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# PHYSIOLOGY OF ANIMALS

## PECULIARITIES OF WEIGHT AND LINEAR GROWTH DYNAMICS OF THE UKRAINIAN RED AND BLACK-SPOTTED DAIRY BREEDS HEIFERS

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### **Abstract**

The research results on dynamics of weight and linear growth of heifers of the Ukrainian red-spotted and black-spotted dairy breeds are highlighted in the work. It is obligatory to lay the foundations for high productivity of adult animals during the young cattle rearing period, which is associated with the growth and development of the young body. The live weight that animals reach at a certain age and their exterior are indicators of their quality. The effect of proper breeding on the productive qualities of animals can be achieved through targeted and effective selection.

The heifers of Ukrainian red-spotted and black-spotted dairy breeds feeding during the research period (average 6.0 feed units and 660 g of digestible protein per average annual head per day) ensured their optimal growth and development. Red-spotted heifers significantly outperformed their black-spotted peers at in live weight, i.e. by 7.7 kg at the age 6 months of, by 12 kg at the age of 12 months of age, by 22 kg at the age of 18 months. The growth rate of heifers of red-spotted breed was 647 g, and black-spotted was 637 g per head per day for the heifers rearing period (from birth to 18-month age).

**Keywords:** breeding, feeding, researched heifers, dairy breeds, young animals, selection, live weight, growth, development.

Statement of the problem. Modern methods of dairy cattle breeding should be based on body biological peculiarities and cause the animals desired productivity. The application of advanced technologies for keeping animals and increasing their intensive application requires a clear organization, a set of measures for feeding, care, sanitary and preventive conditions for keeping animals.

The organization of a rational system of replacement animals breeding should improve its quality through intensive development [4]. Increasing labor productivity is ensured through the advanced methods of keeping animals, rational organization of labor, creating appropriate conditions that harden the body making it resistant to diseases.

Depending on the complex of physiological functions of the organism and living conditions the process of raising animals is divided into separate age periods of individual development. Each of these periods is characterized by certain unique features and has its own technology. This is especially evident in the conditions of animal husbandry intensification; it necessitates the constant combination of biological features of individual animal development with technological features [3].

The efficiency of growing young animals depends on its development dynamics and breed.

Analyses of recent research and publications.

Progressive selection is one of the first factors determining the pace of livestock development. It is an important factor in improving efficiency, it can accelerate the qualitative improvement of existing breeds and creation of new more productive breeds, lines and types meeting modern needs and technology [1].

In Ukraine the milk production crisis is primarily caused by the unprofitability of dairy farming in previous years [2]. As a result, there has been a reduction in the number of dairy herds, including replacement

young animals. The research of the dynamics of weight and linear growth of heifers of Ukrainian red-spotted and Ukrainian black-spotted dairy breeds is important and necessary. It gives a clear picture of replacement young animals. It is necessary to be acquainted with features of differentiation of separate organs, tissues and body in the postembryonic period [8]. Growth and development are two sides of the same process of each animal individual development.

Most researchers are for intensive rearing of replacement young animals, it is a major factor in the formation of animals with a strong constitution, capable of long-term high productivity [6].

The aim of the research. The aim was to research the dynamics of weight and linear growth of heifers of Ukrainian red-spotted and Ukrainian black-spotted breeds in the conditions of SE Artemida Kalynivka district of Vinnytsia region.

Objects and methods of research. The animals of the SE Artemida Kalynivka district of Vinnytsia region were the research objects. The research objectives were:

to investigate the live weight of heifers of the researched breeds by age, i.e. at birth, at 6 months, 12 months, and 18 months;

to research the absolute and average daily increase in live weight;

to investigate the indicators of heifers' linear growth by measurements at different ages;

to determine the correlation between individual indicators of body structure.

Keeping and feeding conditions of experimental heifers of Ukrainian red-spotted and Ukrainian black-spotted dairy breeds were the same; they did not differ from those at the farm. They were kept loosed in group cages or sections with livestock in one cage, i.e.

- from birth to 20 days age (4-5 heads);

- from 2 to 6 months of age (10-12 heads);

- from 6 to 12 months of age (12-15 heads);
- from 12 to 18 months of age (in sections of 25-30 heads).

Two groups of different breeds heifers were formed for the experiment. We selected Ukrainian red-spotted heifers for the first group, and Ukrainian black-spotted heifers for the second group, each group has 10 heads. The groups of animals were formed for two months as the cows calved. Experimental animals were observed from birth to 18 months of age.

