



## INSECT'S BIOMASS AS A LIVESTOCK FEED. STUDY OF THE IMPACT OF INSECTOPROTEIN ON THE LIVESTOCK VITALS

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### ABSTRACT

The anatomy and physiology of the gastrointestinal tract (GCF) of ruminants differ from monogastric animals, which allowed scientists to look for specific ways to increase the meat and dairy productivity of these animals. It has been found that the organization of full feeding, especially of highly productive cattle, is primarily related to the optimization of protein nutrition. The availability of protein and amino acids is influenced by the complexity and specificity of microbiological processes occurring in the complex stomach of ruminants. These issues are of particular importance when rationalizing the feeding of highly productive cows since the newly synthesized microbial protein in the scar plays an important role in ensuring the dairy productivity of cows only in the impact of up to 3500-4000 kg per year and in the low-intensity feeding of bullies.

The work proposes the use of insect protein in the diets of farm animals. The authors analyzed the main indicators of life activity of cattle and small cattle, concluded on the prospect of using a new kind of protein in animal feeding. Economic justification is given.

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### Introduction

An important factor is the complex introduction of amino acids, mineral elements, and vitamins into the animal body, which shows a synergistic effect so that the productivity will be higher, as evidenced by the high level of metabolic intensity. It is important to note the minimum dietary doses of protein concentrate compared to other feed products [1-4].

Protein-mineral vitamin supplement «InFood» contains a complete set of amino acids in optimal amounts according to the physiological needs of the animals. The necessity of using the above concentrate in the feeding of farm animals is due to the increased efficiency of using fodder components (including cereals) by 15-20%, with obtaining economic effect due to the leveling of nutrient feed deficiency.

Protein concentrate does not contain GMO, dyes, and preservatives, with no smell and taste, which makes this food product universal for any kind of farm animal to produce environmentally safe products.

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## Materials and Methods

The change in live mass was determined from the results of the control weighing once a month before the morning feeding of all animals.

Hematological indices were studied to investigate the physiological condition of animals. There were indicated hemoglobin content (using a hemometer), refraction (using a refractometer), number of leukocytes and erythrocytes (by direct counting in the Goryaev chamber), common protein, albumins, and globulins according to methodological recommendations [4,11].

The obtained materials of the scientific and economic experiments were processed according to the method of Plokhinsky [7].

Determination of the chemical composition of fodders, productivity, and biochemical indices of blood was carried out according to conventional methods [12, 13].

The economic efficiency of the application of the developed product was calculated according to conventional methods [14].

## Results and Discussion

The purpose of this work was to study the effectiveness of protein mineral vitamin supplement (PMVS) «InFood» in feeding dairy cows, young cows, beef cattle, sheep, and goats.

**Table 1:** Hematological indicators of lambs

Indicator		Group	
		Control	Experimental
Hemoglobin. g/l		93.0±1.00	97.3±0.72
Erythrocytes. 10/l		8.9±0.74	9.7±0.23
Leukocytes. 109/l		6.9±0.53	7.0±0.04
General protein. g/l		60.0±0.21	65.7±0.16
Albumine. g/l		27.3±0.41	28.1±0.27
Globulins. g/l	in total	32.7±0.51	37.6±0.47
	$\alpha$	9.0±0.37	10.9±0.30
	$\beta$	9.7±0.38	11.7±0.33
	$\gamma$	14.0±0.40	15.0±0.25
Glucose. mg%		44.0±0.71	48.5±0.50
Calcium. mg%		10.2±0.11	11.3±0.07
Phosphorus. mg%		5.4±0.11	6.0±0.08

The content of hemoglobin and erythrocytes within the norm indicates that there is no anemia in the young. A slight increase in hemoglobin in blood samples of the test group animals on the 4.6% ( $P < 0.01$ ) and the amount of erythrocytes on the 9.0% ( $P < 0.01$ ), compared to the controls, contributes to a more intense metabolism of substances. The leukocyte content was almost at the same level, and the difference was 1.4%.

