UDC 636.234.034.06.082.2
DOI: https://doi.org//10.31073/abg.68.10

EXTERIOR CHARACTERISTICS OF HOLSTEIN CATTLE OF DIFFERENT ORIGIN AND THE RELATIONSHIP OF COMPLEX TRAITS TO MILK PRODUCTIVITY

N. S. CHERNIAK*
Institute of Animal Breeding and Genetics nd. a. M.V. Zubets of NAAS (Chubynske, Ukraine)
https://orcid.org/0000-0002-2430-7168 - N. S. Cherniak
irgt2017@ukr.net

A linear assessment of first-calf heifers was conducted based on exterior type at the "Ostriykivske" dairy-industrial complex in Kyiv region (n = 180 heads). The degree of development of the main descriptive exterior traits of first-calf heifers of Holstein breed indicates significant intrastadial variability. Cows of different paternal origins differ in the development of certain body parts. The influence of sire on the variability (12.95–37.69%) of the descriptive traits of linear classification by type was revealed. The highest rating for the complex of traits (86.72 points) and the best milk productivity (yield – 12.942 kg, fat – 546 kg, and protein – 427 kg) is observed in the daughters of the bull Elkhart US3148929453of Holstein breed. The offspring of the bull Password CA13638215 have the lowest rating for the complex of traits (80.11 points) and a lower yield – 8.554 kg compared to the daughters of other bulls.

A strong, statistically significant correlation was established between the overall type score and the amount of milk yield (r = 0.740) in first-calf heifers of the Holstein breed. A high level of significant positive correlation was found between the group traits of the exterior and the milk yield during the first 305 days of lactation, which characterize the expression of the milk type (r = 0.323), body development (r = 0.438), udder (r = 0.545), and limbs (r = 0.332). The correlation coefficients between the descriptive traits of type and the milk yield of Holstein first-calf heifers over 305 days of lactation showed significant variability, ranging from negative (r = -0.168) for the angle of the pelvic limbs (side view) to moderate positive (r = 0.493) for the front attachment of the udder.

Keywords: **linear assessment of type, exterior traits, milk productivity, Holstein breed, complex assessment, bull**

ЕКСТЕР'ЄРНІ ОСОБЛИВОСТІ КОРІВ ГОЛШТИНСЬКОЇ ПОРОДИ РІЗНОГО ПОХОДЖЕННЯ ТА ЗВ'ЯЗОК КОМПЛЕКСНИХ ОЗНАК З МОЛОЧНОЮ ПРОДУКТИВНІСТЮ

Н. С. Черняк
Інститут розведення і генетики тварин імені М.В. Зубця НААН (Чубинське, Україна)

Проведено лінійну оцінку корів-первісток за екстер'єрним типом на молочно-промисловому комплексі «Острійківське» Київської обл. (n = 180 гол). Ступінь розвитку основних описових ознак екстер'єру корів-первісток голштинської породи свідчить про їхню значну внутрістадну мінливість. Корови різного походження за батьком відрізняються за розвитком окремих частин тіла. Виявлено вплив батька на мінливість (12,95–37,69%) описових ознак лінійної класифікації за типом. Найвища оцінка за комплексом ознак (86,72 бала) і краща молочна продуктивність (надій – 12942 кг, жир – 546 кг та білок – 427 кг) спостерігається у дочок бугая-плідника Елькгарта US3148929453 голштинської породи. У нащад-

*Науковий керівник – Ю. В. Вдовиченко, доктор сільськогосподарських наук, старший науковий співробітник, член-кореспондент НААН

ків бугая Пассворда CA13638215 відмічаємо найнижчу оцінку за комплексом ознак (80,11 бала) та нижчий надій – 8554 кг у порівнянні з дочками інших бугаїв.

Сильна, статистично вірогідна кореляція встановлена між загальною оцінкою типу та величиною надою (r =0,740) у первісток голштинської породи. Високий рівень достовірного додатного зв'язку встановлено між груповими ознаками екстер'єру та величиною надою за 305 днів першої лактації, які характеризують вираженість молочного типу (r =0,323), розвиток тулуба (r = 0,438), вим'я (r = 0,545) та кінцівок (r = 0,332). Коефіцієнти кореляції між описовими ознаками типу та надоєм первісток голштинської породи за 305 днів лактації відрізнялися істотною мінливістю, від від'ємної (r = -0,168), між кутом тазових кінцівок (вид збоку), до середньої позитивної (r = 0,493), між переднім прикріпленням вимені.

Ключові слова: **лінійна оцінка типу, ознаки екстер'єру, молочна продуктивність, голштинська порода, комплексна оцінка, бугай**

Introduction. Linear type traits form the basis for all modern classification systems and are fundamental in all systems for describing dairy cows. Linear assessment is based on the measurement of individual type traits. It describes the degree of development of a trait rather than its desirability. A number of domestic researchers, Khmelnychy et al., (2019), Khmelnychy & Karpenko (2021), and Malinovska (2019), report in their scientific works that visual assessment of type is a necessary element in the comprehensive analysis of dairy cows. According to authors Borsch & Borsch (2021), when using dairy cows in production-milk complexes, quality products can only be obtained under the condition of successful selection of cows for suitability for breeding under intensive technology conditions.

