Lipine grain and amido-concentrative additives in young cattle feeding

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Abstract. The development of intensive forms of animal husbandry and the consistent improvement of their efficiency require solving both technical problems and issues of feeding and using full-fledged and cost-effective feed for all types of bred animals. This article presents data on the use of feed additives containing natural antioxidants in the aspect of influence on the quality indicators of the resulting meat. The assessment was carried out after a control slaughter at the age of 120 days in the amount of 3 heads from each group. The results of physical and chemical tests of rabbit meat of experimental groups are presented, and the positive effect of natural additives "Vitazar" and "Ecostimul" on the quality indicators of raw meat is determined.

1. Introduction
Increase in the efficiency of animal feed usage and in the manufacturing of livestock products, the reduction of its cost can be achieved by feeding animals with balanced rations including such important nutrients as protein, macro- and microelements [1-5].

Protein is one of the main components in the nutrition of farm animals. However, the provision of their diets often does not meet science-based standards. The deficit of the protein is about 10-30% of the needs of animals [6-11].

Along with protein rations must be balanced in terms of a number of macro- and microelements that play an important role in all metabolic processes of the body, they are part of the tissues and body fluids, they take part in the synthesis of organic compounds that enhance the processes of digestion, absorption and assimilation of digested feed nutrients, contribute to creation of an environment in which hormones and enzymes become active [12-15].

The lack of such important nutrients as protein, macro- and microelements in the diets leads to a decrease in the efficiency and the productivity of animal feed and to losses of a significant part of livestock products and an increase in its cost [16-19].

One of the ways to improve the efficiency of feed is the balancing of rations using protein-vitamin-mineral supplements (PVMS), which activate metabolic processes in the body of animals, increase their productivity by 10-15%, and in some cases up to 20% or more [20-23].
PVMS can be prepared in any farm if the appropriate components are available, but it is best to prepare them in plants specializing in production of compound feed. More than 2 million tons of grain fodder, which is not enriched with all necessary nutrients, is used for feeding animals in farms, due to the absence of the necessary components and the impossibility of purchasing them. In this regard, the genetic potential of animal productivity is used only by 60-70%; overconsumption of feed in comparison with scientifically based norms exceeds 30-40% [24-27].

Recently, PVMS, premixes and concentrates have been imported to our republic from France, Germany, Poland, Croatia and other countries. These supplements are very expensive and are purchased for foreign currency. Domestic producer do not manufacture enough PVMS and PVMS for cattle are practically not produced in our country. Therefore, it is necessary to develop new PVMS, which are not less qualitative in their feed value than existing domestic and foreign additives. They should be competitive in quality, productive action, cost and at the same time should be prepared using cheap local raw materials – secondary products of the local processing industry [28-31].

The purpose of the research is to develop protein-vitamin-mineral supplements (PVMS) and to study the effectiveness of their use in feeding young cattle.

The investigation program included the following objectives:

- analysis of the chemical composition of feed rations of young cattle in the farms of the republic;
- development of new PVMS for young cattle on the basis of the existing deficiency of nutrients and biologically active compounds in the diets of livestock;
- study of the effectiveness of feeding the fattening cattle with grain forage enriched with the developed PVMS in a comparative aspect;
- establishment of the economic efficiency of using PVMS in feeding young cattle.

2. Methods and materials

On the basis of the data obtained in the analysis of feed rations of young cattle, new PVMS have been developed (table 1).

Table 1. The composition of PVMS.

| Components                               | Composition I | II | III | IV |
|------------------------------------------|---------------|----|-----|----|
| Lupine                                   | 40            | 40 | 40  | -  |
| Complex mineral feed additive (CMFA)     | 30            | 30 | 30  | 70 |
| CMFA №1                                  | 20            | -  | -   | 20 |
| CMFA №2                                  | -             | 20 | -   | -  |
| CMFA №3                                  | -             | -  | 20  | -  |
| Premix PKR-2zh                           | 10            | 10 | 10  | 10 |

Components in 1 kg of PVMS:

