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MODERN CALF REARING SYSTEM

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Abstract. *Calf rearing is critical to a successful dairy or beef cattle breeding. Maximum productivity at the lowest cost can be obtained from healthy calves only.*

Zootechnical, biochemical and economic research methods were used during the experiments.

It has been determined that feeding calves with experimental milk replacer with milk period duration of 65 days allowed to obtain 692 g of the average daily weight gain for the experiment period, that is 2.3% lower than the control indicator. Feeding calves with WMR helps to reduce the cost of diet by 6.0% and the price cost of weight gain by 3.6%.

Use of dry skimmed milk replacer and whole milk replacer during the rearing period, with milk period duration of 115 days, contributed to decrease in weight gain by 1.8 and 1.2% compared to the control variant. Feeding calves with DSMR and WMR helped to reduce the cost of diet by 10.3 and 5.8% and the price cost of weight gain by 8.5 and 4.8%.

Feeding with DSMR and WMR in diet for young animals over 115 days of age during the post-milk period increases concentration of erythrocytes in blood by 10.0 and 9.8%, hemoglobin - by 5.8 and 3.9%, amount of glucose - by 11.0 and 9.5%.

Inclusion of DSMR and WMR in diet for young cattle with milk period duration of 65 and 115 days contributed to increase in the average daily weight gain in the post-milk period by 9.2 and 10.7%, while reducing the cost of feed by 5.8 and 7.6%, price cost of weight gain by 6.1 and 7.7% and increase in additional profit in the amount of 8.35 (3.5 USD) and 10.58 (4.5 USD) rubles per animal during

experimental period.

In the future, it is necessary to improve the feeding system of young cattle using new developments in this area.

Keywords: *young cattle, whole milk, whole milk replacer, dry skimmed milk replacer, hematological indicators, productivity, efficiency.*

Introduction

System of young cattle rearing consists of three technological periods: growing, rearing, fattening, which include the milk and post-milk period, period of intensive growth and the final fattening. Rearing calves using modern technology, feed and feed additives is critical for a successful dairy or beef cattle breeding. Maximum productivity at the lowest cost can be obtained from healthy calves only. In this regard, it is necessary to constantly improve the calves feeding system and develop new feed additives (Marques et al., 2019).

Analysis of recent research and publications

Digestive system of newborn calves is characterized by incomplete development: they have poorly developed proventricles: in the first three weeks of a calf's life, the ratio of rumen and abomasum volumes is 1:2; 6 weeks of age – 2:3; 8 weeks – 3:2; 10 weeks – 2:1. In an adult animal, the abomasum makes only 8% of the total stomach capacity, while the rumen is 80% (Antonovich, 2019).

Liquid milk feed is used as the main feed during the milk period for calves feeding, the rest of the diet consists of concentrates, hay or grass cutting. Feeding young calves should ensure a rational combination of high-grade nutrition like a monogastric animal, while simultaneously stimulating the development of proventriculus function in a targeted manner (Radchikova et al., 2018; Boorboor et al., 2020).

After birth, the calf needs to be fed with colostrum as early as possible and should receive it within 7-10 days, and then collected milk or milk of the nursing cows. At the most farms, whole milk or milk replacers are fed to calves. When using whole milk and skimmed milk replacer, whole milk is fed during 1-2 months, and skimmed milk is fed up to 4-5 months of age. It is required to feed milk at the rate of 1 liter per 5-6 kg of body weight of animal up to 10 days of age 4 times a day, and 3 times after. The maximum daily milk feedings fall on 2-3 decades, after that it is constantly reduced (Buryakov et al., 2019; Liu Ting et al., 2020; Lopez et al., 2020;).

When rearing young calves using liquid feed in large quantities, which are most attractive to their taste, animals eat relatively less of dry feed which delays development of proventriculus (Jiang et al., 2020; Radchikova et al., 2020; Rai et al., 2020; Turini et al., 2020).

From birth to 6 months of age, calves grow vigorously, skeleton, muscular system and internal organs are formed for which requires a certain amount of energy, nutrients and biologically active substances.

Up to 2 months of age, calves should receive feed with a high biological value of proteins, until the rumen is underdeveloped and synthesis of microbial protein in the proventriculus is absent or very weak. During this period, it is almost impossible to provide calves with full-grade protein with no milk feeding. With development of the proventriculus, a variety of plant food also become sources of protein (Sintzerova et al., 2019).

In the post-milk period, young animals are transferred to vegetable feed. The main challenges of this period: formation of animals of the desired type; achieving high body weight and condition (Gading et al., 2020; Shiasi Sardoabi et al., 2021).