Assessment and Selection of Dairy Cattle Based on Exterior and Constitution (Ladyka et al., 2023) are closely related to the overall direction of breeding work aimed at improving the herd. Animals with a strong constitution and corresponding exterior type indicators can demonstrate high milk productivity, reproductive capacity, endurance, and the ability to live long and maintain lifetime productivity in industrial production conditions (Polupan et al., 2021). In their work, Polupan & Pryima (2023) indicate that the improvement of exterior and milk productivity is determined not only by the paratype influence of a complex of economic and natural conditions, better technological conditions for keeping animals, and their feeding as well as improving the process of rearing replacement heifers, but also by the genetic progress of the herd through the use of registered Holstein bulls.

A certain relationship has been established between the exterior and constitutional characteristics of animals and their growth, weight, body condition, milk productivity (Yelemesov, 2020; Baimukanov, 2022), health, resistance, and duration of productive use (Fedorovych et al., 2019). There is a noted connection between form and function, exterior and body structure proportions of animals, and the functional reliability of their bodies as an integrated biological system (Pendyuk et al., 2020; Karateeva & Lesik, 2020).

Currently, a number of studies have been conducted by Ladyka et al., (2019) and Karpenko (2021) on linear classification both in Ukraine and beyond (Vries & Marcondes, 2020), which have demonstrated a significant influence of linear descriptive traits of exterior type on milk productivity and the duration of productive use of cows of various breeds.

The aim of the study was to investigate the influence of genetic factors on the formation of the exterior of heifers and to establish the relationship between certain linear and group traits of exterior with milk productivity.

Materials and Methods. The research was conducted at the dairy complex of LLC "Ostriykivske" in the village of Ostriyky, Kyiv region. The visual evaluation of heifers' exterior was carried out according to the method of linear classification by type (Khmelnychy et al., 2016). The evaluation of heifers' exterior was performed at 2–4 months of lactation. The visual assessment of the type of heifers' exterior was conducted based on the description of individual exterior traits us-

ing a 9-point scale and an evaluation of complex traits by type using a 100-point scale. The average expression of traits is assessed at five points, while biological deviations are rated from 1 to 9 points. The total score is calculated based on complex traits that are based on linear descriptive characteristics. In total, 180 heifers of the Holstein breed were evaluated in the farm. The main linear traits assessed included: height, chest width, body depth, angularity, slope and width of the rump, hind limbs (viewed from the rear and side), hock angle, movement (gait), front attachment of the udder, positioning of the front and rear teats, teat length, udder depth, height of the udder from the rear, central ligament, and body condition scoring.

The total score was calculated based on composite traits, which in turn were based on linear descriptive characteristics. Using a 100-point system, four complexes of linear traits were considered: milk type, body, limbs, and udder. Each exterior complex was assessed separately with a corresponding weight coefficient in the final evaluation of the animal: milk type – 15%, body – 20%; limbs – 25%, and udder – 40%.

The maximum score for first-calf cows was no more than 89 for each individual complex of traits. The evaluation was as follows: 85–89 points – very good (VG), 80–84 points – good plus (GP), 75–79 points – good (G), and 70–74 points – satisfactory (S).

The reliability of the obtained data was evaluated through calculations of statistical error magnitudes (S. E.) and Student's t-tests (td) for correlation analysis. The significance level was determined by comparisons with standard criteria indicators. The results were considered statistically significant at the first threshold – $P < 0.05$ (*), the second – $P < 0.01$ (**), and the third – $P < 0.001$ (***).

Data statistical processing was conducted using Microsoft Excel 2020 software.

Results and Discussion.

In light of the mechanization and complete automation of production processes, high demands regarding animal health, constitution strength, and technological efficiency are placed on the dairy cattle industry. Assessing cattle based on exterior characteristics is one of the oldest methods for determining their biological and economically useful properties based on their external forms.

The dairy complex of LLC "Ostriykivske" has the status of a breeding reproducer for the Holstein breed. The farm has implemented a free-stall housing system for the animals. Advanced technological processes for feed harvesting, preparation, and distribution are utilized, with the addition of mineral and vitamin supplements.

The results of the linear evaluation of Holstein first-calf heifers for body structure type are presented in Table 1.

The body structure of the evaluated first-calf cows (n = 180 animals) has a sufficiently good characterization of descriptive traits. The evaluated animals have well-expressed: height (6.40 points), chest width (5.70 points), body depth (6.29 points), angularity (4.81 points), rump angle (4.10 points) and rump width (6.67 points), fore udder attachment (6.03 points), rear udder attachment (6.21 points), central ligament (5.71 points), and udder depth (5.78 points). Overall, the body structure of the evaluated first-calf cows has a sufficiently good characterization of descriptive traits.