- Dry matter, g: 859, 859, 859, 859
- Feed units: 0.57, 0.57, 0.57, 0.38
- Metabolizable energy, MJ: 6.35, 6.35, 6.35, 4.6
- Crude protein, g: 316, 316, 316, 376
- Crude fiber, g: 87, 87, 87, 75
- Starch, g: 120, 120, 120, 133
- Sugar, g: 8, 8, 8, 2
- Crude fat, g: 24.2, 24.2, 24.2, 10.2
- Calcium, g: 26.1, 25.3, 26.1, 25.37
- Phosphorus, g: 9.8, 9.8, 9.8, 7.84
- Magnesium, g: 2.8, 2.8, 2.8, 2.8
- Potassium, g: 6.5, 6.5, 6.5, 3.43
- Sodium, g: 22.2, 24.2, 22.2, 22.5
Sulfur, g  
Iron, mg  
Copper, mg  
Zinc, mg  
Cobalt, mg  
Manganese, mg  
Iodine, mg  
Vitamins: A, thousand IU  
D, thousand IU  
E, mg  

The protein part of PVMS in No. 1, 2 and 3 consisted of lupine variety “Mirtan” – 40% and amide concentrate additive (ACA) – 30%, in No. 4 – 70% ACA; the mineral part in the PVMS was represented by the corresponding complex mineral feed additive (CMFA)– 20% and the PKR-2 premix – 10%.

CMFA No. 1 consisted of the following components, in %: halite waste – 26, phosphogypsum–24, dolomite powder–10, tricalcium phosphate–20 and sapropel–20 and was standard. In CMFA No. 2 defluorinated phosphate was used instead of tricalcium phosphate, in CMFA No. 3 sapropel from Lake Kelpenitsa, situated in Baranovichi region of Russia, was used instead of the same amount of sapropel from Lake Sergeevskoye. PVMS No. 4 included a standard CMFA No. 1.

The composition of the PKR-2zh1 premix is shown in table 2.

Table 2. The composition of the premix (per 1 ton).

| Components        | Unit of measurement | PKR-2zh1 |
|-------------------|---------------------|----------|
| Vitamins: A       | million IU          | 1500     |
| D                 | million IU          | 380      |
| E                 | g                   | 1000     |
| Iron              | g                   | 3000     |
| Copper            | g                   | 500      |
| Zinc              | g                   | 2500     |
| Cobalt            | g                   | 90       |
| Manganese         | g                   | 4000     |
| Iodine            | g                   | 12       |
| Selenium          | g                   | 17       |
| Santohin          | g                   | 1250     |
| Filler            | kg                  | up to 1000 |

The scientific and economic experiment was carried out on four groups of bulls, consisting of 12 numbers of cattle in each, with an initial live weight 300-310 kg at the beginning of the research (table 3). The experiment lasted 62 days.

Table 3. The scheme of the experiment.

| Groups            | Numbers of cattle in a group | Features of the diet  |
|-------------------|------------------------------|------------------------|
| I control group   | 12                           | Basic diet (BD) + PVMS №1 |
| II control group  | 12                           | BD + PVMS №2          |
| III control group | 12                           | BD + PVMS №3          |
| IV control group  | 12                           | BD + PVMS №4          |

The differences in feeding consisted in the fact that the grain fodder of the young animals of the 1st group included PVMS No. 1, II –PVMS No. 2, III – PVMS No. 3, IV – PVMS No. 4. Grain fodder was...
represented mainly by barley. A protein-vitamin-mineral supplement made up for 20% of the missing protein.

All the experimental livestock were in the same conditions: feeding was carried out twice a day according to the standards of the All-Union Agricultural Academy (1985), drinking was carried out from automatic drinkers. The rations were combined and adjusted according to the needs of the young cattle and the chemical composition of the feed.