We have studied the following indicators of weight growth:

- live weight by monthly weighing;
- absolute and average daily gain of live weight by the calculation method, according to the formula: absolute gain = the final live weight – the start live weight.

Average daily gain = Absolute gain / Days number;

$$\frac{\text{Absolute gain}}{\text{Days number}}$$

Linear growth of heifers was researched by taking basic measurements at birth, 6 months, 12 months and 18 months.

The main indicators of animals' live weight of and their bodies measurements are processed by the method of variation statistics (Plokhinskyi N.A., 1969) [7].

We have also studied the correlation between individual indicators of body structure, i.e. between the live weight and the girth of the chest behind the shoulders;

between the live weight and the oblique length of the torso.

Research results and their discussion. Rational growth of replacement heifers is the basis for the organism formation with all its physiological and adaptive properties. The cardiovascular, respiratory and food systems, endocrine glands and skeletons develop intensively for the first months of young animals' life, the animal type, its reproductive organs and mammary glands are formed and at the age of 12-18 months. Thus, the breeding of replacement heifers should be carried out with full and balanced feeding in all periods of animal growth.

In our experiment, young animals up to 6 months were fed according to the scheme shown in table 1.

According to Table 1, the feeding heifers up to 6 months includes the consumption of 400 kg of whole milk and 600 kg of skim milk at the Artemida experimental farm. Such norms of dairy feed ensure the 170-175 kg live weight of heifers at 6 months.

Table 1

Age		Daily feed consumption, kg											
Months	Decades	Milk		Concentrated feed				Hay	Silage and haylage	Root crops	Summer green fodder	Salt / g	Chalk / g.
		Whole	Skim	Oats	Starter. Compound feeds								
1	1	4											
	2	6		0.1							5	5	
	3	7		0.2			acc.			acc.	5	5	
2	4	6	2		0.3		2			1.0	10	20	
	5	6	2		0.6		0.5	acc.	acc.	2.0	10	20	
	6	4	4		0.8		0.6			3.0	10	20	
3	7	3	5		0.8		0.8	0.4	0.4	5.0	15	20	
	8	2	6		0.8		1.0	0.5	0.5	5.5	15	20	
	9	2	6		0.8		1.1	1.0	1.0	6.0	15	20	
4	10		8		1.0		1.5	1.3	1.3	7.0	15	20	
	11		8		1.3		1.5	1.5	1.5	8.5	15	20	
	12		7		1.5		1.8	1.8	1.8	12.0	15	20	
5	13		6		1.7		2.0	2.0	2.0	16.0	20	25	
	14		4		1.7		2.5	2.5	2.5	16.5	20	25	
	15		2		1.7		2.5	3.0	3.0	17.5	20	25	
6	16				1.6		2.5	3.0	3.0	18.0	25	30	
	17				1.6		2.5	3.5	3.5	19.0	25	30	
	18				1.6		2.5	3.5	3.5	20.0	25	30	
Total for 6 months		400	600	3	177		235	240	240	1,570	2,650	3,550	

The heifers older than 6 months were fed by plant feeds according to the diets listed in Table 2. They were

developed in accordance with the feeding rate to obtain an average daily gain of 600-700 g per day.

Table 2

Heifer's average daily diets in winter and summer (average daily live weight gain is 600-700 g)

Feed and nutrients	Heifers' age, months			
	6-12		12-18	
	Season			
	winter	summer	winter	summer
1	2	3	4	5
Cereal and bean hay, kg	2		3	
Clover-alfalfa haylage, kg	3		3	
Corn silage, kg	7		7	
Fodder beet, kg	5		5	
Concentrated feed (mixture), kg	1.5	1.2	1.5	1.5
Salt, g	30	30	40	40
Disodium phosphate, g	50			
Greens (mixture), kg		26		29
Barley-oat straw, kg			1	
Molasses, kg			0.5	0.3
Monocalcium phosphate, g		30		40
Diammonium phosphate, g			40	
Diet includes:				
Feed units	5.4	5.6	6.53	6.62
Exchange energy, MJ	69.6	66.1	86.03	77.92
Dry matter, kg	6.7	6.2	8.12	7.24
Digestible protein, g	582	705.2	614.2	819.5
Crude fiber, g	1,505	1,608	2,077	1,800
Starch, g	1,051	1,407.6	1,097	1,644
Sugar, g	458	514.8	744	728
Crude fat, g	623.5	181.2	200.6	205.6
Calcium, g	58	57.9	781	67.66
Phosphorus, g	28.4	28.4	31.1	35.36
Magnesium, g	40.7	16	19.4	18.03
Potassium, g	97.8	118.4	35.4	142.8
Sulfur, g	19.1	18.4	22.5	21.5
Iron, g	1293	1584.4	124.8	1825.7
Copper, g	37.6	211.8	47.7	237.8
Zink, g	287.6	78.7	347.8	94.54
Cobalt, g	2.1	7.3	2.9	8.43
Manganese, g	288.2	483.5	397	546.5
Iodine, g	1.1	0.8	2.05	1.24
Carotene, g	141	1,092	166	1218
Vitamin D, thousand IU	1.6	1.8	2.2	9
Vitamin E, mg	648	1,880	688	2,105.9