Body depth depends on the cow's age, lactation, and characterizes the development of the digestive tract. For this linear trait, there is a statistically significant advantage observed in the offspring of the bull Maggiordomo CA13353511, which amounted to 0.03–0.7 points ($P < 0.001$).

The indicators of rear and fore udder attachment are highest in the offspring of the bull Elkhart 148929453, corresponding to 8.40 and 7.97 points ($P < 0.001$), indicating high milk productivity of the first-calf heifers.

For chest width, which characterizes the strength of the animals, higher variability is observed with a better trait assessment in the daughters of the bull Pinball 13353753, exceeding the daughters of the other evaluated bulls with a significant difference of 0.07–0.84 points ($P < 0.001$).

1. Impact of breeding bulls on the linear type traits of offspring (30 daughters from each breeder)

Traits, score	Elkhart	Bosa	Majordomo	Pinball	Starjack	Password
Stature	7.29 ± 0.05	6.20 ± 0.06	5.63 ± 0.06	6.60 ± 0.05	6.3 ± 0.06	6. 4 ± 0.06
Chest width	5.83 ± 0.06	5.13 ± 0.07	5.67 ± 0.05	5.97 ± 0.06	5.9 ± 0.07	5.7 ± 0.05
Body depth	6.34 ± 0.04	6.08 ± 0.05	6.60 ± 0.06	6.57 ± 0.04	5.9 ± 0.05	6.23 ± 0.06
Angularity	5.46 ± 0.06	5.06 ± 0.04	4.86 ± 0.07	5.37 ± 0.06	4.4 ± 0.04	3.7 ± 0.07
Rump angle	3.50 ± 0.07	4.37 ± 0.08	3.97 ± 0.06	4.43 ± 0.07	3.8 ± 0.08	4.5 ± 0.06
Rump width	6.69 ± 0.05	6.30 ± 0.06	6.43 ± 0.07	6.51 ± 0.05	6.8 ± 0.06	7.3 ± 0.07
Rear legs angle	5.09 ± 0.06	5.03 ± 0.05	5.10 ± 0.08	5.32 ± 0.06	4.7 ± 0.05	5.3 ± 0.08
Rear legs position	6.71 ± 0.04	7.23 ± 0.05	6.11 ± 0.06	6.97 ± 0.04	7.1 ± 0.05	6.3 ± 0.06
Foot angle	5.11 ± 0.07	5.06 ± 0.06	3.97 ± 0.05	4.94 ± 0.07	4.4 ± 0.06	3.4 ± 0.05
Fore udder attachment	7.97 ± 0.05	6.09 ± 0.07	5.60 ± 0.06	6.95 ± 0.05	5.3 ± 0.07	4.3 ± 0.06
Rear udder attachment	8.40 ± 0.04	5.43 ± 0.05	5.45 ± 0.08	6.84 ± 0.04	6.2 ± 0.05	5.3 ± 0.08
Central ligament	7.64 ± 0.10	5.37 ± 0.09	5.11 ± 0.07	6.64 ± 0.10	5.2 ± 0.09	4.6 ± 0.07
Udder depth	6.14 ± 0.04	5.09 ± 0.06	5.01 ± 0.09	6.14 ± 0.04	5.5 ± 0.06	6.8 ± 0.09
Front teat placement	5.11 ± 0.05	5.00 ± 0.07	5.14 ± 0.04	5.11 ± 0.05	4.9 ± 0.07	5.8 ± 0.04
Rear teat placement	5.34 ± 0.06	5.03 ± 0.08	5.37 ± 0.05	5.34 ± 0.06	5.4 ± 0.08	6.2 ± 0.05
Teat length	3.91 ± 0.04	4.17 ± 0.05	3.94 ± 0.05	3.91 ± 0.04	3.8 ± 0.05	4.2 ± 0.05

Note: *Elkhart 3148929453 is the name of the bull, (n = 30 animals) is the number of the bull's daughters.*

When evaluating the mammary system, preference is given to traits that influence high milk productivity, adaptability to milking on various milking installations, and reduction of injuries. A well-expressed central ligament will ensure strong udder attachment throughout many lactations. The daughters of the bull Elkhart 148929453 have a strong supporting ligament (7.64 points), while the offspring of the sire Password CA13638215 have a weak one (4.6 points) ($P < 0.001$).

The depth of the udder depends on the age of the cows and their milk production. A deep udder often leads to injuries and infectious diseases. This trait in the experimental animals has an average value. For the trait of angularity, the daughters of the bull Password CA13638215 received lower scores compared to the daughters of other bulls with a significant difference ($P < 0.001$).

Among the evaluated first-calf heifers in the herd, we note the widest rump (7.3 points) in the offspring of the sire Password CA13638215, with an advantage over their peers by 1.0–0.5 points ($P < 0.001$). This trait has a significant impact on calving ease.