During this period, different feeding systems can be used: uniform feeding throughout the year, when animals are fed with balanced mono feed, consisting of crushed and mixed different types of feeds in predetermined proportions, or seasonal feeding with a set of appropriate feeds. Typically, feeding programs are designed to use 3-4 types of feed to obtain feed mixtures (Dolzenkova, 2016; Smynev et al., 2017; Dalla, 2020).

When rearing calves, there are four main periods:

- milk period, starting from birth of calf and up to 3-4 months of age;
- post-milk period – from 3-4 to 6 months of age;
- period of intensive growth – from 6 months to 1 year of age;
- the period of final fattening – from 1 to 1.5 years of age.

Rearing calves up to 6 months of age is carried out according to feeding schemes with a set of diets for each decade. This is due to the fact that calves grow quickly, they need frequent diet changes. In addition,

dairy and concentrated feeds are used for calves, consumption of those is planned in advance. Costs of rearing young stock when using pure milk feeding programs are quite high. One calf usually requires 250-500 kg of whole milk to feed. Consumption of significant amounts of milk for feeding young animals, along with rise in cost of rearing animals, leads to sharp decrease in marketability of milk and excludes it from the field of direct human use.

Inclusion of whole milk replacers (WMR) in diet for calves allows to reduce the period of milk feeding to 7-10 days, and its quantity to 50-60 kg per animal (Grice et al., 2020; Radchikova et al., 2020).

However, certain requirements shall be met for successful use of whole milk replacers. In terms of nutritional value, they should be equivalent to whole milk, and surpass it in some indicators. One cannot completely replace all components of milk with vegetable ones.

For feeding calves during the entire milk period, it is advisable to use several replacers, depending on the age.

WMR intended for calves up to 30 days of age should contain 40-43% lactose, max. 0.5% fiber, 20-25% protein, with milk protein share of at least 60%.

Advantages of using WMR are also due to as follows:

- they are easy to prepare and easy to dose;
- convenient for transportation and storage (the shelf life is much longer compared to whole milk);
- higher content of vitamins and minerals compared to whole milk.

Until recently, agricultural enterprises used a calf rearing scheme that involves feeding with milk feed for 4 months. However, world practice has proven that milk period can be shortened to 2-3 months. The main criterion for this is physiological development of calves and their ability to consume vegetable feed in the required quantities (Radchikova et al., 2017).

Purpose of the research is to develop a feeding system for calves with the optimal duration of milk period, ensuring normal course of digestion processes, high resistance and productivity of animals during post-milk period.

Research objectives:

- to study chemical composition of feed used for feeding calves during milk and post-milk periods;
- to develop schemes for feeding calves during milk and post-milk periods using whole milk and its replacer, as well as with different duration of milk period;
- to determine intensity of metabolic processes by analyzing morphological and biochemical parameters of blood of experimental animals;
- to determine the effect of the developed feeding schemes for young cattle on indicators of rumen digestion during the post-milk period;
- to study the dynamics of body weight of experimental animals reared using whole milk and its replacers and with different duration of the milk period;
- to determine costs of feed and efficiency of their use for production.

Materials and methods of research

To fulfill the aim set, samples of feed were selected that are used for feeding calves (milk feed, compound feed KR-1, KR-2, grain mixture, silage-and-hay mixture, corn, hay, cereal-and-legume cultures, soybean meal). The analysis of chemical composition of feed was carried out in the laboratory of biochemical analyzes of the Republican Unitary Enterprise Research and Practical Center of the National Academy of Sciences of Belarus for Animal Breeding according to the generally accepted methods of zootechnical analysis. The following was determined in feeds: moisture in accordance with GOST 13496.3-92; calcium, phosphorus (GOST 26570-95; 26657-97); total nitrogen (GOST 13496.4-93), crude fiber (13496.2-91), crude fat (13492.15-97), crude ash (26226-95), dry and organic matter.

To fulfill the aim set, 3 scientific and economic experiments were carried out in conditions of the State Enterprise ZhodinoAgroPlemElita (Table 1).

1. Layout of experiment

Group	Number of animals, animals	Duration of experiment, days	Feeding specification
The first scientific and economic experiment (calves of 10-65 days of age)			
I control	10	55	Main diet (MD) – whole milk, grain mix, hay, compound feed KR-1

II experimental	10	55	MD + WMR
The second scientific and economic experiment (calves of 66-115 days of age)			
I control	10	50	Main diet (MD) – whole milk, corn, silage mixture, compound feed KR-2
II experimental	10	50	MD + DSMR
III experimental	10	50	MD + WMR
The third scientific and economic experiment (calves over 116 days of age)			
I control	10	60	Main diet (MD) – silage mixture, compound feed KR-3
II experimental	10	60	MD
III experimental	10	60	MD

The entire experimental livestock was in the same conditions.

