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INFLUENCE OF GENOTYPIC FACTORS ON MILK PRODUCTIVITY TRAITS IN BROWN SWISS COWS

B. S. CHERNIAK*
Institute of Animal Breeding and Genetics nd. a. M.V. Zubets of NAAS (Chubynske, Ukraine)
https://orcid.org/ 0009-0000-1633-7538 – B. S. Cherniak
cherniakbo@gmail.com

Abstract. The article presents the results of a study on the influence of genotypic factors (sire lineage, line affiliation) on the development of key milk productivity traits in the first-calf Brown Swiss cows at the dairy production complex LLC " Yekaterynoslavskyi". The herd of the Brown Swiss cattle originates from four genealogical lines of the breed: Distinction 159523 – 35%, Elegant 148551.66 – 30%, Stretch 143612 – 24%, and Payven 136140 – 11%. The inclusion of these genealogical lines in the farm is due to the high breeding and productive qualities of their offspring, as well as the presence of a significant number of cows and heifers sired by bulls of these lines in the herd.

It was noted that the Brown Swiss cows from different genealogical lines, under identical conditions of housing and feeding, showed significant differences in milk productivity traits. The highest milk yield (9768 ± 127.1 kg) was demonstrated by cows of the Stretch 143612 line, which significantly exceeded their peers from other lines (P < 0,001). At the same time, the descendants of this line had the lowest fat (3.81 ± 0.021%) and protein (3.23 ± 0.012%) contents in milk. It was found that first-calf cows of different origins were characterized by a considerable level of variability in the main milk productivity traits. The daughters of the bull Apex 109736195, who had the lowest milk yield (8048 ± 134.2 kg), turned out to have the best fat and protein content in milk (4.30 and 3.36%, respectively). In contrast, the daughters of the bull Sesdeblum 68144448 had the highest milk yield (10,445 kg) but showed the lowest fat and protein levels (3.77 and 3.08%, respectively). The difference is significant in all cases (P < 0,001).

The influence of Brown Swiss sires on milk yield and milk composition in their daughters was as follows:

– for milk yield over 305 days of lactation: η^2_x = 0.510 (P = 0.001), indicating a high level of genetic determination;

– for milk fat content: η^2_x = 0.03, a statistically insignificant value, indicating minimal heritability;

– for milk protein content: η^2 = 0.11 (P < 0.01), indicating a moderate but significant paternal influence.

The variability in the main milk productivity traits of first-calf Brown Swiss cows is determined more by the differences between offspring of individual sires within the same genealogical line than by their line affiliation alone.

Keywords: **Brown Swiss breed, line, milk productivity, sires, sire origin, line affiliation**

ВПЛИВ ГЕНОТИПОВИХ ФАКТОРІВ НА ОЗНАКИ МОЛОЧНОЇ ПРОДУКТИВНОСТІ КОРІВ ШВІЦЬКОЇ ПОРОДИ

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

У статті представлено результати дослідження впливу генотипових чинників (походження за батьком, належність до лінії) на формування основних ознак молочної продукти-

*Науковий керівник – О. Д. Бірюкова, доктор сільськогосподарських наук, старший науковий співробітник

вності первісток швіцької породи на молочно-виробничому комплексі ТОВ «МВК» Єкатеринославський». Маточне поголів'я великої рогатої худоби швіцької породи походить від чотирьох генеалогічних ліній швіцької породи: Дістінкшна 159523 – 35%, Елеганта 148551.66 – 30%, Стретча 143612 – 24% та Пейвена 136140 – 11%.

Відмічаємо, що тварини швіцької породи різних генеалогічних ліній, за однакових умов їх утримання та годівлі у господарстві, значно відрізняються за показниками молочної продуктивності. Найвищий рівень надою (9768 ± 127,1 кг) продемонстрували корови швіцької породи лінії Стретча 143612, які значно перевершували ровесниць інших ліній (P < 0,001). Водночас, у нащадків даної лінії відмічали найнижчі показники вмісту жиру (3,81 ± 0,021%) та білка (3,23 ± 0,012%) в молоці.