The condition of the pelvic and thoracic limbs and hooves was evaluated. When viewed from the side, the hock joints in the evaluated cows are well-developed, clearly defined, without pathological thickening or tumors. The pelvic limbs have a wide and parallel stance, and when viewed from the side, they are straight. The hooves are strong, well-rounded, and the hoof angle is high.

The degree of development of the main descriptive traits of the exterior in first-calf Holstein cows at the dairy complex indicates their significant intra-herd variability.

According to the results of the linear evaluation of the experimental herd, the highest score for the complex of traits was observed in the daughters of the breeding bull Elkhart 3148929453 of the Holstein breed, which amounts to: 86.72 points for dairy type, 85.23 points for body condition, 86.77 points for limbs, 87.22 points for morphological traits of the udder, and 86.72 points for overall type evaluation (Table 2). The lowest scores in the final evaluation were received by the daughters of the bull Password CA13638215 (80.11 points).

In the evaluation of group traits of dairy type, the advantage of daughters of the bull Elkhart 48929453 of the Holstein breed over the offspring of the bull Maggiordomo CA13353511

was 7.65 points (P < 0.001), and in the evaluation of limbs and hooves condition with a difference of 9.71 points (P < 0.001). In udder development, the first-calf heifers of the bull Elkhart 48929453 surpassed the peers of the bull Password CA13638215 by 8.61 points (P < 0.001), and in body evaluation, they surpassed the offspring of the bull Pinball CA13353753 by – 3.73 points (P < 0.001).

2. Impact of the sire on exterior characteristics of Holstein first-calf heifers *(30 daughters from each breeder)*

Bull's name	Composite traits, points, %									
	Dairy type		Body		Legs		Udder		Overall score	
	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %
Elkhart US3148929453	87.22 ± 0.40	2.80	85.2 ± 0.73	5.19	86.77 ± 0.53	3.86	87.64 ± 0.44	3.02	86.72 ± 0.36***	2.53
Bosa US1339112680	83.5 ± 0.29	2.04	83.6 ± 0.65	3.79	79.0 ± 0.54	4.01	83.2 ± 0.54	3.86	82.50 ± 0.26	1.87
Pinball CA13353753	80.8 ± 0.64	4.68	81.5 ± 0.67	4.89	78.7 ± 0.51	3.83	81.8 ± 0.64	4.60	80.39 ± 0.47	3.47
Majordomo CA13353511	79.57 ± 0.63	4.41	82.80 ± 0.59	3.97	77.06 ± 0.52	3.85	82.09 ± 0.58	4.37	80.89 ± 0.37	3.36
Password CA13638215	80.46 ± 0.70	4.92	82.0 ± 0.86	4.52	77.2 ± 0.65	3.93	79.03 ± 0.66	3.83	80.11 ± 0.39***	2.86
Starjack US3138498788	79.77 ± 0.73	3.91	81.90 ± 0.64	4.37	77.96 ± 0.55	3.65	82.79 ± 0.52	4.37	80.60 ± 0.40	3.31

Source: *developed by the author.* ***Note:*** *P < 0.001(***).*

Several scientists (Polupan et al, (2023); Khmelnychyi et al, (2021)) assert the influence of paternal origin on the traits of milk productivity and exterior type of their daughters. Similar conclusions were reached by various authors, including Loboda et al., (2019), based on the results of their scientific research.

Among the evaluated herd, the highest percentage of animals received a rating of "good plus". The research results indicate that the highest score for the complex of traits (86.72), which corresponds to "good plus", and higher milk productivity is observed in the daughters of the breeding bull Elkhart 3148929453 of the Holstein breed, whose milk yield is 12942 kg, fat content is 4.22%, and protein content is 3.30%. Also, a high score for the complex of traits and high milk productivity was received by the daughters of the bull Boss US1339112680 (82.50 points) (milk yield – 11480 kg; fat – 4.30%; protein – 3.16%) (Table 3).

In the offspring of bull Password CA13638215 of Holstein breed, we observe the lowest score for the complex of traits (80.11 points) and lower milk yield – 8554 kg compared to daughters of other bulls. In terms of milk yield, daughters of Elkhart 3148929453 surpassed daughters of Password CA13638215 by 4388 kg or 33.9% (P < 0.001), and in milk protein content, the offspring of bull Pinball CA13353753 by 0.25% or 7.57% (P < 0.001). Daughters of bull Boss US1339112680 showed the highest milk fat content – 4.30%, which is 0.68% more compared to daughters of bull Starjack US3138498788 (P < 0.001).

Domestic scientists (Polupan, 2021; Vechorka et al, 2019) report a statistically significant influence of paternal origin on the traits of milk productivity and exterior type of their daughters.

The obtained research results indicate that one of the methods for improving the breeding and productive qualities of dairy breed cows on dairy-industrial complexes is the use of the best breeding bulls in selection for the breeding stock, which pass on valuable traits to their offspring. This

will make it possible to create dairy herds with high milk productivity and desired exterior type, which will increase the duration of economic use.