Differences in feeding experimental animals in the 1-2 scientific and economic experiments consisted in the fact that the animals of the control groups received whole milk as part of the diet, and their analogs of the experimental groups were fed with WMR and DSMR.

To determine the physiological state and productivity of experimental young animals during the post-milk period fed with whole milk, WMR, DSMR, the third scientific and economic experiment was carried out.

In the course of the research, zootechnical, biochemical and mathematical methods of analysis were used and the following parameters were studied:

- chemical composition and nutritional value of feed – via samples testing;
- feed consumption – based on the weighing data of the specified feeds and their residues – once every 10 days;
- morphological composition – erythrocytes, leukocytes, hemoglobin, platelets and hematocrit – using MedonicCH620 device (in whole blood); in blood serum: total protein, urea, glucose, phosphorus, calcium, AST, ALT – using ACCENT 200 device, at the end of the experiments, blood from 3 animals from each group was taken to control the physiological state and metabolic processes in their body;
- indicators of rumen digestion by taking rumen fluid from steers bulls in each experimental group. The rumen content was taken through fistula 2-2.5 hours after the morning feeding for two days, and the following was determination in it: values – pH, total nitrogen, ammonia, total volatile fatty acids;
- the growth rate of animals – according to the data of individual weighing of animals at the beginning and at the end of the experiment;
- economic efficiency was determined by the following indicators: the price cost of production, feed cost for obtaining products.

The obtained digital material was processed using method of variation statistics, considering the Student-t validation criteria, using the Microsoft Excel software package.

Results of the research and their discussion

When studying the analyzes of feed chemical composition, it has been determined that the amount of dry matter in hay of cereal grasses used for rearing calves was 850 g and cereal-and-legume mixtures – 890.3 g in 1 kg of natural feed. Content of crude protein in hay of cereal grasses – 71.1 g, of cereals-and-legumes – 96.1 g, crude fat – 15.0 g and 19.8 g, respectively. Crude fiber level in hay of cereal-and-legume grasses was 319.7 g, of cereals – 240.1 g, calcium – 8.21 g and 5.2 g, phosphorus – 3.2 and 2.9 g, respectively.

Studies helped to determine that 1 kg of dry matter of the silage-and-hay mixture contained 426 g, crude protein – 42.0 g, crude fat – 14.3 g, crude fiber – 93.0 g, NFES – 247.2 g, calcium – 3.1 g, and phosphorus – 5.8 g.

Dry matter content in 1 kg of whole milk was 132.7 g, crude protein – 31.3 g, crude fat – 33.9 g, NFES – 45 g, calcium – 1.4 g, and phosphorus – 1.0 g. 1 kg of whole milk replacer contained 945.1 g of dry matter, 226.3 g of crude protein, 107.0 g of crude fat, 13.0 g of calcium and 10.6 g of phosphorus. Content of the basic nutrients in 1 kg of dry skimmed milk replacer was as follows: dry matter – 899.3 g, crude protein – 127.2 g, crude fat – 11.9 g, NFES – 497.3 g, calcium – 12.8 g, and phosphorus – 7.5 g.

In the presented samples, dry matter content in 1 kg of compound feed KR-1, KR-2 and KR-3 was at the level of 885.0-894.0 g, crude protein – 119.1-208.4 g, crude fat – 14.5-30.1 g, crude fiber – 51.1-66.2 g,

NFES – 535.7-658.5 g, crude ash – 26.0-53.6 g, calcium – 7.9-9.4 g, and phosphorus – 4.8-6.1 g.

An experimental whole milk replacer and feeding scheme for calves of 10-65 days of age have been developed for the research.

1 kg of milk product contained 16.6 MJ of metabolizable energy, crude protein – 204 g, crude fat – 162 g, and crude fiber – 14 g.

Feeding with whole milk replacer should be carried out at the correct temperature and at regular intervals (Table 2).

2. Scheme for feeding calves of 10-65 days of age

Calf age	Number of feedings per day x number of liters
day 8	2 x 2 l (75% cow milk/25% WMR)
day 10	2 x 2.5 l (50% cow milk/50% WMR)
day 12	2 x 2.5 l (25% cow milk/75% WMR)
day 13-65	2 x 3 l WMR
from day 14	Concentrated feed, clean water after 0.5-1 hours after feeding with WMR

Note. From 8 to 12 days, the reconstituted WMR was mixed with cow milk.

In the first scientific and economic experiment, whole milk was replaced with a whole milk replacer in diet for calves of the experimental group (Table 3).