According to Table 2, the rations for heifers at different ages were mostly balanced. The completeness of these diets can be judged from the ratios of the most essential nutrients (Table 3). So, in the winter the energy concentration in 1 kg of dry matter was 0.8 feed

units in average rations for heifers aged 6-12 months. It was 0.74 kg at 12-18 months of age, and in the summer, it was respectively 0.9 and 0.91 feed units.

Table 3

Nutritional value of replacement heifers' diets

Ratio	Heifers' age, months			
	6-12		12-18	
	Season			
	winter	summer	winter	summer
Concentration of energy in 1 kg of dry matter = $\frac{\text{feed unit}}{\text{dry matter}}$ (feed unit).	0.8	0.9	0.74	0.91
The amount of digestible protein per 1 feed unit $\frac{\text{digestible protein(g)}}{\text{feed unit}}$	107.7	125	94.2	123.7
Fiber content in dry matter: $\frac{\text{fiber content}}{\text{dry matter}} \times 100, \%$	22	25	23.5	24.8
Ratio: $\frac{\text{sugar}}{\text{digestible protein}}$	0.79	0.73	1.2	0.98
Ratio: $\frac{\text{calcium}}{\text{phosphorus}}$	2.0	2.0	2.3	1.91

The ratio of sugar to digestible protein in the diets of heifers aged 6-12 months was 0.79 in winter and 0.73 in summer; the ratio of sugar to digestible protein in the diets of heifers aged 12-18 months was 1.2 and 0.98 respectively.

The heifers' rations met the scientifically sound feeding norms for the amount of digestible protein per 1 feed unit.

Thus, the level and completeness of feeding of experimental heifers almost met the scientifically sound standards for obtaining average daily gains of 600-700 g live weight.

The different breeds heifers change in growth are presented in Table 4.

Analyzing the weight growth dynamics of experimental heifers in different age periods (Table 4), we noticed that the live weight of heifers of Ukrainian red-spotted dairy breed was higher than heifers of Ukrainian black-spotted dairy breed.

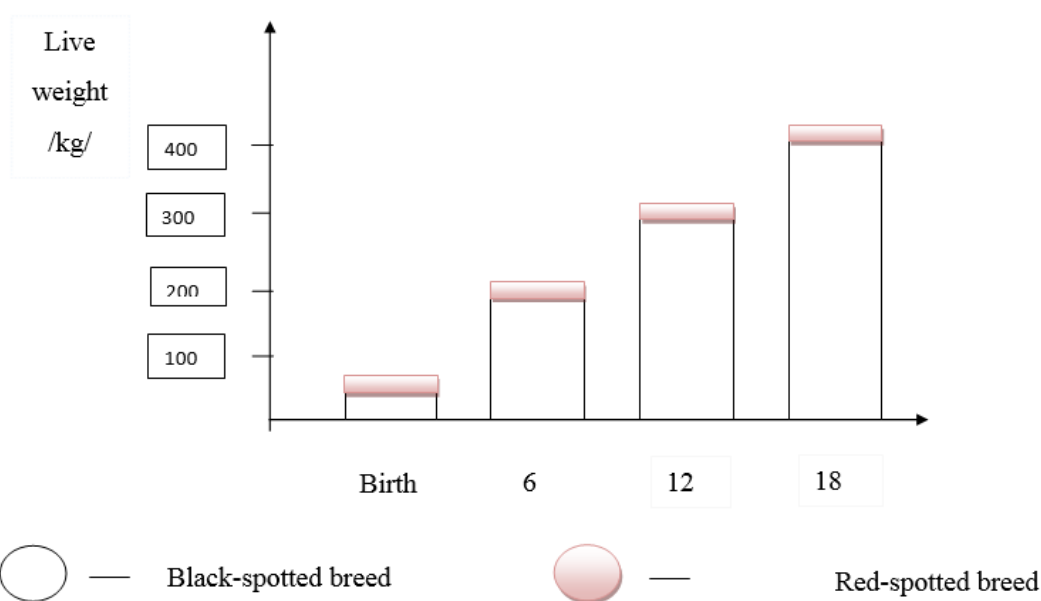
The probability criterion of the difference between the live weight of heifers from birth to 18 months of age ranges from 3.1 to 4.63 in favor of animals of the Ukrainian red-spotted dairy breed.