3. Impact of the sire on exterior characteristics of first-calf heifers (30 daughters from each breeder)

Bull's name	Total composite score, points		Milk production					
			milk yield, kg		fat, %		protein, %	
	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %	$\bar{x}$ ± S.E	Cv, %
Elkhart	86.72 ± 0.36	2.53	12942 ± 320.0**	21.20	4.22 ± 0.04	5.72	3.30 ± 0.01**	3.02
Bosa	82.50 ± 0.26	1.87	11480 ± 204.7	19.62	4.30 ± 0.07***	6.21	3.16 ± 0.01	1.82
Pinball	80.39 ± 0.47	3.47	9380 ± 221.6	16.42	4.05 ± 0.03	4.34	3.05 ± 0.01**	2.32
Majordomo	80.89 ± 0.37	3.39	10425 ± 198.4	14.61	3.95 ± 0.07	4.16	3.18 ± 0.01	2.12
Password	80.11 ± 0.39	2.86	8554 ± 188.1***	15.20	3.73 ± 0.07	5.52	3.12 ± 0.01	2.54
Starjack	80.60 ± 0.40	3.11	8891 ± 193.5	16.85	3.62 ± 0.05***	5.48	3.07 ± 0.01	2.41

Source: *developed by the author. Note: P < 0.001(***)*

The correlation coefficients between linear type traits of Holstein breed first-calf heifers and 305-day lactation milk yield are presented in Table 4.

4. Correlation between linear type traits of Holstein breed first-calf heifers and 305-day lactation milk yield (n = 180 animals)

Traits	r ± mr	tr
stature	0.389 ± 0.091***	4.28
chest width	0.191 ± 0.097*	2.01
body depth	0.308 ± 0.097***	3.84
angularity	0.317 ± 0.092***	4.26
rump angle	0.010 ± 0.099	0.11
rump width	-0.031 ± 0.098	-0.31
rear legs angle	-0.168 ± 0.097	-1.73
rear legs position	0.024 ±0.099	0.24
foot angle	0.356 ± 0.092***	3.86
fore udder attachment	0.493 ± 0.086***	5.75
rear udder attachment	0.132 ± 0.098*	1.13
central ligament	0.226 ± 0.096*	2.35
udder depth	0.195 ± 0.097*	2.07
front teat placement	-0.033 ± 0.098	-0.33
rear teat placement	0.019 ± 0.099	0.19
teat length	0.085 ± 0.098	0.87
Overall score	0.740 ± 0.066***	11.17
– dairy type	0.323 ±0.093***	3.46
– body	0.438 ± 0.096***	4.95
– legs	0.332 ± 0.093***	3.57
– udder	0.545 ± 0.083***	6.60

A strong, statistically significant correlation was established between the overall type score and milk yield ($r = 0.740 \pm 0.066$, $tr = 11.17$, $P < 0.001$) in Holstein breed first-calf heifers.

A high level of significant positive correlation was found between group exterior traits and 305-day milk yield in the first lactation, which characterize dairy type expression ($r = 0.323 \pm 0.093$, $t = 3.46$, $P < 0.001$), body development ($r = 0.438 \pm 0.096$, $tr = 4.95$, $P < 0.001$), udder ($r = 0.545 \pm 0.083$, $tr = 6.60$, $P < 0.001$), and legs ($r = 0.332 \pm 0.093$, $tr = 3.57$, $P < 0.001$).

In their studies, Povod et al., (2022) obtained high correlation coefficients between the group of linear traits characterizing dairy type ($r = 0.502$), body ($r = 0.488$), and udder ($r = 0.537$) and 305-day milk yield in the first lactation.

Sufficiently high significant correlations were obtained between first-calf heifers' milk yield and descriptive traits characterizing body development: height ($r = 0.389$, $tr = 4.28$, $P < 0.001$) and depth ($r = 0.308$, $tr = 3.84$, $P < 0.001$). Authors Povod et al., (2022) in their work also report establishing a high correlation between milk yield and height ($r = 0.382$) and body depth ($r = 0.481$).

A moderate, statistically significant correlation was established between 305-day lactation milk yield and a number of individual descriptive exterior traits of Holstein breed first-calf heifers characterizing the udder: fore udder attachment ($r = 0.493$, $tr = 5.75$, $P < 0.001$), angularity ($r = 0.317$, $tr = 4.26$, $P < 0.001$), a weak correlation with central ligament ($r = 0.226$, $tr = 2.35$, $P < 0.05$), and a very weak correlation with udder depth ($r = 0.195$, $tr = 2.07$, $P < 0.05$), rear udder attachment ($r = 0.132$, $tr = 1.13$, $P < 0.05$), and teat length ($r = 0.085$, $tr = 0.84$).

Based on the research results, a weak correlation ($r = 0.195$) was established between udder depth and 305-day lactation milk yield of first-calf heifers. A similar correlation between udder depth and milk yield was found by scientists Bohlouli et al., (2015) ($r = 0.12$). The weak or inverse correlation between udder depth and milk yield is explained by the fact that at the time of evaluation, cows have a high daily milk yield, which in turn leads to udder lowering, therefore evaluation scores decrease.

