The genetic productivity potential of Holstein heifers of different selections in conditions of the Volgograd region

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Abstract. The article presents results of a comparative assessment of intensity, dynamics of growth and development of Holstein heifers of two ecological-genetic types considering the factor of the age. Experimental studies were conducted in the conditions of a dairy unit for milk production, “Donskoe” farm enterprise, LLC, Surovikinsky district, the Volgograd region. Despite the fact that at birth the Dutch heifers were superior to the Russian ones with respect to the live weight by 4.0 kg, by the third month of age the live weight of the heifers in both groups was equal and amounted to 102.4 and 102.5 kg, respectively. Under the same feeding and keeping conditions, the heifers in Group I were established to surpass the heifers in Group II in terms of the overall live weight gain by 1.3 and 0.7 kg at 3 and 10 months of age, respectively. The heifers in Group I had higher average daily live weight gain than heifers in Group II by 5.5% (P ≥ 0.999) at the age of 3 months and by 4.5% (P ≥ 0.999) at the age of 10 months. The intensive rearing procedure enabled reaching the heifers’ live weight, corresponding to the minimum breed requirements for insemination, i.e. 365.5 kg in Group I and 366.3 kg in Group II by the age of 15 months. Thus, that heifers of Russian selection had good growth and development indices in all life periods in the arid zone of the Volgograd region.

1. Introduction
Ensuring the country's food security is the priority task today. The problem of increasing volume of milk and meat production also remains relevant. The expanded herd reproduction that enables realizing the genetic potential of livestock productivity due to creating conditions for intensive rearing of replacement young animals is of great importance in solving the problem of providing the population with food and the industry with raw materials.

Directional rearing of heifers begins with proper selection and parental combination for reproduction, taking into account blood groups and their genetic compatibility [1-3]. Phenotypic traits formed in animals even with a similar heredity are known to be not the same due to the influence of various environmental conditions, such as care, keeping, and feeding [4, 5]. So heifers raised in unsatisfactory conditions never become highly productive cows, even if they come from high-value parents, since the diversity of phenotypic traits is based on the relationship between heredity and rearing conditions [6, 7]. Therefore, important elements of breeding and milk production technologies are growing and feeding of replacement heifers, since the milk productivity is formed in the process of growth and development of an individual [8]. Heifers noted for insufficient development are known to experience difficulties in the first calving and are subsequently characterized by a rather low milk production during lactation [9-
11]. For a stable realization of their genetic productivity potential, intensive rearing of the replacement heifers requires monitoring the dairy heifers’ physiological states so as the live weight gain not to turn into the weight excess that causes obesity and decrease in reproductive capacity of the heifers in the future [4]. In this regard, the study of the growth and development of heifers with a high genetic productivity potential in the age dynamics contributes to improving the technology of rearing replacement heifers to obtain highly productive animals in the future [12]. For this purpose, we conducted a comparative assessment of the intensity, dynamics of growth and development of Holstein heifers of two ecological-genetic types from birth to 15 months of age, with the dynamics of the live weight, average daily and overall live weight gain in Holstein heifers of Russian and Dutch selections being studied considering the factor of the age.

2. Materials and methods

Experimental studies were conducted on Holstein heifers of Dutch and Russian selections in the conditions of a dairy unit for milk production, “Donskoe” farm enterprise, LLC, Surovikinsky district, the Volgograd region. The research work was performed on the daughters of Holstein heifers imported from the Netherlands and heifers selected in Russia from birth to 15 months of age. The ancestors of the experimental animals belonged to three main lines of Holstein bulls, i.e. Reflection Sovering, Wis Burke Ideal, and Montvik Chieftain. The average productivity indices for 305 days of lactation were 10083.0 kg of milk, fat content of 4.1% for Dutch selection mothers and 9787.6 kg with 4.0% fat content for Russian selection mothers.

To conduct the research, two experimental groups of young animals at the age of 15 days were formed, namely, Group I included heifers of Russian selection (n = 10) and Group II contained heifers of Dutch selection (n = 10).

Up to 6 months of age, the diet of experimental animals included 0.7 kg of alfalfa hay, 2.5 kg of haylage, 1.8 kg of silage, 1.0 kg of sunflower cake, 0.01 kg of soybean meal, 1.0 kg of wheat extrudate, 0.4 kg of crushed corn, and 0.3 kg of premix. The diet structure contained 64% of bulky herbal feed and 35% of concentrates. In summer, the main feed was calf crop with the concentrates in feeders.