Встановлено, що корови різного походження характеризувалися значним рівнем мінливості основних ознак молочної продуктивності. Нащадки бугая Апекса 109736195, які характеризувались найнижчим надоєм (8048 ± 134,2 кг), виявилися найкращими за вмістом жиру та білка в молоці (4,30% та 3,36%, відповідно). Натомість, дочки бугая Сесдеблума 68144448 мали найвищий рівень надою (10445 кг), однак показали найнижчі показники за даними ознаками (3,77% та 3,08%). Різниця у всіх випадках вірогідна (P < 0.001).

Виявлено, що вплив бугаїв-плідників швіцької породи на надій та якісний склад молока їхніх дочок мав наступний прояв:

– для надою за 305 днів лактації: η^2_x = 0,510 (P < 0,001) – що свідчить про високий рівень генетичної зумовленості;

– для вмісту жиру в молоці: η^2_x = 0,03 – показник є статистично недостовірним, що вказує на мінімальний спадковий вплив;

– для вмісту білка в молоці: η^2_x = 0,11 (P < 0,01) – що вказує на помірний, але достовірний вплив походження за батьком.

Рівень мінливості основних ознак молочної продуктивності первісток швіцької породи обумовлюється не стільки їх належністю до окремих ліній, скільки характером мінливості між нащадками різних бугаїв-плідників однієї генеалогічної лінії.

Ключеві слова: **швіцька порода, лінія, молочна продуктивність, бугаї-плідники, походження за батьком, лінійна належність**

Introduction. Dairy cattle breeding is a leading branch of animal husbandry in many countries around the world. Selection is a crucial factor in improving the efficiency of this sector, as it enables the accelerated enhancement of existing breeds and the creation of new, more productive breeds, lines, and types that better meet modern requirements (Ladika et. al., 2017; Kruglyak et. al., 2020).

To further intensify the cattle industry, it is essential to form high-yielding dairy herds, while the economic efficiency of keeping cows in large industrial complexes is a key factor for the success of agricultural businesses.

Milk productivity in cows is one of the primary indicators of efficiency in dairy farming. Important genetic factors influencing productivity include the paternal origin and affiliation with a particular line. Studying the genetic impact helps identify the best breeding strategies for improving breed productivity (Shpetnyi et. al., 2021).

Improvement of the intra-line structure of the studied herd is primarily achieved through the use of specific sire lines. This approach allows for the maintenance of necessary genetic diversity within the herd and facilitates its overall improvement while preserving breed-specific traits. Furthermore, it enables the formation of a desired genealogical structure within the herd (Cherniavska, 2022).

The genetic improvement of dairy cattle breeds greatly depends on the heritability of traits passed on by breeding bulls, which is confirmed by increased productivity levels as well as improvements in exterior and technological traits of the animals (Kuziv et. al., 2022).

The use of bulls that pass on valuable traits to their offspring is one of the most effective methods for improving productive, technological, and breeding qualities in dairy and dual-purpose breeds. This approach makes it possible to relatively quickly create high-yielding dairy herds that are consolidated in terms of exterior type, milk productivity, and longevity in economic use (Ilyashenko, 2020; Ladika et. al., 2017).

The proper selection of bulls for herd reproduction is a crucial and responsible task, as the genetic influence of sires on breed improvement is highly significant at the current stage of selection. Therefore, in forming a high-yielding herd, it is logical to use bulls whose daughters are characterized by high milk productivity, early maturity, and desirable body conformation. Systematic evaluation of bulls based on the quality of their offspring contributes to herd improvement and increased profitability in the dairy industry (Polupan et. al., 2020; Fil' et. al., 2019).

Hence, studying the specifics of milk productivity development in Brown Swiss cows kept under large-scale industrial conditions is of scientific and practical importance for the further development of a competitive dairy industry in Ukraine (Perekrestova, 2018).

Objective of the Study. To investigate the influence of genetic factors (sire origin and line affiliation) on the development of key milk productivity traits in Brown Swiss cows.