3. Average daily diet for experimental animals (based on actually eaten feed)

Feed and nutrients	Group			
	I		II	
	kg	%	kg	%
Compound feed KR-1	0.5	19.8	0.6	24.4
Grain mix	0.2	3.6	0.23	11.0
Whole milk	6.0	69.4	-	-
WMR	-	-	0.75	60.2
Cereal hay	0.2	7.2	0.25	4.4

During the experiment, calves received 1.5-1.5 kg of dry matter in diet. 12.3-13.2 g of digestible protein accounted for 1 kg of metabolizable energy. Concentration of metabolizable energy in 1 kg of dry matter was within the range of 15.5 and 15.2 MJ. Calcium-phosphorus ratio in diets was on the level of 1.34-1.37:1.

Study of morphological and biochemical composition of blood of experimental animals showed (Table 4) that saturation of blood erythrocytes with respiratory pigment - hemoglobin in experimental young animals of group II was 8.7% higher compared to the control analogs, which indicates the intensity of nutrients metabolism. Use of whole milk replacer in diets increased leukocytes count in blood of experimental young animals compared to the control group by 3.0%.

4. Morphological and biochemical composition of blood of calves at the age of 62 days

Parameter	Group	
	I	II
Red blood cells, 10^{12}/L	7.3 ± 0.5	7.5 ± 0.2
White blood cells, 10^{9}/L	6.1 ± 0.4	6.3 ± 0.9
Hemoglobin, g/L	84.2 ± 2.4	91.5 ± 1.2
Total protein, g/L	76.6 ± 0.6	79.1 ± 0.7
Glucose, mmol/L	4.7 ± 0.4	5.2 ± 0.2
Urea, mmol/L	5.3 ± 0.9	4.63 ± 0.9
Platelets, 10^{9}/L	463.0 ± 4.7	469.0 ± 5.3
Hematocrit, %	27.8 ± 0.5	29.4 ± 0.2

Notes: * The difference is significant in comparison with the values in the group I of animals, $P < 0.05$.

Studies helped to determine that concentration of glucose in blood increased by 10.6%, respectively, compared to group I, although this indicator was within the physiological standard.

There was also 3.3% increase in the total protein level in blood serum of group II calves and 12.1% decrease in urea in blood, which indicates more efficient use of nitrogen in the body.

The main indicators of calf rearing are body weight and growth rate (Table 5).

5. Variability of body weight and daily average weight gains

Parameter	Group	
	I	II
Body weight: - at the beginning of the experiment, kg	39.4 ± 1.5	39.0 ± 1.6
- at the end of the experiment, kg	78.4 ± 2.4	77.1±2.4
Gross weight gain, kg	39.0 ± 2.1	38.1 ± 2.0
Average daily weight gain per experiment, g	709,0 ± 29.6	692,0 ± 38.9
% to control	100.0	97.7

Notes: * The difference is significant in comparison with the values in the group I of animals, P < 0.05.

Results of weighing showed that the average daily weight gain in experimental calves did not differ significantly and amounted to 709 and 692 g. The calves fed with dietary whole milk showed the highest growth energy values, and therefore their gross weight gain during the experiment turned out to be 2.3% higher.

Studies helped to determine that the cost of diet in WMR for experimental steers turned out to be 6.0% cheaper compared to the control group, which affected the price cost of weight gain (Fig. 1).

Inclusion of WMR in the diet for calves of the experimental group II ensured decrease in the cost of weight gain by 3.6% compared to the control group.

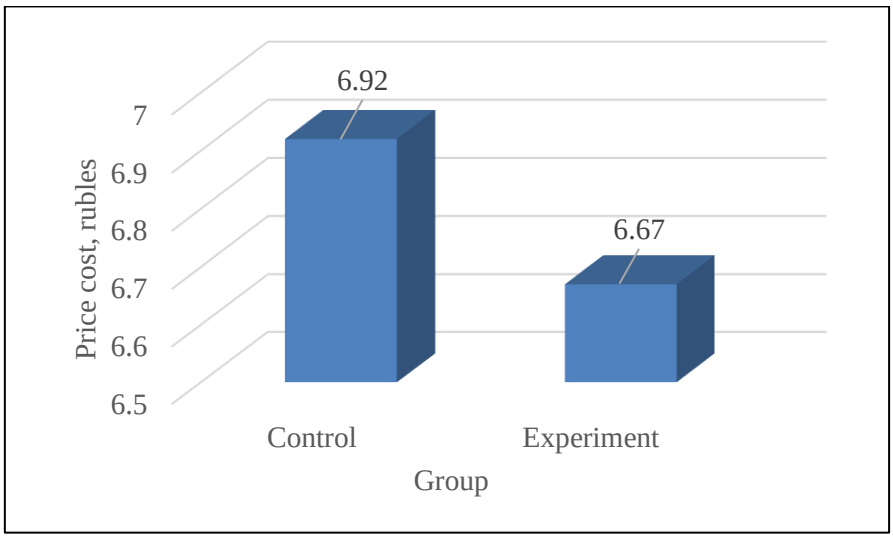

Fig. 1. Price cost of weight gain for obtaining products, rubles.