During the research, the following indicators were studied:

- chemical composition of the feed – by sampling and analysis;
- feed consumption based on the data of weighing the initial amount of the feed and its leftovers during the control feeding once a decade on two adjacent days;
- morpho-biochemical composition of blood - by taking blood from the jugular vein 2.5-3 hours after morning feeding, stabilizing EDTA- 2Na (2.0-2.5 U/ml) in the blood of 3 individuals from each group (both in scientific and economic, and physiological experiments);
- intensity of animals growth – according to the data of monthly weighing of each bull before feeding;
- economic effect of feeding – by determining the level of consumption of the fodder aimed at obtaining the increase in livestock productivity;
- the economic efficiency of raising and fattening of bulls.

The analysis of the chemical composition of feed and metabolic wastes was carried out in the laboratory of biochemical analyzes of the Republican Unitary Enterprise “The Scientific and Practical Center of the National Academy of Sciences of Belarus for Animal Husbandry” according to the generally accepted methods of zootechnical analysis.

The study of the digestibility of nutrients in the diet was carried out in the physiological department of the laboratory. In the scientific and economic experience the live weight of the animals corresponded to accepted norms. The nutritional value of the rations during the physiological experiment was calculated based on the actually consumed feed. The duration of each physiological experiment was 30 days, including 7 days of the reference period. Each group consists of 3 individuals in it.

In physiological experiments, such parameters were studied:

- consumption of feed - by daily weighing of the given feed and its residues;
- processes of cicatricular digestion - by taking and analyzing the contents of the rumen 2-2.5 hours after the morning feeding for two days. Taking the samples of the rumen contents was carried out through a chronic fistula of the rumen using forceps.

In samples of rumen fluid filtered through four layers of gauze, the following parameters were determined:

- concentration of hydrogen ions (pH) - with an electronic potentiometer pH-340;
- total and non-protein nitrogen - according to Kjeldahl method;
- protein nitrogen – by calculation of the difference between total and non-protein nitrogen;
- concentration of ammonia – according to Conway’s microdiffusion analysis;
- total amount of volatile fatty acids — by steam distillation in the steam distillation apparatus by Roy Markham;
- total number of ciliates - by counting in the hemocytometer and diluted with formalin in 1: 4 proportion.
- digestibility and usage of nutrients and minerals - by calculation of the difference between the amount of nutrients received with food and excreted with metabolic wastes;
• hematological indicators – by drawing and analyzing blood.

Morpho-biochemical parameters of blood were determined on analyzers Medonic CA-620 and Cormay Lumen; mineral composition – on an atomic-absorption spectrophotometer AAS-3; oxygen content and vitamin composition of the blood – according to generally accepted methods (photocolorimetric method).

The digital materials of the conducted research were processed by the method of variation statistics using the Microsoft Excel software package. Statistical processing of the analysis results was carried out taking into account the Student's t-test. When evaluating the value of the reliability criterion (td), we proceeded depending on the volume of the analyzed material. The likelihood of differences was considered significant at P <0.05.

3. Main findings of the study
Based on the data of the analysis of the chemical composition of the feed ration of the animals of the farm and the data obtained in earlier experiments, a deficiency in such nutritional elements as protein, phosphorus, magnesium, trace elements and vitamins was revealed. According to this, a protein-vitamin-mineral supplements (PVMS) have been developed.

Due to the fact that the amount of food given to the experimental animals was limited, the diet in all groups was the same (table 4).

Table 4. Rations of experimental bulls according to the actually eaten feed.

| Feed, kg       | Group | I   | II  | III | IV   |
|----------------|-------|-----|-----|-----|------|
| Grain forage   | 2.38  | 2.38| 2.38| 2.48|      |
| PVMS №1        | 0.62  | -   | -   | -   | -    |
| PVMS №2        | -     | 0.62| -   | -   | -    |
| PVMS №3        | -     | -   | 0.62| -   | -    |
| PVMS №4        | -     | -   | -   | 0.52|      |
| Green plants   | 12    | 12  | 12  | 12  |      |
| Straw          | 2     | 2   | 2   | 2   |      |