Results on total protein content in blood serum showed that the processes of protein digestion and absorption of amino acids in the intestine, as well as protein synthesis in the liver, were carried out more intensively in animals of the experimental group, which was confirmed by the obtained live mass increases. In blood serum samples of the young test group, the percentage of total protein was higher by 9.5% ( $P < 0.001$ ) compared to the analogues of the control group.

The number of albumins related to fine proteins was at the same level, and the difference was 2.9%.

Statistically proven increase in globulin content on the 15.0% ( $P < 0.001$ ) was due to  $\alpha$  and  $\beta$  fractions contributing to more intensive transport of substances in the body.

The content of globulins  $\gamma$  - fraction within the limits of the norm indicates the absence of chronic infections and inflammatory processes, ensuring better development of humoral immunity. Analysis of the ratio between protein fractions showed no dysproteinemia.

The amount of glucose indicates no hyperglycemia, and compared to the control samples in the animals of the test group, its content was higher by 10.2% ( $P < 0.001$ ), which indicated a better supply of energy to the body cells.

The difference in blood serum calcium content per 10.8% ( $P < 0.001$ ) compared to the samples of the control group was statistically proven. There was a similar tendency to increase the content of phosphorus in the samples of the test group per 11.1% ( $P < 0.01$ ), which indicates a better saturation of bone tissue and strength of the young bone.

Introduction of «InFood» PMVS to the diet of dairy cows (0,5 kg per day), dairy calves (80 g/head per day) and young sheep (40 g/head per day), contributed to a 4.0% (cows), 7,4 % (dairy calves), and 23.0% (young sheep) increase in productivity, respectively with simultaneous improvement in milk quality and hematological indices.

To achieve the stated goal, the following tasks were set:

- Doing a chemical analysis of feeding agents, supplements and, in general, feeding diets;
- Determination of the productivity of dairy cows (quantitative and qualitative indicators of milk);
- Studying the growth of the live mass of young farm animals;
- Calculating the payment of feed by-products;
- to define the influence of PMVS «InFood» morphological and biochemical indices of blood;
- Assessment of the cost-effectiveness of the application of PMVS «InFood».

In the conditions of the experimental division of FSBNU VNIIOK of the Spakovsky district and the SPK PZ (collective farm) "Kazminsky" of the Kochubeevsky district of the Stavropol region, scientific and economic experiments were carried out to study the effectiveness of the protein-mineral-vitamin concentrate "InFood" in the feeding of the North-Caucasus lamb at of 2016.

In order to carry out the research, two experimental groups-analogues of different species of animals were formed, which lasted for 50 days (25.10-13.12.2016) according to the following scheme (Table 2).

**Table 2** – Scheme of the experiment

Group	Animals quantity	Features of feeding
Dairy cows		
Control	10	Main Diet (MD).
Experimental	10	MD + PMVS «InFood» in a daily dose 0,5 kilogram, heads.
Calves milk sellers		
Control	15	Main Diet (MD).
Experimental	15	MD + PMVS «InFood» in a daily dose 0,08 kilogram, heads.
It is bright - young growth of sheep		
Control	15	Main Diet (MD).
Experimental	15	MD + PMVS «InFood» in a daily dose 0,04 kilogram, heads.

The rations were balanced in basic nutrients, which ensured the full growth and development of the young. The animals were characterized by good feed consumption.

According to the results of the chemical analysis of the feed included in the diets, their high nutritional value was found to be class I.

The diet of cows of the test and control groups consisted, of course, juicy and combined fodders and was compiled according to the established detailed standards of cattle feeding (Table 3).