Thus, the use of whole milk replacer for calves of 10-65 days of age is economically feasible, which is reflected in reduction of price cost for obtaining products.

For research in the second scientific and economic experiment, dry skimmed milk replacer and scheme for feeding calves at the age of 66-115 days were developed (Table 6).

6. Composition and nutritional value of the experimental DSMR for calves

Ingredient, %	DSMR
Dry milk whey	27
Dry skimmed milk	8

Soy meal	28
Wheat meal	7
Dry milk fat concentrate	27
Vitamin and mineral complex	1
1 kg contains:	
Crude protein, g	200
Crude fat, g	157
Fiber, g	13
Metabolizable energy, MJ	16.3

The following was included in DSMR (% wt): dry milk whey – 27, dry skimmed milk – 8, soy meal – 28, wheat meal – 7, dry milk fat concentrate – 27, vitamin and mineral complex – 1.

1 kg of milk product contained: crude protein – 200 g, crude fat – 157 g, fiber – 13 g, metabolic energy – 16.3 MJ.

As a result of control feedings, it has been determined that feed intake by calves during scientific and economic experiment was practically the same (Table 7). Minor differences were noted for the silage-and-hay mixture. The rest of feeds were consumed with no residue.

7. Average daily diet for experimental animals (based on actually eaten feed)

Feed and nutrients	Group		
	I	II	III
Compound feed KR-2, kg	1.0	1.0	1.0
Silage mixture, kg	1.4	1.5	1.5
Whole milk, kg	4.0	-	-
DSMR, kg	-	0.5	-
WMR, kg	-	-	0.5
Corn, kg	0.5	0.5	0.5

The daily diets for experimental calves contained 3.09-3.11 feed units, and concentration in dry matter was at the level of 1.3 feed units. Metabolizable energy concentration in dry matter of diet for experimental animals made 10.95-10.97 MJ. Animals of the control group consumed 12.1 g of digestible protein with feeds, against 13.73 and 13.76 g of consumed by young animals from II and III experimental groups per 1 MJ of metabolizable energy. Energy-protein ratio in the experimental groups made 0.1:1.0.

Consumption of crude fat per 1 kg of dry matter was at the level of 81.9 g in the I control, and 78.2 and 79.3 g – in the II and III experimental groups. Fiber content in 1 kg of dry matter of diet for steers of the I control group was 106.7 g, in the II and III experimental – 113.2 and 114.1 g. Sugar content in dry matter of diet was at the level of 9.9-10.7%.

Calcium-phosphorus ratio in diets was 1.39-1.42:1.

Study of morphological and biochemical composition of blood of experimental animals (Table 8) indicates that inclusion of dry skimmed milk replacer and whole milk replacer in the diet instead of whole milk had no negative effect on physiological state of animals.

8. Morphological and biochemical composition of blood of calves at the age of 113 days

Parameter	Group		
	I	II	III
Red blood cells, 10^{12}/L	5,38 ± 0,40	5,34 ± 0,10	5,35 ± 0,20
White blood cells, 10^{9}/L	12,70 ± 0,33	9,07 ± 0,38	9,15 ± 0,46
Hemoglobin, g/L	123.0 ± 1.7	121.0 ± 2.4	120.0 ± 2.5
Total protein, g/L	46.8 ± 3.4	53.1 ± 2.4	54.0 ± 2.4
Glucose, mmol/L	2.6 ± 0.6	2.8 ± 0.2	2.8 ± 0.3
Urea, mmol/L	4.9 ± 0.1	5.0 ± 0.2	5.1 ± 0.2
Platelets, 10^{9}/L	559,0 ± 5.4	550,0 ± 5.7	555,0 ± 5.9
Hematocrit, %	20.5 ± 0.6	20.5 ± 0.7	21.4 ± 0.7
Phosphorus, mmol/L	2.42 ± 0.08	2.82 ± 0.05	2.84 ± 0.05
Calcium, mmol/L	2.08 ± 0.11	2.38 ± 0.14	2.39 ± 0.17

Notes: * The difference is significant in comparison with the values in the control (I) group of animals, $P < 0.05$.