Materials and Methods. The research was conducted using primary zootechnical records and data from the SUMS electronic database at "Yekaterynoslavskyi". At the dairy production complex, cows are housed in group box stalls with rubber mats (Fig. 1). Young stock are raised in group pens under sheds using straw-based deep or accumulated bedding systems. Milking is carried out using a "Parallel" milking system by DeLaval, equipped with the "Alpro" herd management system. Feeding of the main herd is performed using total mixed diets, and calves are fed whole milk through group drinker systems. The study analyzed the milk productivity indicators of first-calf Brown Swiss cows (n = 277) over a standard lactation period of 305 days, including: milk yield (kg per lactation), fat content (%), and protein content (%).

Photo 1**. Cows housing**

Statistical data analysis was performed using Microsoft Excel 2020. The influence of sires on the variability of milk yield and milk fat content in their daughters was assessed through one-way analysis of variance. The significance of differences was evaluated using Student's t-test.

Research Results. The core herd of the Brown Swiss cattle at the dairy production complex originates from four genealogical lines of the breed: Distinction 159523, Elegant 148551.66, Stretch 143612 and Payven 136140 (Fig. 2). The most numerous lines are Elegant 148551 and Distinction 159523, each representing 65% of the herd. A smaller portion of the breeding stock descends from sires of the Payven 136140 line. Linebreeding within the Brown Swiss herd ensures diversity in animals' productive traits and supports the genetic improvement of the population. This approach allows for the targeted combination of animals with desirable characteristics – particularly high milk productivity, disease resistance, good reproductive performance, and longevity.

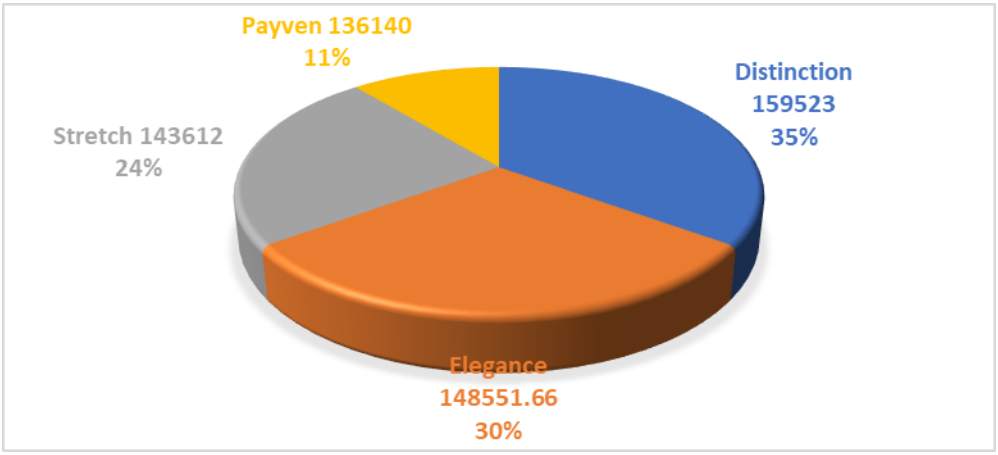

Figure 2. **Genealogical structure of the Brown Swiss herd core**

We conducted a comparative analysis of milk productivity indicators among Brown Swiss cows with different line affiliations. It was established that animals belonging to different genealogical lines, despite being kept and fed under the same conditions, showed statistically significant differences in milk production levels.

When comparing the productivity of daughters from different lines, a significant advantage in milk yield was observed in cows from the Stretch 143612 line, with an average yield of 9768 ± 127.1 kg, clearly outperforming their peers from other lines (Fig. 3). Compared to the Payven 136140 line, the yield was significantly higher by 1435 kg ($P < 0.001$), compared to the Elegant 148551 line – by 1258 kg, and compared to the Distinction 159523 line – by 641 kg. The lowest average milk yield (8333 ± 111.0 kg) was recorded in daughters of the Payven 136140 line, indicating significantly lower production compared to the other lines.

The obtained data highlight the substantial influence of line affiliation on the milk productivity level of Brown Swiss cows, which should be taken into account when conducting breeding programs within the herd.