In the period from 6 to 12 months of age, the amount of bulky feed in the diet was increased to 72% and concentrated feed was reduced to 26.5%. The deficiency in macro- and microelements was compensated by premixes and feed supplements. In winter, the main feed for heifers was hay, silage, silage, and concentrates. When compiling the ration for this period, the following structure was adhered to: 18-20% of hay, 50-55% of haylage, and 27-30% of concentrates.

From the age of 12 months, the ration of heifers was calculated for an average daily gain of 750-850 g. That is, in the process of growing, the feeding rations were adjusted to the age, live weight, and breed characteristics of the experimental animals.

The dynamics of the heifers’ live weight was determined on the basis of monthly weighing of the experimental livestock.

In the research, data from primary livestock accounting and our own previous research studies were used. The digital data were processed by the method of variation statistics (Plokhinsky N.A., 1970), using Microsoft Office and Microsoft Excel programs and determining the reliability Student criterion.

3. Results and discussion

A rational system of rearing young animals that considers their biological characteristics contributes to normal growth, development, high productivity, a strong constitution, preservation of health, and further extension of the terms of their economic use. When raising replacement young animals, specially developed growth plans that take into account the breed characteristics of livestock are applied. The growth rate of young animals changes with age. This feature should be taken into account when planning their growth rates by age. Nutrient requirements of young animals depend on the age, live weight, and average daily gain.
On the farm, the system of rearing heifers makes it possible to ensure the live weight standards for all growth periods up to mating. From the very beginning, the young animal's life is paid particular attention to.

For raising heifers, the farm was equipped with a preventive maintenance workshop with isolated sections; one of them was divided into individual cages. The heifers were placed in one and then in another section of the workshop. The heifers were kept on a deep non-replaceable straw bed. At the age of 15 days, the animals were transferred from the workshop into a calf barn for further group keeping and rearing. Particular attention was paid to mother-bonded rearing heifers to ensure good health and rapid growth of young animals.

During the preweaning period, heifers consumed 242.5 liters of whole milk and 200 liters of whole milk substitute per head in accordance with the farm's scheme of rearing young animals. The heifers were fed with colostrum and milk depending on their physiological states in the amount of 1.5-2.0 liters per feeding 3 times a day. The feeding time lasted for 2.5 months. When rearing dairy cattle, an important place was given to the early plant feeding. Starting from the 6th day of life, the young animals’ diet was added with starter compound feed that covered the need for micro- and macroelements and finely crushed corn grain that contributed to the rapid development of the villi of the ruminal epithelium. Feeding with bulk fodders began from the 26th day (with hay) and 70th days (with haylage). In all seasons of the year, chalk and table salt were added as mineral supplements. During this period, it was important to adhere to the regime of all production processes—feeding, drinking, rest, and exercise, since any deviation led to a decrease in productivity and could adversely affect the heifers’ health. The feeding scheme used in the farm ensured 750-850 g of average daily live weight gain of heifers at an early age.

The live weight of cattle is the main criterion for assessing their development, therefore, the compliance of the nutritional value of the diets with biologically complete feeding guarantees correct development, good health, rapid growth of young animals, and maximum life-long productivity [2].

The data on the change in the live weight of heifers from birth to 15 months of age are given in table 1.

| Age       | Groups of experimental heifers |
|-----------|--------------------------------|
|           | I                | II               |
| At birth  | 30.9±1.13        | 34.9±0.97        |
| 3 months  | 102.4±2.03       | 102.5±1.98       |
| 4 months  | 126.5±1.89       | 127.8±1.76       |
| 5 months  | 149.7±1.92       | 152.2±1.85       |
| 6 months  | 178.9±1.86       | 181.7±1.92       |
| 10 months | 271.6±2.14       | 271.6±2.08       |
| 12 months | 307.5±2.23       | 308.3±2.18       |
| 15 months | 365.5±2.09       | 366.3±2.11       |

The live weight values of heifers at birth in Groups I and II differed. This indicator in Group I was lower by 4.0 kg in comparison with Group II, although the difference was insignificant. By the end of the milk feeding period—the third month of life—the heifers’ weight in both groups was equal and amounted to 102.4 and 102.5 kg, respectively. By the age of 4 months, the heifers reached an average live weight of 126.5 kg in Group I and 127.8 kg in Group II. The difference was 1.3 kg in favor of Group II heifers.