**Table 3** – Diet feeding lactating cows

Indicators	Units of measure	Group	
		Control	Experimental
Corn silage	Kg	15.4	15.4
Mixed grass haylage	Kg	7.5	7.5
Hay sowing alfalfa	Kg	3.6	3.6
Corn	Kg	2.5	2.5
Barley	Kg	1.1	1.1
Wheat	Kg	1.34	1.34
Oats	Kg	0.8	0.8
Wheat bran	Kg	0.17	0.17
Soy meal	Kg	0.55	0.20
Concentrate « InFood »	Kg	-	0.5
Chalk	Kg	0.08	0.08
Salt	Kg	0.06	0.06

Contains in a diet:			
Energy feed unit (EFU)		15.9	15.97
Exchange energy	MJ	159.23	159.91
Dry matter	Kg	15.9	16.0
Crude protein	MJ	2117.78	2245.13
Digestible protein	g	1434.1	1498.71
Lysine	g	64.42	67.32
Methionine + cystine	g	58.46	69.52
Tryptophane	g	24.87	25.22
Crude fat	g	520.42	522.77
Crude cellulose	mg	3564.43	3573.61
Starch	mg	3215.47	3217.25
Sugar	mg	376.65	380
Calcium	mg	149.67	149.9
Phosphorus	mg	55.6	56.38
Magnesium	mg	37.65	37.98
Potassium	mg	205.14	205.65
Sulfur	g	29.31	29.52
Iron	mg	3877.02	3898.19
Copper	mg	110.07	111.6
Zinc	mg	410.92	413.52
Manganese	mg	603.92	607.01
Cobalt	mg	1.85	1.98
Iodine	mg	4.46	4.5
Carotene	mg	604.78	614.97
Vitamin D	ME	3365.41	3385.73
Vitamin E	mg	1546.53	1556.72

The effectiveness of PMVS was determined in the investigation of the productivity of the experimental livestock population (Table 4).

**Table 4**– Use of feed additive "InFood" in livestock diets

Group	Daily yield of milk, kg	Yield of milk (4 %), kg	Fat content, %	Protein content %	% to Control group
Dairy cows					
Control	22.3	18.96	3.7	3.11	100.0
Experimental	23.2	19.72	3.9	3.12	104.0
Milky calfs					
Group	Live weight.kg		Gain of live weight		% to Control group
	at statement	in 50 days	absolute. kg	average daily. g	
Control	58.4	94.8	36.4	727	100.0
Control	58.3	97.4	39.1	781	107.4
It is bright - young growth of sheep					
Control	31.50	35.20	3.70	74	100.0
Experimental	31.55	36.10	4.55	91	123.0

According to the results of studies, it was found that feeding of PMVS «InFood» Milking cows in a dose of 0.5 kg/day allowed to increase productivity by 4.0% with simultaneous improvement of milk quality: fat by 0.2% and protein-0.01%. When the PMVS "InFood" was fed to dairy calves aged 30-80 days at a dose of 0.08 kg, the average daily increase was 781 g, which was 7.4% higher than the control group that was 727 g.

In 2016, the use of PMVS "InFood" in the cultivation of barley at a dose of 40 g/head allowed to bring the average daily increase to 91 g, while in the control this indicator was 74 g, which was 23.0% higher.

Therefore, the use of the feed additive "InFood" increased the productivity of cows up to 4.0%.

In determining the productivity of experimental farm animals, the effectiveness of PMVS "InFood" was determined (Table 5).

**Table 5** – Use of "InFood" feed supplement in livestock diets

Group	Daily yield of milk, kilogram	Yield of milk (4%), kilogram	Fat content, %	Protein content, %	In % to control
Dairy cows					
Control	22.3	18.96	3.7	3.11	100.0
Experimental	23.2	19.72	3.9	3.12	104.0
Milky calfs					
Group	Live weight. kg		Gain of live weight		In % to control
	at statement	in 50 days	absolute. kg	average daily. g	
Control	58.4	94.8	36.4	727	100.0
Control	58.3	97.4	39.1	781	107.4
Yar - young growth of sheep					
Control	31.50	35.20	3.70	74	100.0
Experimental	31.55	36.10	4.55	91	123.0

According to the results of the studies, the feeding of PMVS "InFood" to milking cows at a dose of 0.5 kg/day allowed to increase productivity by 4.0% with a simultaneous increase of milk quality: fat by 0.2% and protein-0.01%.