During the experiment, blood indices were recorded to be within physiological standard, which indicates the normal course of metabolic processes in calves of experimental groups.

In blood of young animals of the II and III experimental groups, an increase in concentration of total protein by 13.5 and 15.4%, glucose – 6.5 and 7.3%, calcium – 14.4 and 14.9%, phosphorus – 16.5 and 17.3% had been determined in comparison with control analogues.

Dry skimmed milk replacer and whole milk replacer used instead of whole milk in the diet for calves aged 66-115 days had an insignificant effect on the average daily body weight. So, young animals consuming whole milk reached the average daily weight gain of 982 g, and their coevals from II and III experimental groups 964 and 970 g, respectively. Feed costs per 1 kg of weight gain were recorded to be nearly at the same level (Table 9).

9. Variability of body weight and daily average weight gains

Parameter	Group		
	I	II	III
Body weight at the beginning of the experiment, kg	78.4 ± 2.4	77.1 ± 2.4	77.9 ± 2.5
Body weight at the end of the experiment, kg	127.5 ± 2.7	125.3 ± 2.2	126.4 ± 2.5
Gross weight gain, kg	49.1 ± 1.0	48.2 ± 1.2	48.5 ± 1.4
Average daily weight gain, g	982.0 ± 14.6	964.0 ± 10.7	970.0 ± 11.4
% to control	100.0	98.2	98.8
Feed costs per 1 kg of weight gain, feed units	3.17	3.21	3.20

Notes: * The difference is significant in comparison with the values in the control (I) group of animals, $P < 0.05$.

Analysis of experimental data obtained during scientific and economic experiment indicates that feeding animals with dry skimmed milk replacer in diet contributes to increase in the economic efficiency of rearing young cattle (Fig. 2).

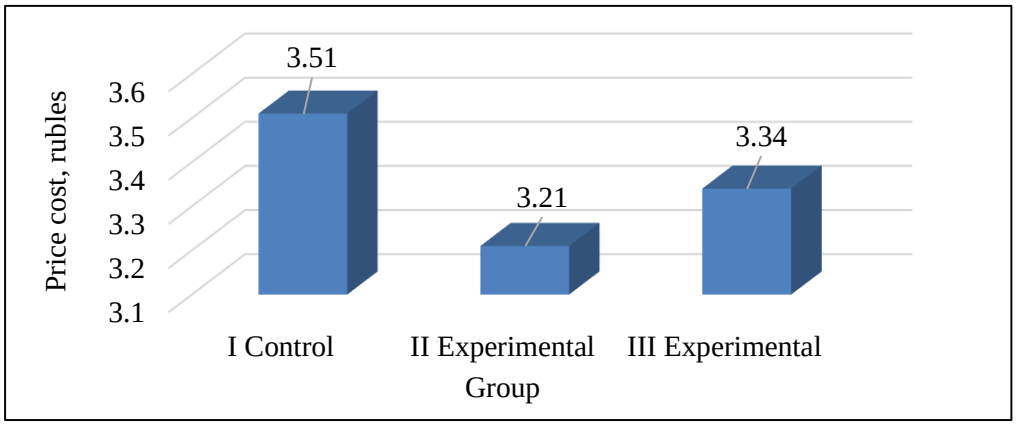

Figure 2 – Price cost of weight gain for obtaining products, rubles.

Cost of daily diet in experimental groups turned to be 10.3 and 5.8% cheaper compared to the control group. Calculation of economic efficiency of use of dry skimmed milk replacer and whole milk replacer by animals in diet showed a decrease in price cost of weight gain by 8.5 and 4.8%.

The main diet for animals for the third experiment was formulated in accordance with the set of feeds available at the farm and used for feeding according to the technology. The diets are formulated according to the main nutrients and presented by the average values for the last two months of the summer period (Table 10).

Succulent feeds in diet made 47.8-50.3%, concentrated feeds – 49.7-52.2%.

Feed consumption records showed that consumption of silage-and-hay mixture in animals of the experimental groups increased by 0.5-0.6 kg.

10. Average daily diet for experimental calves (based on actually eaten feed)

Feed and nutrients	Group					
	I		II		III	
	kg	%	kg	%	kg	%
Compound feed KR-3	1.80	50.3	1.80	47.8	1.80	48.5
Silage mixture	7.0	49.7	7.7	52.2	7.5	51.5

Notes: * The difference is significant in comparison with the values in the control (I) group of animals, $P < 0.05$.

Concentration of metabolizable energy in 1 kg of dry matter made 10.47-10.56 MJ and 0.90-0.91 feed units. Dietary dry matter contained 13.4% of crude protein and 22.4-23.2% of fiber.