The dynamics of the live weight with respect to the age of Holstein heifers of the Russian and Dutch selections showed, that Group I heifers had better indices under the same feeding and keeping conditions (table 2). In terms of the overall live weight gain, the heifers in Group I exceeded their peers in Group II at 3 and 10 months of age by 1.3 and 0.7 kg, respectively. However, at the age of 15 months, this indicator in both groups was equal and amounted to 19.33 kg.
Table 2. – Overall live weight gain of experimental heifers, kg (n = 10).

| Age       | Groups of experimental heifers |   |   |
|-----------|-------------------------------|---|---|
|           | I                             | II |   |
| 3 months  | 23.83±0.36                    | 22.53±0.41 |   |
| 4 months  | 24.10±0.26                    | 25.30±0.29*|   |
| 5 months  | 23.20±0.31                    | 24.40±0.28*|   |
| 6 months  | 29.20±0.24                    | 29.50±0.27 |   |
| 10 months | 23.17±0.26                    | 22.47±0.29 |   |
| 12 months | 17.95±0.28                    | 18.35±0.27 |   |
| 15 months | 19.33±0.26                    | 19.33±0.28 |   |
| From birth to 15 months | 22.30±0.29 | 22.09±0.32 |   |

The overall live weight gain of Group I heifers from birth to 15 months of age was 22.30 kg, which was more by 0.21 kg in comparison with heifers in Group II.

At the same time, we should note faster heifers’ development rates in Group I in comparison with the heifers in Group II (table 3).

Table 3. – Average daily gain of experimental heifers, g (n = 10).

| Age       | Groups of experimental heifers |   |   |
|-----------|-------------------------------|---|---|
|           | I                             | II |   |
| 3 months  | 785.71±0.46                   | 742.85±0.64***|   |
| 4 months  | 803.33±0.65                   | 843.33±0.69***|   |
| 5 months  | 773.33±0.72                   | 813.33±0.76***|   |
| 6 months  | 938.70±0.69                   | 951.60±0.74***|   |
| 10 months | 771.30±0.82                   | 736.88±0.86***|   |
| 12 months | 615.00±0.79                   | 611.66±0.85***|   |
| 15 months | 620.80±0.81                   | 637.36±0.84***|   |
| From birth to 15 months | 732.16±0.95 | 725.16±1.04***|   |

Table 3 shows that in terms of the average daily increase in live weight, the heifers in Group I were significantly superior to the heifers in Group II in all periods of growth. The highest gains in both groups were obtained in the period of up to six months of age, since internal organs and muscle tissues develop to the fullest extent in the first months of life. In Group I, the heifers’ average daily live weight gain was by higher 42.86 g or 5.5% (P ≥ 0.999) at the age of 3 months and by 34.42 g or 4.5% (P ≥ 0.999) at the age of 10 months. For the period from birth to 15 months of age, the average daily live weight gain was 732.16 g in Group I and 725.16 g in Group II, so the parameter was also higher in Group I.

The Holstein cattle belongs to early maturing breeds, therefore the most intensive growth occurs in the period of up to one year of age, then the growth energy decreases. The maximum average daily live weight gain was noted in heifers of both groups at the age of 6 months and amounted to 938.70 and 951.60 g, respectively, with the heifers’ live weights differing insignificantly in both groups.

At heifer breeding age of 6-10 months, there was no significant difference between the groups in terms of both average daily weight gain and live weight.

By the 15-month age of heifers, the intensive rearing method made it possible to reach the live weight that meets the minimum breed requirements for insemination, i.e. 365.5 kg in Group I and 366.3 kg in Group II.

4. Conclusion

The research allowed establishing that the heifers of Russian selection had good growth and development indices in the arid zone of the Volgograd region at all periods of life.

The difference in the weight at birth between heifers in Groups I (Russian selection) and II (Dutch selection) was compensated by faster development rates and higher indices of the average daily gain of heifers in Group I by the third month of life.
For the better development of heifers, their readiness for fruitful insemination in the proper period and in the long term for high milk productivity, it is necessary to find an optimal strategy for rearing heifers. Therefore, the data obtained in the experiment serve as additional data for adjusting the rearing system in the farm.

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