shape, size and health of the udder in the lactating cows during breeding is of great importance since the minimum body weight is reached earlier than the peak milk yield, and much earlier than the peak feed intake. The genetic breeding for a higher milk yield will result in the cows with lower body weight gain during lactation and therefore the cows that are less well prepared to meet the energy requirements of subsequent lactation. The breeding of cows based on milk production alone will increase the physiological load on the udder and therefore increase the incidence of mastitis (Søndergaard et al., 2002).
A deep and well-attached udder is closely associated with high productivity. The udder must be well attached to support more milk without functional problems. The placement of the teats for mechanical milking should be vertical and their size should be the same to fit the teat cup. Therefore, we were tasked with assessing the shape and size of the udder in the dairy cows of studied groups, as well as their suitability for machine milking technologies.
It was found that among the Holstein cows the majority of animals (70%) had a bath-like udder shape, while the percentage among the Montbéliard breed was 74% (Table 4).

Table 4. Assessment of dairy cows of French breeding according to the udder shape

Indicators	Parameters including the udder shape						
	bath-like			cupped			$\overline{X}$ by herd
	n	%	$\overline{X} \pm S\overline{x}$	*n*	%	$\overline{X} \pm S\overline{x}$	$\overline{X} \pm S\overline{x}$
Holstein breed, n = 40							
One-time milk yield, kg	28	70	18.6±0.31	12	30	18.1±0.26	18.4±0.28
Tme of milking, min.	28	70	9.62±0.220	12	30	8.33±0.32	8.85±0.193
Intensity of milk flow, kg/min	28	70	2.08±0.018	12	30	2.09±0.026	2.08±0.022
Montbéliard breed, n = 34							
One-time milk yield, kg	25	74	17,.6±0.29*	9	26	17.4±03.8	17.5±0.33*
Tme of milking, min.	25	74	9.62±0.351	9	26	9.49±0.362*	9.56±0.356
Intensity of milk flow, kg/min	25	74	1.84±0.026***	9	26	1.82±0.032***	1.83±0.029***

Note: * P≤0.05, ** P<0.01, *** P<0.001 compared to Holstein breed

As a result of the studies carried out, it was found that the cupped shape of the udder is characteristic for both Holstein (30%) and Montbéliard cows (26%). The animals of Holstein breed are characterized by high intensity of milk yield (2.08 kg/min) under the conditions of milking on the automated installation “Parallel”, which was by 12.0% higher than the same indicator of Montbéliard breed (1.83 kg/min) (P≤0.001). This is due to their manufacturability and better suitability for machine milking and intensive technology conditions.
In order to assess effectively the udder condition of highly productive cows during their breeding for machine milking at modern dairy complexes, Palii et al. (2020) developed a methodology that provides the classification of the udder into the following categories: Category I (not suitable); II category (suitable); Category III (not suitable). The minimum percentage of cows leaving the main herd according to this method was determined by linear assessment indicators: the udder depth (6 points), the attachment of the front lobes of the udder (5 points) and the placement of the front teats (6 points).
Gussmann et al. (2019) used records from the Danish cattle database to identify factors associated with culling at different stages of lactation, with particular attention to udder health. The authors proved that most of the factors were predominantly motivating factors for culling, however, high average milk yield reduced the possibility of culling. For early lactation cows, the treatment of dry cows in the previous lactation also reduced the risk of culling in most herds.

CONCLUSIONS

Thus, the obtained results make it possible to assert that the French breeds of cows are well adapted for breeding in Ukraine, and their breed influences the efficiency of milk production. Based on the foregoing, it can be concluded that Holstein cows, in terms of lactations, are characterized by better milk yield, but at the same time they are inferior to Montbéliard cows in terms of quality indicators, namely, the content and amount of milk fat and protein.

It has been proved that lactation in the experimental cows of both breeds is characterized by a high coefficient of lactation constancy and index of milk yield decline, which indicates the stability of their lactation curves. By the course of lactation, the Holstein cows can be attributed to the type of cows with high and constant productivity and a uniform course of lactation, while the Montbéliard breed to those that immediately after calving show high productivity, which subsequently sharply decreases. Their lactation curve after a short upward movement quickly decreases.

It was found that among the Holstein cows the majority of animals (70%) had a bath-like udder shape, while the percentage among the Montbéliard breed was 74%. The animals of Holstein breed are characterized by high intensity of milk yield under the conditions of milking on the automated installation "Parallel", which was higher than the same indicator of Montbéliard breed.

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