When the PMVS "InFood" was fed to dairy calves aged 30-80 days at a dose of 0.08 kg, the average daily increase was 781 g compared to 727 g in the control group or 7.4% higher.

In 2017, the use of PMVS "InFood" in the cultivation of the barley composition at a dose of 40 g/head allowed to bring the average daily increase to 91 g, while in the control, this indicator was 74 g, which was 23.0% higher.

Therefore, the use of the feed additive "InFood" allows to increase the productivity of farm animals: in cows up to 4.0% with simultaneous improvement of milk quality, in young cattle up to 7.4%, and in small animals up to 23.0%.

Digestibility coefficient (Table 6) shows that in the control group organic substance, protein, fat, fiber, and BEV were slightly lower than in the experimental group by 2.50, 2.30, 0.19, 1.70, and 1.26%, respectively.

**Table 6** - Digestibility coefficient (%)

Indicator	Group	
	Control	Experimental
Organic matter	73.35	75.85
Protein	68.13	70.43
Fat	69.43	69.62
Cellulose	60.17	61.87
Nitrogen-free extractives	75.91	77.17

However, a slight increase in nutrient digestibility affected the productivity of dairy cows in the experimental group, as shown in Table 7. This can be explained by the fact that animals of the experimental group utilized nitrogen for milk generation compared to cows of the control group.

Furthermore, the reproduction qualities of the cows in the test group were slightly better than that of the animals of the control group. The fertilization percentage at the first insemination in the animals of the experimental group was 69.0%, which was 2.25% higher than the control cows.

The results of determining feed nutrients digestibility coefficients of North Caucasus cows were determined on the basis of analysis of nutrient substances content in origin feed and cow's feces. Received data are given in Table 7.

**Table 7 - Food feed nutrient transportability (average, %)**

Indicator	Group	
	Control	Experimental
Organic matter	47.97	57.48
Protein	51.27	59.03
Fat	43.67	57.75
Cellulose	49.70	57.18
Organic matter	40.50	44.84
Nitrogen-free extractives	56.79	64.30

Table 7 shows that animals of the experimental group had a higher ability to digest and absorb nutrients of diets. They significantly better digested the dry matter by 9.51, organic matter by 8.16, protein by 14.08, and fat by 7.48% compared to the animals of the control group.

The results of the physiological test carried out on dairy calves at 5 months of age showed that the transportability of nutrients (except fiber) was higher in calves receiving "InFood" as an additional feeding.

The increase of dry and organic substances transportability in the experimental group of calves was unreliable ( $P > 0.05$ ), while it was reliable in protein, fat, and BEV ( $P < 0.05$ ) (Table 8).

**Table 8 - Nutrient digestion factors in dairy calves (%)**

Indicator	Group	
	Control	Experimental
Organic matter	74.25	73.84
Protein	74.25	78.74
Fat	71.29	74.06
Cellulose	64.30	69.37
Organic matter	61.27	61.25
Nitrogen-free extractives	80.35	84.58

A slight decrease in fiber transportability in animals of the experimental group was due to the hay content in their diet of different sizes, which contained an increased amount of lignin due to late feeding.

The results of studies of the effect of PMVS "InFood" on blood indices of dairy cows, calves, and young sheep are given in Tables 9-10.

**Table 9 - Morphological and biochemical blood indices in the animals of the test group**

Indicator	Group	
	Control	Experimental
General protein, g/l	73.0±0.19	78.2±0.35
Urea, mol/l	39.4±0.29	36.1±0.331
Ketone bodies, mol/l	5.1±0.29	3.6±0.25
Erythrocytes, 10/l	6.3±0.12	6.9±0.27
Leukocytes, 10%	7.2±0.11	7.3±0.15
Hemoglobin, g/l	114.3±2.31	121.4±3.15

In analyzing the hematological data of Table 9, it was observed that the indicators studied were consistent with the physiological norm.

Administration of PMVS "InFood" to lactating cows (experimental group) in the main diet had a positive effect on blood hemoglobin and erythrocyte levels.