In our research results, a very weak correlation was established between teat length and milk yield of Holstein breed first-calf heifers ($r = 0.085$). We note a negative, insignificant correlation between the placement of front teats and milk yield ($r = -0.033$). In their works, Bohlouli et al., (2015) also obtained an inverse, insignificant correlation.

The level of positive significant correlation between angularity and milk yield ($r = 0.317$) in our study indicates high milk production of Holstein breed cows. Genetic ($r = 0.58$) and phenotypic ($r = 0.40$) correlations between angularity and milk yield were confirmed by studies of Bilal et al., (2016).

A moderate, statistically significant correlation was established between the 305-day lactation milk yield of Holstein breed cows and traits characterizing body development: height ($r = 0.389 \pm 0.091$, $tr = 4.28$, $P < 0.001$), and a weak correlation between chest width ($r = 0.191 \pm 0.097$, $tr = 2.01$, $P < 0.05$), body depth ($r = 0.178 \pm 0.097$, $tr = 1.84$, $P < 0.05$).

A moderate, positive, significant correlation was established between 305-day milk yield and hoof angle ($r = 0.356 \pm 0.092$, $tr = 3.86$, $P < 0.001$), and a weak, insignificant correlation with rear legs side view ($r = 0.024 \pm 0.099$, $tr = 0.24$).

We note an inverse, insignificant correlation between rump width ($r = -0.031 \pm 0.098$, $tr = -0.31$), rear legs rear view ($r = -0.168 \pm 0.097$, $tr = -1.73$), front teat placement ($r = -0.033 \pm 0.098$, $tr = -0.33$) and first-calf heifers' milk yield.

Linear type traits characterizing leg condition – rear legs side view ($r = 0.024$), rear legs rear view ($r = -0.168$) in our studies weakly correlate with the 305-day lactation milk yield of Holstein breed cows in the controlled herd.

Khan et al., (2016) (from -0.20 to 0.07) and Bohlouli et al., (2015) (from -0.08 to 0.06) report low effectiveness of selection based on these descriptive traits due to weak or inverse correlation between them and milk yield.

In their works, Loboda et al., (2019) note that the application of linear classification methodology in the breeding process of dairy cattle is a quite effective means of objectively determining breed characteristics of cows based on exterior.

Conclusions.

The genetic factor (paternal origin) has a significant substantial influence on the variability of linear exterior traits of Holstein breed first-calf heifers. Paternal origin accounted for 12.95–37.69% of the variability in descriptive traits of linear type classification.

The highest score for the complex of traits (86.72 points) and better milk productivity (milk yield – 12942 kg, fat – 546 kg, and protein – 427 kg) is observed in daughters of the breeding bull Elkhart US3148929453 of Holstein breed. In the offspring of bull Password CA13638215, we note the lowest score for the complex of traits (80.11 points) and lower milk yield – 8554 kg compared to daughters of other bulls.

We found positive correlations within statistical significance between the 305-day lactation milk yield of Holstein breed first-calf heifers and group exterior traits characterizing dairy type expression (r = 0.323), body development (r = 0.438), udder (r = 0.545), legs (r = 0.332), and overall type score of cows (r = 0.740). The existence of a relationship between milk yield and group linear traits will significantly increase the efficiency of selection through the selection of cows based on exterior.

We note an inverse, insignificant correlation between rump width (r = -0.031), rear legs rear view (r = -0.168), front teat placement (r = -0.033) and first-calf heifers' milk yield.

We recommend selecting first-calf heifers with better measurement indicators for breeding stock replacement, which will ensure more functional reliability and extend the duration of economic use of cows.

REFERENCES

Baimukanov, D. A., Bissembayev, A. T., Batanov, S. D., Baranova, I. A., & Kuzmina, N. N. (2022) Exterior and Body Types of Cows with Different Levels of Dairy Productivity. *American Journal of Animal and Veterinary Sciences*, 17 (2), 154–164. https://doi.org/10.3844/ajavsp.2022.154.164

Bilal, G., Cue, R. I., & Hayes, J. F. (2016). Genetic and phenotypic associations of type traits and body condition score with dry matter intake, milk yield, and number of breedings in first lactation. *Can. J. Anim. Sci*., 96, 434–447. https://doi.org/10.1139/cjas-2015-0127

Bohlouli, M., Alijani, S., & Varposhti, M. R. (2015). Genetic relationships among linear type traits and milk production traits of Holstein dairy cattle. *Ann. Anim. Sci*, 15 (4), 903–917.