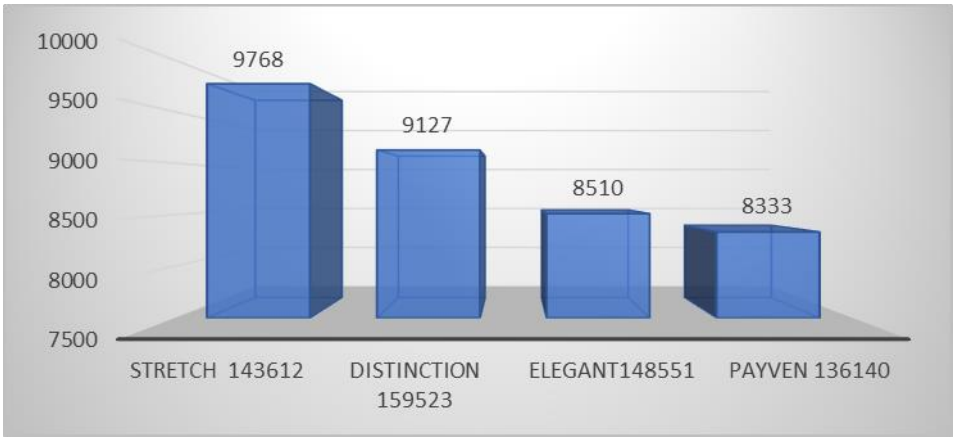

Figure 3. **Milk yield of first-calf Brown Swiss cows from different genealogical lines, kg**

One of the important breeding traits that reflects milk quality is fat content. A significant difference in milk fat content was observed among cows of different lines (Figure 4). The highest fat percentage (4.10 ± 0.010%) was found in the milk of daughters from the Distinction 159523 line. The lowest fat content (3.81 ± 0.021%) was recorded in first-calf heifers from the Stretch 143612 line. Cows of this line showed a significantly lower fat percentage compared to the daughters of the Distinction 159523 line, with a difference of 0.29% ($P < 0.001$).

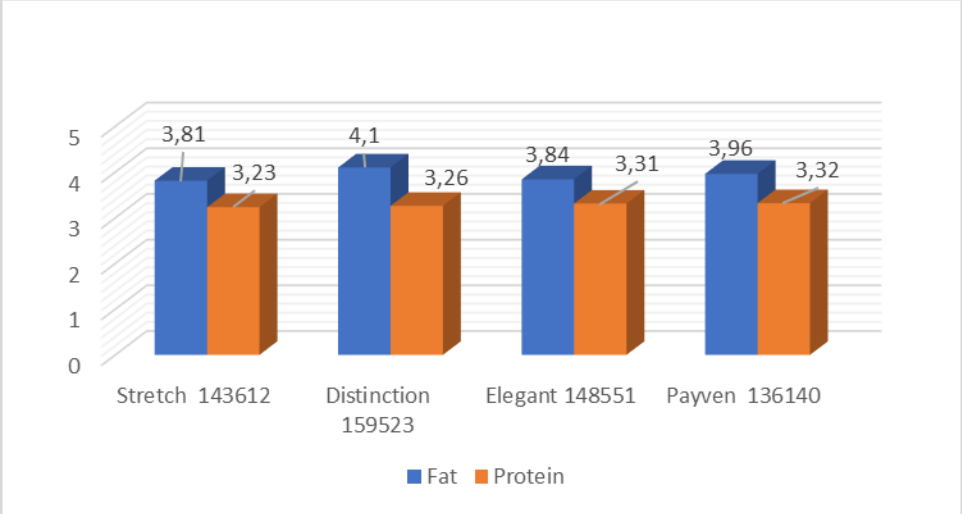

Figure 4. **Fat and protein content in the milk of first-calf Brown Swiss cows from different genealogical lines, %**

There were no significant differences in milk protein content among the studied groups of animals. However, the lowest protein content during the first lactation was observed in cows of the Stretch 143612 line (3.23 ± 0.012%), while the highest was found in descendants of the Payven 136140 line (4.10 ± 0.012%).

A certain degree of intergroup differentiation was also found in the indicator of total milk fat yield. The highest values for this trait (372 ± 10.7 kg) were recorded in cows of the Stretch 143612 line, while the lowest (326 ± 10.2 kg) were observed in animals from the Elegant 148551 line. The significant difference in milk fat yield between these lines was 46 kg ($P < 0.001$) (Fig. 5).