Animals of the experimental group outperformed the control analogues of erythrocyte and hemoglobin by 9.5 and 6.2%, respectively, indicating more intensive processes occurring in animals. The inclusion of PMVS "InFood" increased the total protein in the blood serum by 7.1% with simultaneous reduction of urea and ketone bodies, which indicates the improvement of protein metabolism, provision of energy and carbohydrates to the body, and reduction of such diseases as ketosis.

**Table 10** - Morphological and biochemical parameters of blood in dairy calves

Indicator	Group		
	Control	Experimental	
Leukocytes, 10 <sup>9</sup> /l	6.5±0.7	7.6±1.1	
Erythrocytes, 10 <sup>12</sup> /l	5.7±0.4	6.9±0.3*	
Hemoglobin, g/l	101.0±4.7	117.0±10.5*	
General protein, g/l	72.2±5.5	79.7±3.3*	
Albumine, g/l	26.5±2.7	29.7±1.8	
Globulins, g/l	$\alpha$	9.8±1.2	11,1±0.5*
	$\beta$	9.7±1.1	8,8±0,9
	$\gamma$	26.24±5.7	30,1±3,1*
AST, myllykatu/l	0.56±0.1	0.54±0.05	
ALT, myllykatu/l	0.36±0.15	0.36±0.07	
AST/ALT	1.56	1.5	
Glucose, mmol/l	2.73±0.47	3.2±0.37	
Cholesterol, mmol/l	4.9±0.5	3.9±0.8	
Urea, mmol/l	5.2±1.3	4.9±1.8	
Phosphorus, myllykatu/l %	4.4±0.8	5.9±0.4*	
Calcium, mg %	10.3±0.7	12.6±0.9*	

Hematological analyses showed an increase in the test values in the calves of the test group to the upper limits of the norm. However, significant changes were observed for the following indicators: erythrocytes - by 21.0%; Hemoglobin 15.8%; Total protein 10.4%; A-globulins - by 13.3%; and - globulins - 14.7%.

According to the de Ritis coefficient, the marker enzymes AST and ALT, indicating pathological processes in the body, were also within normal limits.

The blood indices of young sheep showed positive changes under the influence of the additionally introduced PMVS "InFood," which were within the physiological norm (Table 10).

Analysis of the studies carried out on cows in the first phase of lactation using "InFood" in the experimental group at a dose of 0.5 kg/head allowed to increase the productivity of cows by 4.0% or 0.9 kg, and when translated to basic fat content by 9.8% or 2.4 kg with simultaneous increase of quality indices of milk (fat by 0.21% and protein by 0.01%). The profit per head from each cow is an additional 1 of 8.80 rubles when the ruble is invested. Given the diet of feeding lactating cows in the first phase of lactation, it is necessary to note a slight deficiency of raw fat, sugar, as well as essential amino acids such as lysine and tryptophan. The use of protein-mineral-vitamin additive "InFood" made it possible to make up for this disadvantage. However, it should be noted that the production costs of 1 kg of milk were 0.96 in the test group and 1.04 in the control feed.

Therefore, the use of the protein-mineral-vitamin supplement "InFood" in the diets of lactating cows in the lactation phase for 50 days is economically justified.

## Conclusion

It has been found that the Introduction of «InFood» PMVS to the diet of dairy cows (0,5 kg per day), dairy calves (80 g/head per day) and young sheep (40 g/head per day), contributed to a 4.0% (cows), 7,4 % (dairy calves), and 23.0% (young sheep) increase in productivity, respectively with simultaneous improvement in milk quality and hematological indices.

Analysis of the studies carried out on cows in the first phase of lactation using "InFood" in the experimental group at a dose of 0.5 kg/head allowed to increase the productivity of cows by 4.0% or 0.9 kg, and when translated to basic fat content by 9.8% or 2.4 kg with simultaneous increase of the quality indices of milk (fat by 0.21% and protein by 0.01%). Profit per head from each cow is 1 ruble from invested 8.80 rubles.

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