The ration contains:

| Dry matter, kg | 7.84 | 7.84 | 7.84 | 7.82 |
| Feed units     | 6.27 | 6.27 | 6.27 | 6.23 |
| Metabolizable energy, MJ | 76  | 76  | 76  | 75  |
| Crude protein, r | 919 | 919 | 919 | 928 |
| Crude fat, g   | 210  | 210 | 210 | 202 |
| Crude fiber, g | 1988 | 1988| 1988| 1978|
| Sugar, g       | 192  | 192 | 192 | 188 |
| Calcium, g     | 50.3 | 49.9| 50.4| 47.6|
| Phosphorus, g  | 28.8 | 29.2| 28.8| 27.2|
| Magnesium, g   | 19.8 | 20.7| 19.8| 19.4|
| Potassium, g   | 84   | 106 | 84  | 82  |
| Sodium, g      | 24.5 | 25.7| 24.5| 22.5|
| Sulphur, g     | 21.5 | 21.5| 21.5| 19.8|
| Iron, mg       | 3751 | 3757| 3758| 3334|
| Copper, mg     | 76.5 | 76.5| 75.8| 70.7|
| Zinc, mg       | 368  | 368 | 366 | 340 |
| Manganese, mg  | 698  | 698 | 694 | 610 |
| Cobalt, mg     | 6.46 | 6.46| 6.46| 5.54|
| Iodine, mg     | 2.35 | 2.35| 2.35| 2.21|

Vitamins:

| A, thousand IU  | 93   | 93  | 93  | 78  |
| झ, thousand IU  | 23   | 23  | 23  | 20  |
| E, mg           | 275  | 275 | 275 | 265 |
Differences in nutrient intake in young cattle between the groups were not actually established, except for those components (mainly in the mineral part) that were in defluorinated phosphate and new sapropel (calcium, iron, copper, zinc, manganese, cobalt, phosphorus, magnesium, potassium, sodium).

Young cattle of all groups readily ate food with the PVMS and the daily ration in general. No cases of diseases and feed refusal were identified.

The study of the processes of digestion in the rumen showed that the concentration of hydrogen ions was practically at the same level in the cicatricial contents of animals of all groups. The differences in the concentration of ammonia, volatile fatty acids, total nitrogen, and the number of ciliates in the samples of rumen fluid of young animals from groups I, II, and III were insignificant. In the samples of rumen fluid of animals from group IV, the concentration of ammonia in comparison with I, II and III was higher by 15.58, 23.61 and 21.9%, VFA - by 6.7, 19.4 and 11.1%, total nitrogen - by 3.32, 31.44 and 24.03%, ciliates - by 4.35, 14.29 and 9.09%, respectively (table 5).

Table 5. Composition of the contents of the rumen.

| Figure | Group | I  | II | III | IV  |
|--------|-------|----|----|-----|-----|
| pH     |       | 7.5| 7.5| 7.5 | 7.5 |
| Ammonia, mg % | 30.8 | 28.8 | 29.2 | 35.6 |
| VFA, mmol /100 ml | 7.5 | 6.7 | 7.2 | 8.0 |
| Number of ciliates, thousand/ml | 460 | 420 | 440 | 480 |
| Total nitrogen, mg % | 78.4 | 68.7 | 72.8 | 90.3 |

The intensity of metabolic processes in the body of animals was determined by hematological parameters, which are presented in table 6. As a result of the analysis of the obtained results, it was established that all studied morpho-biochemical blood parameters of the experimental animals were within the physiological norms without significant differences between the groups.

Table 6. Morpho-biochemical composition of blood.

| Figure | Group | I  | II | III | IV  |
|--------|-------|----|----|-----|-----|
| Hemoglobin, g % | 9.4 | 8.84 | 9.42 | 9.16 |
| Red blood cells, mln/mm3 | 8.31 | 7.83 | 8.07 | 7.81 |
| Alkaline reserve, mg % | 453 | 480 | 467 | 414 |
| Carotene, ug % | 0.62 | 0.65 | 0.72 | 0.98 |
| Vitamin A, mg % | 0.70 | 0.69 | 0.67 | 0.69 |
| Calcium, mg % | 11.7 | 11.4 | 11.6 | 11.3 |
| Phosphorus, mg % | 6.76 | 6.74 | 6.91 | 6.97 |
| Total protein, mg % | 7.85 | 7.85 | 7.85 | 8.28 |

However, it should be noted that there was a tendency to an increase in the amount of carotene by 36.11-58.06% and total protein by 5.48% in the blood of animals from group IV compared to I, II and III groups. The digestibility of dietary nutrients is shown in table 7.