Table 4

Live weight of experimental heifers (kg)  $M \pm m$ 

Heifers' age, months	Animals group and breed		Probability criterion, td
	1. red-spotted	2. black-spotted	
Birth	39.1 ± 0.48	36.4 ± 0.61	3.5
6	170.6 ± 1.13	162.9 ± 2.04	3.3
12	307.5 ± 0.99	195.5 ± 2.4	4.63
18	388.5 ± 2.21	380.3 ± 1.43	3.1

(Figure 1).



According to Table 4, we see that the weight of the newborn heifer increases by 4.3 times for 6 months. The intensity of heifers' growth naturally decreases after 12 months, it can be seen from the calculations of absolute and average daily gains in live weight. It is common for both breeds of animals. Depending on the breed, animals have different live weight at birth, it affects their further growth and development in subsequent age periods (Figure 1).

Graphic representation of live weight changes of heifers by age depending on the breed is shown in Fig. 1.

Live weight indicators do not give a complete picture of the growth rate and its intensity. The indicators of absolute and average daily gains in live weight for a certain period of life is an objective assessment of growth (Table 5).

Table 5

Heifers' growth intensity				
Age periods, months	Animals group and breed			
	1. red-spotted		2. black-spotted	
	Live gain weight			
	Absolute /kg/	Average daily /g/	Absolute /kg/	Average daily /g/
0-6	131.5	730	126.5	703
6-12	136.9	760	132.6	737
12-18	81.0	450	84.8	471
18-0	349.4	647	343.9	637

Indicators of heifers' growth intensity differed markedly (Table 5). In the first half of life the average daily gain of live weight of the Ukrainian red-spotted dairy breed heifers was 730 g per head, in the second it was 760 g per head; in the third it was 450 g per head. The growth intensity of heifers of the Ukrainian black-spotted dairy breed was 703 g per head, 737 g per head and 471 g per head, respectively.

It should be noted that the growth intensity of heifers of the Ukrainian black-spotted dairy breed increased and was higher by 21 g than Ukrainian red-spotted dairy breed. It can be assumed that these animals can catch up with their peers of the Ukrainian red-spotted breed in conditions of good feeding in subsequent periods of growth.

The luminaries of zootechnical science (Sviechyn K.B., 1961; Lyskun Ye.F., 1961; Kravchenko M.A.,

1963) attached great importance to the exterior of animals because it characterizes the peculiarities of their growth. Ye.F. Lyskun (1961) wrote that the size and weight of an animal affect both its productivity and the amount of feed costs per unit of output. That's why, the economic value of the animal consists of both productivity signs and body structure.

All considered measurements increase and acquire certain values or parameters depending on animals age (Table 6). Both weight and linear growth are closely related.

Certain values of weight growth correspond to certain values of linear growth within one breed under normal conditions.

Analysis of changes in the animals exterior from birth to 18 months in terms of breeds showed that no significant difference in the absolute values of the measurements of different breeds heifers was found.

Table 6

Measurements of experimental heifers (cm), M ± m								
Measurements	Breed							
	Red-spotted				Black-spotted			
	Heifers' age, months							
	Birth	6	12	18	Birth	6	12	18
Height at the shoulder	77.8±0.78	104.3±0.64	112.1±1.06	118±0.72	76.9±0.76	102.3±0.53	113.5±0.71	118.1±0.67
Height at hips	81.4±0.79	107.9±0.77	118.5±0.76	123±0.81	78.4±0.73	106.2±0.82	118.2±1.05	122.5±0.92
Width of chest	17.5±0.47	27.7±0.66	33±0.89	34.9±0.86	17.6±0.44	26.1±0.70	31.6±0.66	33.7±0.73
Chest depth	28.1±0.72	47.7±0.87	53.1±0.82	59.2±0.92	25.5±0.58	46.3±0.69	53.6±0.79	58.5±0.68
Width in macula	17.0±0.82	29.7±0.96	35.1±0.77	37.3±1.34	14.9±0.86	26.4±0.97	36.2±0.89	38.9±0.77
Chest girth	83.4±1.56	128.4±1.117	143±1.07	159.7±1.30	84.1±0.91	129.8±1.14	141±1.19	158.7±1.36
Pastern girth	12.2±0.43	16.8±0.53	16.6±0.51	17.6±0.51	11.8±0.32	15.6±0.44	16±0.42	17.4±0.42
Oblique body length	76.9±1.01	110.3±1.44	119.8±1.14	125±1.14	77.3±0.74	107.2±0.89	119.6±1.03	125.1±1
Width in the torso	19.7±0.63	21.5±0.76	36.5±0.68	38.2±0.69	19.8±0.64	23.2±0.67	37±0.36	38.8±0.38
Horizontal girth of the rear	60.3±0.82	77.1±1.49	84.7±0.66	94.7±0.82	60.1±0.62	77.4±1.48	84.5±0.98	93.3±1.07

