Rationing of non-degradable protein in diets for breeding steers

V F Radchikov\textsuperscript{1,4}, G V Besarab\textsuperscript{1}, T L Sapsaleva\textsuperscript{1}, V A Baranikov\textsuperscript{2}, A V Glushenko\textsuperscript{2} and M E Spivak\textsuperscript{3}

\textsuperscript{1} RUE Research and Practical Center of the National Academy of Sciences of Belarus for Animal Breeding, 11 Frunze Str., Zhodino, 222163, Republic of Belarus
\textsuperscript{2} Volga Region Research Institute of Manufacture and Processing of Meat-and-milk Production, 6, Rokossovsky street, Volgograd, 400131, Russia
\textsuperscript{3} Volgograd State Agrarian University, Volgograd, Russia

\textsuperscript{4} E-mail: labkrs@mail.ru

Abstract. The paper provides the results of research on development of standards for non-degradable protein in diets for replacement steers of black-and-white breed. Studies were conducted in 3 groups of repair steers aged 12-18 months, with an average initial body weight of 363-367 kg. Differences in feeding consisted in the fact that the amount of non-degradable protein in diet for steers in the control group was 10\% lower than the accepted standard, in II group – corresponded to the accepted standard, in III group – 10\% higher than standard. It has been determined that animals of II and III experimental groups, consuming diets with increased level of non-degradable protein, better digested dry and organic matter, and protein by 6.4 and 6.9; 6.4 and 7.1; 5.6 and 5.5 p.p. However, there was an increase of total protein by 4\%, total and protein nitrogen – by 4-5\% in blood of steers of the II experimental group, while in young animals of III experimental group these indicators increased respectively by 6.5 and 7\%. The average daily weight gain of steers of the experimental groups increased by 3\% and 5\%, ejaculate volume – by 11-14\%, sperm cells count – by 9-12\%, amount of energy deposited in weight gain – by 4.1-9.0\%, diet energy consumption per 1 MJ deposited in weight gain decreased by 4-5\%.

1. Introduction

Adequate feeding, which is possible in case all nutrients are provided in diets in optimal quantities and ratios, largely determine breeding and productive indicators of young farm animals [1, 2].

Diets for farm animals should be developed based on refined detailed feeding standards, taking into account chemical composition and nutritional value of the feed used. This makes it possible to balance them better, which, at the same feed costs, helps to increase productivity of animals. At the same time, for a number of indicators, the existing standards require further improvement and clarification, especially with regard to the requirements of animals for protein and energy [3-5].

Analysis of existing diets of replacement young cattle shows that in many controlled indicators they do not meet regulatory requirements. In this regard, balancing of diets in terms of protein, carbohydrates, minerals and vitamins can be performed with the help various feed additives and premixes [6-9].

Researches of many scientists have proven that requirements for protein in cattle is satisfied not only by amino acids of microbial protein, but also by the protein that has not been decomposed in the rumen [10-13].
In the rumen of ruminants, over 40% of feed protein is decomposed to peptides, amino acids and, mainly, to ammonia [14-18]. In feeding practice, it is considered undesirable when high-quality protein of high-protein feed is rapidly degraded in the proventriculus of animals, where protein and non-protein compounds of less valuable feed (hay, haylage, silage) should be used [19, 20]. One should remember that in case diet contains a lot of digestible protein, then microorganisms of the proventriculus decompose it down to ammonia and do not have enough time to use it to synthesize protein in the body. Based on this, the aim of feeding is to ensure that there is a certain balance of digestible and non-digestible protein in a diet [22].

In recent years, breeding of new varieties of legumes and cruciferous crops with low content of anti-nutritional substances, which can be successfully used in diets for farm animals, including repair steers to enhance the transformation of nutrients into products. However, it should be noted that in studies of many scientists’ data obtained are contradictory, and therefore for wide use of grain of lupine, pea and other crops, additional researches on development of standards for feeding grain of these crops and feed additives with it, providing increase reproductive ability of repair young cattle [20].