Studies helped to determine that all studied blood parameters, reflecting general physiological state of body were within the physiological standard range in the compared groups (Table 11).

11. Morphological and biochemical composition of blood of experimental animals

Parameter	Group		
	I	II	III
Red blood cells, 10^{12}/L	5.49 ± 0.15	6.04 ± 0.19	6.03 ± 0.17
Hemoglobin, g/L	103.0 ± 2.1	109.0 ± 3.6	107.0 ± 2.9
White blood cells, 10^9/L	9.57 ± 0.80	9.94 ± 1.10	9.92 ± 1.40
Total protein, g/L	72.9 ± 0.2	72.2 ± 0.1	72.1 ± 0.2
Glucose, mmol/L	3.90 ± 0.19	4.27 ± 0.15	4.29 ± 0.18
Urea, mmol/L	5.45 ± 0.20	5.98 ± 0.22	5.85 ± 0.23
Calcium, mmol/L	2.73 ± 0.05	2.70 ± 0.06	2.69 ± 0.08
Phosphorus, mmol/L	2.85 ± 0.18	3.63 ± 0.16	3.60 ± 0.17
Platelets, 10^9/L	329,0 ± 5.7	311,0 ± 7.6	310,0 ± 7.0
Hematocrit, %	22.4 ± 0.9	25.7 ± 0.7	24.9 ± 0.8

Notes: * The difference is significant in comparison with the values in the control (I) group of animals, $P < 0.05$.

In the blood of animals of II and III experimental groups, a tendency has been determined to increase concentration of erythrocytes by 10.0 and 9.8%, hemoglobin – by 5.8 and 3.9%, amount of glucose – by 11.0 and 9.5%, respectively, compared to the control. Analysis of the data obtained indicates that metabolic processes in animals of experimental group were more intensive, which influenced productivity of young stock.

Study of growth dynamics of experimental animals for the reporting period of the scientific and economic experiment showed that increase in body weight of young animals in the experimental groups was more intensive compared to the control (Table 12).

12. Dynamics of body weight and daily average weight gains

Parameter	Group		
	I	II	III
Body weight, kg: at the beginning of the experiment	127.5 ± 5.3	125.3 ± 5.36	126.4 ± 5.7
at the end of the experiment	175.3 ± 8.0	177.5 ± 8.2	179.3 ± 8.4
Gross weight gain, kg	47.8 ± 3.5	52.2 ± 5.0	52.9 ± 5.0
Average daily weight gain per experiment, g	797,0 ± 47.6	870,0 ± 43.3	882,0 ± 49.1
% to control	100.0 ± 1.0	109.2 ± 0.5*	110.7 ± 0.9*
Feed costs per 1 kg of weight gain, feed units	5.12	4.93	4.80

Notes: * The difference is significant in comparison with the values in the control (I) group of animals, $P < 0.05$.

At the same time, the average daily weight gain of calves in the control group made 797 g, and in the experimental group – 870,0 and 882,0 g. The average daily weight gain in young animals

of the II and III experimental groups was 9.2 and 10.7% higher (P <0.05). Increase in the growth energy of steers of the experimental group made it possible to obtain additional 4.4 and 5.1 kg of body weight per animal.

As a result of increase in productivity of animals of the experimental groups, feed costs for obtaining products decreased by 3.7 and 6.3% and amounted to 4.93 and 4.80 feed units per 1 kg of weight gain.

Based on the results obtained, it has been determined that cost of feed per 1 kg of weight gain in the II and III experimental groups was 5.8 and 7.6% lower compared to the control, which influenced decrease in the cost of weight gain (Fig. 3).