Chest girth, torso length, and height measurements increase most rapidly with age. Chest depth and width measurements, as well as wrist circumference, increase to a lesser extent.

The measurements of animals allow to obtain objective indicators of their size and body structure.

The disadvantage of this method is that there is no complete idea of the animal as a whole. However, this shortcoming is largely eliminated by calculating the indices of body structure (Table 7).



Table 7

Indices of heifers` body structure				
Indices	Heifers` age, months			
	Birth	6	12	18
Red-spotted breed				
Leggy	63.88	54.26	52.63	49.83
Lengthiness	98.84	105.75	106.86	105.93
Chest	62.27	58.07	62.14	58.95
Pelvic-thoracic	102.9	93.26	94.0	93.56
Compactness	108.45	116.4	119.36	127.76
Overgrowth	104.62	103.45	105.7	104.23
Bony	15.68	16.1	14.8	14.91
Meatiness	77.5	73.92	75.55	80.25
Black-spotted breed				
Leggy	66.84	54.74	52.77	50.46
Lengthiness	100.52	104.78	105.37	105.92
Chest	69.01	56.37	58.95	57.6
Pelvic-thoracic	118.12	98.86	87.29	86.63
Compactness	108.79	121.08	117.89	126.85
Overgrowth	101.95	103.81	104.14	103.72
Bony	15.34	15.24	14.09	14.73
Meatiness	78.15	75.65	74.44	79.0

The obtained indices (Table 7) make it possible to compare the relative development of different heifers of two breeds. The data in Table 7 show that heifers of both breeds developed equally well and differed little in body structure.

The dynamics of both weight and linear growth of heifers depending on age and breed were researched. The correlation between live weight and individual

body measurements of heifers was also studied. As a result, the positive correlation between live weight, breast girth behind shoulders, and oblique length of a body of heifers has been established (Table 8). The closest correlation was observed between the live weight and the girth of the chest behind the shoulder blades and slightly less, i.e. between the live weight and the oblique length of the body of heifers.

Table 8

Correlation between characteristics		
Heifers` age, months	Correlation characteristics	
	Live weight – breast girth	Live weight – oblique length
Red-spotted breed		
6	0.598	0.329
12	0.291	0.215
18	0.533	0.319
Black-spotted breed		
6	0.820	0.530
12	0.450	0.158
18	0.807	0.232

The correlation coefficient (r) between 6-month red-spotted heifers` live weight and breasts girth behind the shoulder is 0.598; it was 0.820 for black-spotted breed. The correlation coefficient (r) between 18-month red-spotted heifers` live weight and breasts girth behind the shoulder is 0.533; it was 0.807 for black-spotted breed (Table 8).

Thus, the basic dimensions of the body of heifers are interrelated with their live weight, regardless of breed.

Conclusions: 1. The heifers of Ukrainian red-spotted and black-spotted dairy breeds feeding during the research period (average 6.0 feed units and 660 g of digestible protein per average annual head per day) ensured their optimal growth and development.

2. Red-spotted heifers significantly outperformed their black-spotted peers at in live weight, i.e. by 7.7 kg

at the age 6 months of, by 12 kg at the age of 12 months of age, by 22 kg at the age of 18 months.

3. The growth rate of heifers of red-spotted breed was 647 g, and black-spotted was 637 g per head per day for the heifers rearing period (from birth to 18-month age).

4. Analysis of changes in animals` exterior showed that no significant difference in the absolute values of the measurements of heifers of different breeds was found. Due to age, breast girth measurements, torso length, and then height measurements increased the most.

5. According to the analysis of body structure, it was found that heifers of both breeds developed equally well and differed little in body structure.

6. A positive correlation was found between live weight and measurements of breast girth and oblique length of the body of heifers in both breeds.

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