Borshch, O. O., & Borshch, O. V. (2021). Ekster'ierni osoblyvosti pervistok ukrainskykh chorno- ta chervono-riaboi molochnykh porid i yikhnikh pomisei zi shvitskoiu ta monbeliardskoiu porodamy [Exterior characteristics of the first-borns of Ukrainian black and red-spotted dairy breeds and their crossbreeds with Shvitsky and Montbeliard breeds] *Scientific Progress & Innovations*, 1, 210–216. [In Ukrainian]. https://doi.org/10.31210/visnyk2021.01.26

Campos, R. V., Cobuci, J. A., Kern, E. L., Costa, C. N., & McManus, C. M. (2015). Genetic Parameters for linear type traits and milk, fat, and protein production in Holstein cows in Brazil. *Asian Australas. J. Anim. Sci.*, 28 (4), 476–484.

Dankiv, V. Ya., Dyachenko, O. B., Pavlyshak, Y. Ya., & Kogut, M. I. (2020). Ekster'ierni osoblyvosti ta molochna produktyvnist koriv symentalskoi kombinovanoi (molochno-m'iasnoi) porody u tzov «litynske» [Exterior characteristics and milk productivity of Simmental cows of the combined (milk-meat) breed at Litynske LLC] *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo – Foothill and mountain agriculture and animal husbandry*. Obroshyne, 68 (1), 189–204. [In Ukrainian]. https://doi.org/ 10.32636/01308521.2020-(68)-1-14

De Vries, A., & Marcondes, M. I. (2020). Review: Overview of factors affecting productive lifespan of dairy cows. *Animals*, 14 (1), 155–164. https://doi.org/ 10.1017/S1751731119003264

Fedorovych, E. I., Fil, S. I., & Bodnar, P. V. (2019). Ekster'ierni osoblyvosti koriv ta yikh potomkiv riznykh heneratsii u vysokoproduktyvnykh stadakh [Exterior features of cows and

their descendants of different generations in highly productive herds] *Naukovyi visnyk LNU veterynarnoi medytsyny ta biotekhnolohii. Seriia: Silskohospodarski nauky – Scientific Bulletin of Lviv National University of Veterinary Medicine and Biotechnology named after S.Z. Gzhytsky. Agricultural Sciences,* 21 (91), 76–82. [In Ukrainian]. https://doi.org/10.32718/nvlvet-a9113.

Karateeva, O. I., & Lesik, I. M. (2020). Otsinka eksterieru osnovnykh promiriv budovy tila telyts zalezhno vid yikh pokhodzhennia [Evaluation of the exterior of the main measurements of the structure of the body of heifers depending on their origin] *Visnyk ahrarnoi nauky Prychornomoria – Bulletin of the Agrarian Science of the Black Sea Region.* Mykolayiv, 4, 79–87 [In Ukrainian]. https://doi.org/10.31521/2313-092X/2020-4(108)-10

Karpenko, B. M. (2021). Vplyv otsinky liniinykh oznak, yaki kharakteryzuiut stan kintsivok, na tryvalist zhyttia koriv ukrainskoi chorno-riaboi molochnoi ta holshtynskoi porid [Influence of linear traits assessment that characterize limbs condition on the lifetime of Ukrainian Blackand-White dairy and Holstein cows] *Visnyk Sumskoho natsionalnoho ahrarnoho universytetu. Tvarynnytstvo – Bulletin of the Sumy National Agrarian University*. Livestock, 3 (46), 52–60 [In Ukrainian]. https://doi.org/10.32845/bsnau.lvst.2021.3.8

Khan, M. A., & Khan, M. S. (2016). Genetic and phenotypic correlations between linear type traits and milk yield in Sahiwal cows. *Pak. J. Agri. Sci*., 53 (2), 483–489.

Khmelnychyi, L. M., & Karpenko, B. M. (2021). Osoblyvosti ekster'ieru koriv chorno-riaboi khudoby riznoho pokhodzhennia za promiramy ta indeksamy budovy tila [Peculiarities of the exterior of cows of black-and-white cattle of different origin according to measurements and body structure indices] *Visnyk Sumskoho natsionalnoho ahrarnoho universytetu. Tvarynnytstvo – Bulletin of the Sumy National Agrarian University. Livestock,* 4 (47), 24–32 [In Ukrainian]. https://doi.org/10.32845/bsnau.lvst.2021.4.5.

Khmelnychyi, L. M., Bardash, D. O., Klymenko, O. I., & Bondarchuk, L. V. (2019). Osoblyvosti formuvannia ekster'ieru koriv-pervistok ukrainskoi chervono-riaboi molochnoi porody za pokaznykamy promiriv ta indeksiv budovy tila [Peculiarities of the formation of the exterior of first-born cows of the Ukrainian red-and-white dairy breed according to the indicators of measurements and body structure indices] *Rozvedennia i henetyka tvaryn – Animal breeding and genetics.* Kyiv, 58, 67–71. [In Ukrainian]. https://doi.org/10.31073/abg.58.09 26.

Khmelnychyi, L. M., Ladyka, V. I., Polupan, Y. P., Bratushko, R. V., Pryima, S. V., & Vechorka, V. V. (2016). *Liniina klasyfikatsiia koriv molochnykh i molchno-miasnykh porid za typom : (metod. vkazivky)* [Linear classification of dairy and milk-meat cows by type. (Methodical Instructions)] 2nd ed., revised. and additional. Sumy National Agrarian University. [In Ukrainian].