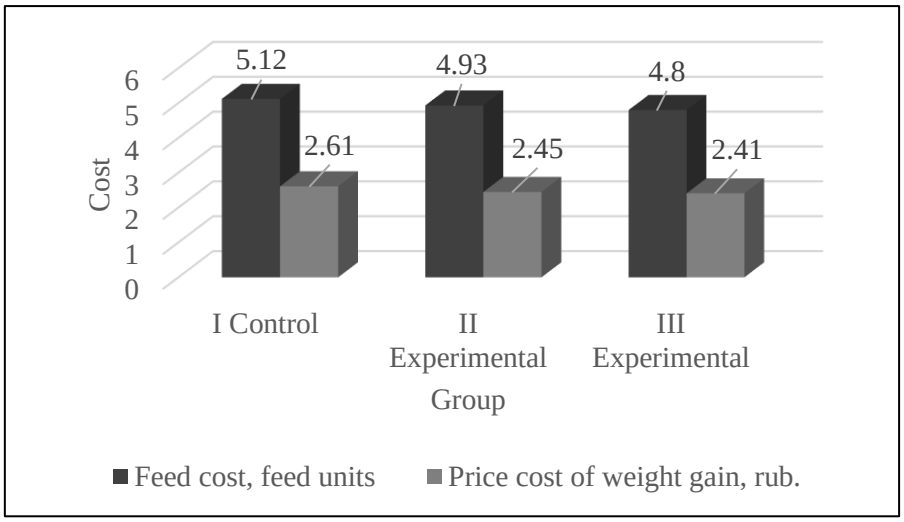

Fig. 3. Feed cost and price cost of weight gain for obtaining products, rubles

Price cost of weight gain in experimental groups compared to the control analogs decreased by 6.1 and 7.7%. It allowed to obtain additional profit in the experimental groups in the amount of 8.35 (3.5 USD) and 10.58 (4.5 USD) rubles per animal during the research period.

Conclusions and perspectives

Based on the research conducted, it has been determined that feeding calves with experimental milk replacer with milk period duration of 65 days allowed to obtain 692,0 g of the average daily weight gain for the experiment period, that is 2.3% lower than the control indicator. Feeding calves with WMR helps to reduce the cost of diet by 6.0% and the price cost of weight gain by 3.6%. Use of dry skimmed milk replacer and whole milk replacer during the rearing period, with milk period duration of 115 days, contributed to decrease in weight gain by 1.8 and 1.2% compared to the control variant. Feeding calves with DSMR and WMR helped to reduce the cost of diet by 10.3 and 5.8% and the price cost of weight gain by 8.5 and 4.8%. It has been determined that DSMR and WMR in diet for young animals over 115 days of age during the post-milk period increases concentration of erythrocytes in blood by 10.0 and 9.8%, hemoglobin – by 5.8 and 3.9%, amount of glucose – by 11.0 and 9.5%. Inclusion of DSMR and WMR in diet for young cattle with milk period duration of 65 and 115 days contributed to increase in the average daily weight gain in the post-milk period by 9.2 and 10.7%, while reducing the cost of feed by 5.8 and 7.6%, price cost of weight gain by 6.1 and 7.7% and increase in additional profit in the amount of 8.35 (3.5 USD) and 10.58 (4.5 USD) rubles per animal during experimental period.

In the future, it is necessary to improve the feeding system of young cattle using new developments in this area.

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Радчиков В. Ф., Богданович, Д. М. Кот А. Н., Цай В. П., Томчук В. А., Грищенко В. А., Карповський В. І., Трокоз В. О. (2021). **Сучасна система вирощування телят.** Ukrainian Journal of Veterinary Sciences. *Вирощування телят має вирішальне значення для успішного молочного або м'ясного скотарства. Тільки від здорових телят можна отримати максимальну продуктивність при найменших витратах.*

При проведенні дослідів використовували зоотехнічні, біохімічні, економічні методи досліджень.

Встановлено, що згодовування дослідного замінника незбираного молока (ЗНМ) телятам з тривалістю молочного періоду 65 діб дозволило отримати за період досліду 692 г середньодобового приросту, що на 2,3% нижче контрольного показника. Випоювання телятам ЗНМ дозволяє знизити вартість раціону на 6,0% і собівартість приросту на 3,6%.

Використання замінника сухого знежиреного молока і ЗНМ в період вирощування молодняку (молочний період – 115 діб) знижує приріст маси тіла лише на 1,8 і 1,2% порівняно з контролем із одночасним зниженням вартості раціону на 10,3 і 5,8% і собівартості приросту на 8,5 і 4,8%.

Згодовування сухого знежиреного молока і ЗНМ у складі раціону молодняку старше 115 діб в післямолочний період сприяє підвищенню в крові кількості еритроцитів на 10,0 і 9,8 і вмісту гемоглобіну – 5,8 і 3,9 та глюкози – 11,0 і 9,5% відповідно.

Включення в раціон молодняку великої рогатої худоби незбираного та сухого знежиреного молока, з тривалістю молочного періоду 65 і 115 діб підвищує середньодобовий приріст у післямолочний період на 9,2 і 10,7%, при зниженні вартості кормів на 5,8 і 7,6%, собівартості приросту – 6,1 і 7,7% і збільшення додаткового прибутку в розмірі 8,35 і 10,58 рублів (3,5 і 4,5 доларів США) на голову за період досліджень.

Надалі необхідно вдосконалювати систему годівлі молодняку великої рогатої худоби з використанням нових розробок у цій галузі.

Ключові слова: *молодняк великої рогатої худоби, незбиране молоко, замінник незбираного молока, замінник сухого знежиреного молока, гематологічні показники, продуктивність, ефективність.*