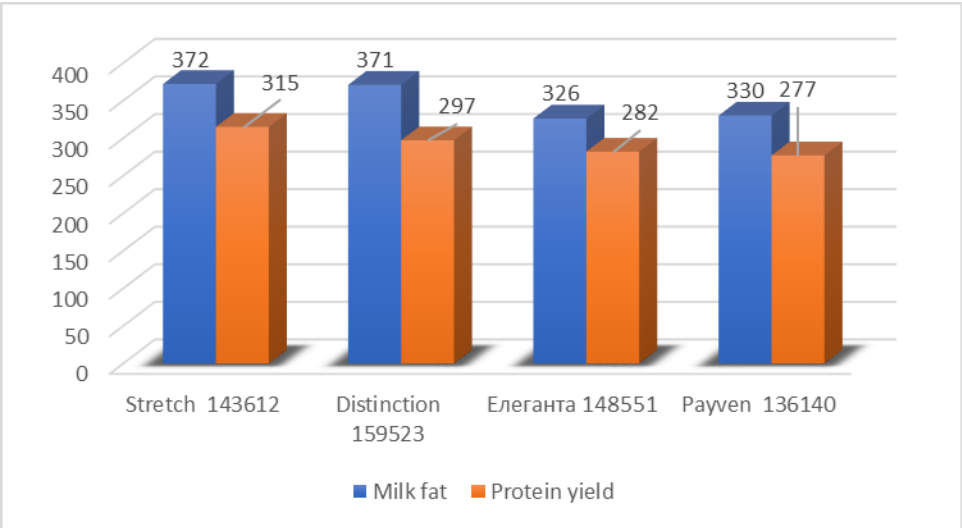

Figure 5. **Milk fat and protein yield in first-calf Brown Swiss cows from different genealogical lines, kg**

A comparative analysis of milk productivity indicators was conducted for the daughters of Brown Swiss breeding bulls (Table 1). The first-calf heifers in all experimental groups demonstrated a sufficient level of milk productivity, which is the result of proper feeding and appropriate housing conditions.

It was established that first-calf heifers of different origin showed a significant level of variability in key milk production traits. Brown swiss cows demonstrated high levels of milk yield; however, the significantly highest milk yields were observed in daughters of the breeding bulls Lester 96695540 (Stretch 143612 line) – 10,248 ± 130.0 kg and Sesdeblum 68144448 (Distinct 159523 line) – 10.445 ± 115.2 kg. The lowest yield (8048 ± 134.2) was found in daughters of Apex 109736195, also of the Distinct 159523 line.

In terms of milk yield, the daughters of Lester 96695540 significantly outperformed the daughters of Apex 109736195 by 2200 kg ($P < 0.001$), while the daughters of Sesdeblum 68144448 exceeded the same group by 2397 kg of milk ($P < 0.001$).

1. Influence of breeding bulls on milk productivity of their daughters ($\bar{x} \pm S.E$)

Nickname and ID of bull	head	Milk yield, kg	Amount of fat		Amount of protein	
			%	kg	%	kg
Gotor 8011946895	35	9649 ± 121.5	3.78 ± 0.011	365 ± 9.23	3.27 ± 0.01	315 ± 6.1
Lester 9695540	28	10248 ± 130.0	3.82 ± 0.022	391 ± 10.91	3.18 ± 0.02	326 ± 8.4
Boeing 36990500134	40	9409 ± 117.1	3.84 ± 0.010	361 ± 9.71	3.23 ± 0.01	304 ± 5.8
Sesdeblum 68144448	40	10445 ± 115.2 [a]	3.77 ± 0.011 [c]	394 ± 9.12 [a]	3.08 ± 0.01 [c]	322 ± 5.3[a]
Diplomat 11899675	32	8889 ± 128.4	4.23 ± 0.01	376 ± 11.34	3.35 ± 0.01	299 ± 6.1
Apex 109736195	38	8048 ± 134.2 [c]	4.30 ± 0.013 [a]	346 ± 10.11 [c]	3.36 ± 0.02 [a]	270 ± 6.4 [c]
Simbaboy 120102541330	33	8980 ± 143.1	3.85 ± 0.020	345 ± 11.01	3.28 ± 0.02	295 ± 5.9
Turbo 3004909742	31	8084 ± 132.2	3.82 ± 0.021	309 ± 12.41	3.34 ± 0.01	270 ± 5.6
Dasher 7855696	40	8466 ± 119.0	3.85 ± 0.012	325 ± 11.70	3.32 ± 0.01	281 ± 5.1
Karl 3139216990	25	8387 ± 145.1	4.10 ± 0.023	344 ± 13.22	3.34 ± 0.02	280 ± 6.5
Chance 142563183	25	8279 ± 145.1	3.82 ± 0.023	316 ± 13.22	3.30 ± 0.02	273 ± 6.5