Ladyka, V. I., Khmelnychyi, L. M., & Khmelnychyi, S. L. (2019). Vplyv rozvytku liniinykh oznak eksterieru, yaki kharakteryzuiut stan rozvytku tuluba, na zhyttiezdatnist koriv ukrainskoi buroi molochnoi porody [Influence of linear traits development of the conformation, that characterize the state of body development, on the viability of Ukrainian brown dairy cows] *Rozvedennia i henetyka tvaryn – Animal breeding and genetics*, Kyiv, 58, 120–129. [In Ukrainian]. https://doi.org/10.31073/abg.58.16

Ladyka, V. I., Khmelnychyi, L. M., Povod, M. G., & Bordunova O. H. (2023). Tekhnolohiia vyrobnytstva ta pererobky produktsii tvarynnytstva: pidruchnyk dlia aspirantiv [Production and processing technology of animal husbandry products: a textbook for graduate students]. Oldi+. [In Ukrainian].

Loboda, A. V., & Bardash, D. A. (2019). Osoblyvosti ekster'ieru koriv-pervistok sumskoho vnutrishnoporodnoho typu ukrainskoi chorno-riaboi molochnoi porody, otsinenykh za metodykoiu liniinoi klasyfikatsii [Exterior features of cows firstborn of sumy intrabreed type of Ukrainian black- and – white dairy cattle, estimated by the method of linear classification] *Rozvedennia i henetyka tvaryn – Animal breeding and genetics.* Kyiv, 57, 87–94 [In Ukrainian]. https://doi.org/10.31073/abg.57.11

Malinovskaya, O. V., Fedorovych, E. I., & Kuziv, M. I. (2019). Ekster'ierni osoblyvosti koriv-pervistok ukrainskoi chorno- ta chervono-riaboi molochnykh porid i yikh pomisei z dzherseiamy [Exterior features of first-born cows of Ukrainian black- and red-and-white milk breeds and their hybrids with jerseys] *Naukovo-tekhnichnyi biuleten Derzhavnoho naukovo-doslidnoho kontrolnoho instytutu veterynarnykh preparativ ta kormovykh dobavok i Instytutu biolohii tvaryn – Scientific and Technical Bulletin of the State Research Control Institute of Veterinary Drugs and Feed Additives and the Institute of Animal Biology.* Lviv, 20, 2, 358–365. [In Ukrainian]. https://doi.org/ 10.36359/scivp.2019-20-2.47.

Pendyuk, A. R., Fedorovych, V. V., & Mazur, N. P. (2020). Formuvannia ekster'ieru koriv ukrainskoi chorno-riaboi molochnoi porody za pohlynalnoho skhreshchuvannia [Formation of the exterior of cows of the Ukrainian black-and-white milk breed with absorption crossing] *Rozvedennia i henetyka tvaryn – Animal breeding and genetics.* Kyiv, 59, 67–77 [In Ukrainian]. https://doi.org/10.31073/abg.59.08.

Polupan, Yu. P., & Pryima, S. V. (2023). Dynamika ekster'iernykh osoblyvostei pervistok molochnykh porid [Dynamics of exterior features of heifers of milk breeds] *Rozvedennia i henetyka tvaryn – Animal breeding and genetics.* Kyiv, 65, 107–127. [In Ukrainian]. https://doi.org/ 10.31073/abg.65.10

Polupan, Yu. P., Stavetska, R. V., & Siryak, V. A. (2021). Vplyv henetychnykh chynnykiv na tryvalist ta efektyvnist dovichnoho vykorystannia molochnykh koriv [Influence of genetic factors on the duration and efficiency of lifelong use of milk cows] *Rozvedennia i henetyka tvaryn – Animal breeding and genetics.* Kyiv, 61, 90–106. [In Ukrainian]. https://doi.org/10.31073/abg.61.11

Povod, M. G., Samokhina, E. A., & Khmelnychyi, S. L. (2022). Uspadkovuvanist liniinykh oznak typu koriv ukrainskoi chervono-riaboi molochnoi porody ta yikhnii zv'iazok z oznakamy produktyvnosti y dovholittia [Inheritance of linear signs of the type of cows of the Ukrainian red-and-white milk breed and their relationship with the signs of productivity and longevity] *Visnyk Sumskoho natsionalnoho ahrarnoho universytetu. Tvarynnytstvo – Bulletin of the Sumy National Agrarian University. Livestock*, 4 (51), 23–32. [In Ukrainian].

Yelemesov, K. Ye., & Baimukanov, A. D. (2020). The estimated breeding value of servicing bulls of domestic breeds by offspring quality using the BLUP method. *Bulletin of national academy of sciences of the Republic of Kazakhstan,* 3 (385), 51–59. [in English]. https://doi.org/10.32014/2020.2518-1467.69.

Одержано редколегією 04.11.2024 р.
Прийнято до друку 18.12.2024 р.