The aim of research is to determine standard rates for non-degradable protein level in diet and to study their efficiency when feeding repair steers.

2. Research materials and methods
Studies were conducted in 3 groups of repair steers aged 12-18 months, with an average initial body weight of 363-367 kg (table 1).

| Group          | Number of animals in group, animals | Body weight at the beginning of experiment, kg | Protein content in diet, % to standard raw | non-degradable |
|----------------|------------------------------------|---------------------------------------------|-------------------------------------------|----------------|
| I control      | 12                                 | 363                                        | 100                                       | 90             |
| II experimental| 12                                 | 365                                        | 100                                       | 100            |
| III experimental| 12                               | 367                                         | 100                                       | 110            |

Differences in feeding consisted in the fact that the amount of non-degradable protein in diet for repair steers in the control group was 10% lower than the accepted standard, in II group it corresponded to the accepted standard. In the diet for steers of the III experimental group, content of non-degradable protein was increased by 10% compared to standard. The amount of degradable and non-degradable protein was regulated by adding flaxseed cake and extruded grains of peas and lupine.

Analysis of chemical composition of feed and metabolic products was carried out in the laboratory of zootechnical analyzes of RUE Research and Practical Center of the National Academy of Sciences of Belarus for Animal Breeding according to the scheme of general zootechnical analysis: initial, hygroscopic and total moisture (GOST 13496.3-92); total nitrogen, crude fiber, crude fat, crude ash (GOST 13496.4-93; 13496.2-91; 13492.15-97; 26226-95); calcium, phosphorus (GOST 26570-95; 26657-97); dry and organic matter, NFES, carotene according to generally accepted methods.

Content of non-degradable protein was determined by in situ method in animals with chronic rumen fistula. Quantity and quality of semen product - according to the method adopted on the elever.

The digital material was processed using variation statistics method on a personal computer using Microsoft Office Excel 2007 spreadsheet analysis package. Differences were considered significant at P<0.05.

3. Research results
Studies helped to determine that in the structure of diet for animals in the control group (% by nutritional value) was composed of: hay – 21%, haylage – 31, grain feed – 38, sunflower meal – 6, molasses – 4%, in young animals in experimental groups, haylage made 31-31, hay – 22.5-21.0, grain feed – 34-30, peas – 3.0-4.5, lupine – 2.5-3.5; linseed cake – 3.0-6.0% and molasses – 4.0-4.0%.
As a result of the research, it has been determined that the average daily consumption of dry matter by steers of experimental groups made 9.1–9.3 kg. 9.7–9.9 MJ of metabolizable energy contained in 1 kg of dry matter in all the groups. Sugar-protein ratio in the diet of I group animals made 0.86, II and III – 0.87 and 0.88:1, respectively. No significant differences were determined in the concentration of minerals in dry matter of diets between the groups.

Research helped to determine (table 2) that in the rumen content of steers of the experimental groups with the level of dietary non-degradable protein according to the standard and 10% higher, increase in the content of total nitrogen has been determined by 5.1% and 5.5%, protein nitrogen – by 7.5 and 8.2%, respectively. A higher level of total nitrogen against the background of a higher ciliates count in the experimental groups indicates its better use by the microflora, as well as increase in absorption of ammonia from rumen fluid by protozoa to build their body’s protein.