Table 7. Digestibility of nutrients, %.

| Figure | Group | I  | II | III | IV  |
|--------|-------|----|----|-----|-----|
| Dry matter | 68 | 68 | 71 | 70 |
| Organic matter | 70 | 70 | 73 | 72 |
| Protein | 67 | 63 | 64 | 68 |
| Fat | 51 | 54 | 57 | 59 |
| Cellulose | 56 | 53 | 54 | 60 |
| NFES | 74 | 77 | 78 | 81 |
The results of the studies showed that the digestibility of all nutrients in animals that consumed different PVMS was at a high level and did not differ much between groups. So, the digestibility of dry and organic matter was within 68-73%, protein – 63-68%, fat – 54-58%, fiber – 53-60%, NFES – 77-81%. It should be noted that the coefficients of digestibility of protein, fiber and NFES were higher in the fourth group by 1-7% compared to the rest (P> 0.05).

The balance of nitrogen, calcium and phosphorus was positive in all groups of animals. A slight increase in nitrogen deposition was found in young animals from group IV (by 4.7-11.9%), which received PVMS with ACA as a source of protein. The use of calcium and phosphorus by animals was practically at the same level.

Studies have established (table 8) that the average daily growth of animals from all groups was within 629-710 g.

Table 8. Live weight, average daily growth and feed costs.

| Figure | Group | I   | II  | III | IV  |
|--------|-------|-----|-----|-----|-----|
| Live weight, kg: |       |     |     |     |     |
| at the beginning of the experiment | 291   | 299 | 302 | 288 |
| at the end of the experiment      | 332   | 338 | 342 | 332 |
| Growth:                          |       |     |     |     |
| gross, kg                        | 41    | 39  | 40  | 44  |
| average daily, g                 | 660   | 629 | 645 | 710 |
| Feed costs per 1 kg of growth, feed units | 9.50 | 9.97 | 9.72 | 8.77 |

The average daily growth in group IV of bulls, which consumed PVMS № 4 with ACA as a protein component, was the highest; the second place in terms of growth was occupied by young animals from group I – 660 g, which consumed PVMS № 2 that included lupine, ACA and standard CMFA № 1; PVMS № 3 with defluorinated phosphate, used as a source of phosphorus, ranked last on this indicator – 629 g. Despite this, the difference in growth turned out to be insignificant. Feed costs per 1 kg of gain were the lowest in group IV – 8.77 feed units, in I, II and III higher by 8.32%, 13.68 and 10.83%, respectively.

The analysis of the obtained results showed that the cost of feed for obtaining the growth in the IV group turned out to be lower than in the I, II and III groups by 30.1%, 35.9 and 33.1%, respectively. That is associated with the cost of PVMS, which turned out to be the cheapest in group IV. In this regard, the cost of growth of one bull from this group during the experiment was the lowest.

The cost of sold products received from one animal during the experiment was higher in the bulls, which received PVMS № 4 compared with groups I, II and III by 6.82, 11.36 and 9.1%, respectively.

4. Conclusion

Protein-vitamin-mineral supplements have been developed, 1 kg of which contains 0.38-0.57 feed units, 4.6-6.35 MJ of metabolizable energy, 859 g of dry matter, 316-376 g of crude protein, 25-26.5 g of calcium, 8-11 g of phosphorus, 7-9 of g sulfur, trace elements and vitamins. The use of protein-vitamin-mineral supplements in the feeding of young cattle has a positive effect on the feed intake of the forage, metabolic processes in the body, digestion and health of animals, contributes to obtaining an average daily growth of 629-710 g at a feed cost per 1 kg of an increase is about 8.77-9.97 feed units, to reducing the cost of feed by 20%, the cost of growth – by 30-36%.

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