***Note**: a:c – $P < 0.001$*

However, the offspring of the bull Apex 109736195, which had the lowest milk yield, demonstrated the best results for milk fat and protein content (4.30 and 3.36%, respectively). In contrast, the daughters of the bull Sesdeblum 68144448, although showing the highest milk yield, had the lowest values for these traits (3.77% and 3.08%). The advantage in fat content of Apex's daughters over those of Sesdeblum was 0.53% ($P < 0.001$), and in protein content – 0.28% ($P < 0.001$).

To determine the extent of genotypic influence on the milk productivity indicators of Brown Swiss cows from the herd of LLC "Yekaterynoslavskyi", a one-way analysis of variance was conducted. The aim of the analysis was to establish the statistical significance of the influence of sire origin and genealogical line on the milk productivity of first-calf heifers (Table 2).

The results of the variance analysis indicate that the milk yield of first-calf cows in the studied herd significantly depends on their paternal lineage. The high coefficient of heritability ($\eta^2_x = 0.510$) points to a substantial genetic contribution to the total phenotypic variability of this trait. The statistical significance of the influence is confirmed by the Fisher criterion ($F = 22.42$), which indicates a statistically significant contribution of the paternal component to the formation of milk yield during the first lactation.

It was established that the most significant influence of sire bulls was observed on the milk yield of their daughters ($\eta^2_x = 0.510$), whereas their effect on milk fat content was much lower and statistically insignificant ($\eta^2_x = 0.03$). This indicates a low heritability level of this trait under the conditions of the studied herd.

2. The influence strength of genotypic factors on the milk productivity of first-calf cows

Trait	Milk yield, kg	Amount of fat		Amount of protein	
		%	kg	%	kg
Line					
F	11,06	0,349	1,92	1,28	3,850
η^2_x	0,264	0,016	0,074	0,052	0,120
P<	0,001	unreliable	0,01	0,01	0,001
Paternal origin					
F	22,42	0,683	3,725	2,778	7,098
η^2_x	0,510	0,03	0,148	0,11	0,248
P<	0,001	unreliable	0,05	0,01	0,001

Thus, the variability in the main milk productivity traits of first-calf heifers is determined more by paternal origin than by affiliation with specific genealogical lines. This highlights the leading role of the sire genotype in shaping economically valuable traits and emphasizes the importance of careful selection of bulls in breeding programs.

Conclusions:

- Line breeding within the Brown Swiss cattle herd ensures genetic diversity in terms of productive traits and contributes to the overall genetic improvement of the population.
- The study showed that genealogical lineage significantly affects milk productivity in Brown Swiss cows. The results confirm the importance of considering genetic inheritance during selective breeding and herd formation to achieve maximum milk productivity.
- It was found that paternal origin had a stronger influence on milk productivity indicators of Brown Swiss cows than affiliation with a specific genealogical line. This is supported by the fact that progeny of bulls from the same line showed significant variation in milk yield and composition, indicating the decisive role of the individual genotypic characteristics of sires in shaping economically valuable traits.
- The daughters of the bull Apex 109736195, which had the lowest milk yield among the studied groups (8048 kg), stood out for their high milk quality – fat content was 4.30%, and protein content was 3.36%. In contrast, daughters of the bull Sesdeblum 68144448 demonstrated the highest milk yield (10445 kg), but had lower fat (3.77%) and protein (3.08%) contents compared to other progeny. These results suggest an inverse relationship between milk quantity and its quality, particularly fat and protein content.

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