Microorganisms in proventriculus are able, with the help of enzymes, to decompose plant fiber, transform ammonia nitrogen into microbial protein and synthesize the entire complex of water-soluble vitamins. It digests 50 to 70% of crude fiber in diets.

| Parameter          | Group  |
|--------------------|--------|
|                    | I      | II     | III    |
| pH                 | 7.1±0.11 | 6.7±0.12 | 6.5±0.14 |
| Total nitrogen, mg%| 142.5±3.5 | 149.8±3.0 | 150.4±2.6 |
| Protein nitrogen, mg% | 97.5±2.0 | 104.8±2.6 | 105.5±2.7 |
| Ammonia, mg%       | 21.5±0.75 | 16.9±0.66* | 16.3±0.58* |
| VFA, mmol/100 ml   | 9.3±0.85 | 10.4±0.71 | 11.3±0.98 |
| Ciliates, thousand ml | 440±25 | 465±20 | 494±29 |

Researches helped to determine that when using feeds rich in carbohydrates and proteins, the ciliates count in the rumen increases. Increase in ciliates count in the rumen by 5.7-12.3% indicates an increase in digestive processes in the proventricles of young cattle of the experimental groups and increase in the use of feed protein into the protein of the microorganisms body, which will subsequently serve as a source of protein for animals.

As a result of the researches carried out, a significant reduction in the amount of ammonia in the rumen of experimental animals was determined by 21 (P<0.05) and 24% (P<0.05), respectively, which indicates decrease in protein degradability and improvement of its use by microorganisms for protein synthesis.

Increase in the amount of volatile fatty acids by 12-21% was observed in the rumen fluid of animals of experimental groups, which indicates more intensive hydrolysis of feed carbohydrates under the effect of diets with different protein quality.

An important element of metabolism in the body of animals is the digestibility of nutrients, which, to a certain extent, may indicate the quality of animal feeding.

The research data indicate that the digestibility of nutrients depends on the breed, type of constitution, individual peculiarities of animals, feeding level, diet structure, chemical composition and ratio of separate nutrients, introduction of premixes, additives, etc. into diets.

The researches helped to determine, that animals of II and III experimental groups with elevated levels of non-degradable protein in diets digested feed nutrients better. Thus, digestibility of dry and organic substances and protein significantly increased by 6.4 and 6.9 p.p.; 6.4 and 7.1 p.p.; 5.6 and 5.5 p.p. There is a tendency to increase of digestibility of fat, fiber and NFES (table 3).

| Parameter          | Group  |
|--------------------|--------|
|                    | I      | II     | III    |
| Dry matter         | 53.5±1.2 | 59.9±0.9* | 60.4±1.2* |
| Organic matter     | 55.7±0.8 | 62.1±1.2* | 62.8±1.5* |

Table 2. Composition of the rumen contents.

Table 3. Nutrients digestibility ratios, %.
Changes in physiological state of animals can be detected through hematological studies. Therefore, study of blood composition should be an integral part of experiments in the field of feeding.

Blood ensures the course of metabolic processes – delivery of nutrients and oxygen to the cells of organs, tissues and removal of metabolic products. Direction of metabolism, its intensity, physiological state of body of animals have a noticeable effect on biochemical and morphological composition of blood. Its composition is closely related to the conditions of feeding and housing.

As a result of analysis of morphological and biochemical composition of blood, no significant differences were determined in the studied parameters, all of them were within the physiological standards with minor variations between the groups, which indicates the normal course of metabolic processes in the body of animals of all groups.

The highest level of hemoglobin in blood, as the main supplier of oxygen to the body of animals, was recorded in steers of the II experimental group, which indicates more efficient use of feed nutrients. As a result of the research, it has been determined that in blood of young animals of the II and III experimental groups there was an increase in the count of erythrocytes by 3.5 and 1.6%, leukocytes – by 6.7 and 3.6%, respectively.

The glucose level in blood of calves of experimental groups was slightly higher compared in the control group (by 1.0–3.4%).

Great importance in body functioning belongs to blood proteins, which show ability to protect substances in the plasma and keep them in dissolved state. By the total protein and its fractions level in blood serum, one can judge the ability of animals to decompose feed protein into animal proteins.

In the blood serum of steers of groups II and III, the total protein level was higher compared to the control by 1.3 and 2.9%, which was probably the result of activation of metabolic processes during the protein utilization and synthesis. In healthy animals, the nitrogen level in blood may increase depending on protein intake.

Researches have shown that calcium level (2.21–2.36 mmol/l) in blood serum was within the physiological standard (2.0–3.0 mmol/l), there was practically no difference between the groups for this indicator, however a slight increase was recorded in the experimental groups, which is directly related to its intake into body with feed. The amount of inorganic phosphorus was within the range of 1.14–1.46 mmol/l.

The maximum value of the acid capacity was recorded in the steers of the II experimental group, which was 10.0% higher compared to the control and 7.5% higher compared to group III.

There was a tendency to increase in carotene level in blood serum of young animals of the II and III experimental groups by 8.2 and 5.4%. Obviously, the increase in the amount of carotene in blood serum is associated with its level in the diet.

The most complete picture of the feed nutrients efficiency and their transformation into products when various feed additives are included in diet for young cattle is provided by the study of the growth energy and meat productivity of animals.

One of the important indicators of efficiency of the research is the study of dynamics of growth and productivity of animals. Research has shown that the average daily weight gain in steers of the control group was 980 g, and in the experimental ones it increased to 1009-1029 g or by 3.0 and 5% (table 4).

Table 4. Productivity of experimental animals.

| Parameter                  | Group       |
|----------------------------|-------------|
|                            | I           | II          | III          |
| Body weight, kg:           |             |             |             |
| at the beginning of the experiment | 363±4.2     | 365±3.9     | 367±4.4     |
| at the end of the experiment | 451.2±4.4   | 455.8±4.5   | 459.6±4.6   |
Gross weight gain, kg  88.2±3.9  96.8±2.4  92.6±2.7
Average daily weight gain, g  980±19.9  1009±12.9  1029±10.7
% to control  100  103.0  105.0

Analysis of data according to quality of semen of repair steers showed (table 5) that in terms of ejaculate volume, steers of groups II and III exceeded their coevals of group I by 11-14%, and in terms of sperm cells concentration – by 9-12%.

Table 5. Quality of semen of repair steers.

| Parameter                                      | Group |        |
|------------------------------------------------|-------|--------|
|                                                 | I     | II     | III    |
| Ejaculate volume, ml                           | 2.8±0.3 | 3.1±0.5 | 3.2±0.52 |
| Sperm cells concentration in ejaculate, billion/ml | 0.75±0.04 | 0.82±0.06 | 0.84±0.07 |
| Sperm activity, points                         | 6.4±0.9 | 6.5±0.4 | 6.6±0.3  |
| Average number of frozen semen doses per experiment | 59±7.3 | 66±9.2 | 67±9.8  |

The energy in weight gain of steers of II and III experimental groups ranged 19.89-20.81 MJ, or 4.1-9.0% over compared to group I (table 6).

Table 6. Transformation of dietary energy into weight gain energy.

| Group | Weight gain energy, MJ | Transformation of ME of the diet into body weight gain, % | Dietary ME spent per 1 MJ of weight gain, MJ |
|-------|------------------------|----------------------------------------------------------|-------------------------------------------|
| I     | 19.10                  | 21.58                                                    | 4.63                                      |
| II    | 19.89                  | 22.37                                                    | 4.47                                      |
| III   | 20.81                  | 22.60                                                    | 4.40                                      |

Transformation of metabolizable energy of diet into body weight gain increased from 21.58% (control) to 22.37-22.60%. The dietary energy spent per 1 MJ for weight gain decreased from 4.63 MJ (control) to 4.40-4.47 MJ or by 4-5%. The best results were observed in young animals of III experimental group, who received diets with the level of non-degradable protein in the amount of 10% above the standard.

4. Conclusion
Diet containing 10% higher non-degradable protein compared to standard for feeding breeding steers with body weight of 363-460 kg, increases conversion of metabolic energy into energy of body weight gain by 9%, which provides increase in the average daily weight gains by 5%, ejaculate volume – by 14%, concentration of sperm cells in ejaculate – by 12%, while reducing the consumption of feed energy for weight gain energy by 5 percent.

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