Nutrient Metabolism of Young Cattle in the Conditions of Yakutia When Non-Traditional Feed Additives are Included in Their Rations

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Abstract. The work is aimed to develop innovative ways to increase effectiveness of a process of acclimatization and adaptation of the Hereford breed youngsters of Siberian selection, to increase its beef productivity, to enhance its usage of nutrient materials in the diet through inclusion to the diet of animals the local mineral feed supplements (Hongurin's zeolite and putrid mud) with mineral salt that compensate a deficit of mineral materials in the diet. The number of hemoglobin was larger in the experimental groups of animals than in the control group of bull-calves, which demonstrates better metabolic processes. Balance of nitrogen, calcium, and phosphorus in every studied group was positive. High rates of the usage of nitrogen, calcium, and phosphorus, from taken to digested, were in the first and the second experimental groups of bull-calves. The usage of the local mineral feed supplements in the Hereford breed bull-calves’ diet provided increasing in their digestibility of nutrient materials, such as, in average, crude protein by 2,63 and 2,78%, crude fat by 2,32 and 3,24%, crude fiber by 1,77 and 3,27%, nitrogen-free extractable substances by 5,12 and 8,40%. Higher indicators of fixed nitrogen, calcium, and phosphorus from taken to digested were in the first and the second experimental groups of bull-calves. Results of the experiment established relevance and effectiveness of the inclusion in the diet the local mineral feed supplements for the Hereford breed bull-calves.

1. Introduction

At the present time existing number of cattle for filling of 3-5 million of tons of beef production volume is not enough. Coverage of population’s own needs is satisfied only by 39%. In states, where beef cattle husbandry is more developed, for example in the USA, total number of beef breed cattle is 78%, in Canada – 67%, in France – 50%. Development of the industry is provided at the expense of high-intensity beef cattle husbandry (Kolesnyak A.A., 2011) [1].

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It is known that there are several serious problems in beef cattle husbandry that are connected with stress, which is caused by natural and climatic conditions, conditions of feeding, management, and technological operations. It is considered that loss of production can reach 22-39% due to these causes (Salo A.V., 2009; Renaudeau D., Collin A., Yahav S., De Basilio V., Gourdine J.L., Collier R.J., 2012) [2, 3, 4].

Yakutia is one of such regions that have lack of mineral nutrients in fodder of its domestic production, and it impacts on the state of health and productivity of animals (Ivanovna G.O., Romanovich S.I., Olegovich S.P., Sergeevich V.A., 2019) [5]. Therefore, for filling of macro- and micronutrients, it is necessary to include different local mineral feed supplements, premixes, and mineral salts in a composition of diets (Kawas J.R., Andrade-Montemayor H., Lu C.D., 2010; Memiši N., Lević J., Ilić N., 2014) [6, 7]. Full-fledged mineral feeding provides higher productivity of agricultural animals (Taov I.K., Kagemzov T.B., Khuranov A.M., 2019) [8].

Honguruu deposit relates to igneous-sedimentary type. Totally there are four layers of zeolitized tuff, reserves of which are assessed at 11,4 million tones, which allow providing needs of the republic in zeolite for the next 120 years. Hongurin’s zeolite consists of minerals from clinoptilolite-heulandite range, quartz, feldspars, crags of silica rocks, calcite, volcanic glass, and clayey minerals (Egorova A.D., Rozhin V.N., Filippova K.E., 2012) [9]. Properties of minerals are defined by high ion-exchangeable capability, adsorbing properties. Defined properties of Hongurin attract scientific and practical interest for usage of it as effective additional feeding resource for agricultural animals (Kolodeznikov K.E., 2003) [10].

Mineral feed supplements have in their composition a reasonable number of vital macro- and microelements, the usage of which increases mineral level of a diet (Harris P.A., Coenen M., Frape D., Jeffcott L.B., Meyer H., 2006; Ndamitso M.M., Jacob J.O., Idris S., Jimoh T.; 2010) [11, 12].

The aim of this research is concluded in the studying of the influence of the usage of the local natural mineral feed supplements in combination with mineral salts on metabolic processes, of bull-calves of the Hereford breed under conditions of the Central Yakutia.

In connection with it the objectives of the research are:
- influence of the usage of the local mineral feed supplements (zeolite and putrid mud) on growth dynamics of bred youngsters of the Hereford breed;
- influence of local mineral feed supplements on digestibility and usage of nutrient materials of a diet.

2. Materials and methods of the researches
Researches were conducted on bull-calves of the Hereford breed of Siberian selection under conditions of the commercial farm “Hereford” at integrated agricultural production center “Churapcha” of Churapcha district, the Republic of Sakha (Yakutia). All animals that were selected for conduction of the scientific research had an average fatness and were clinically healthy. The scheme of scientific and managemental experiment is presented in the table 1.

| Group of animals | Title of the group | Number of animals | Experiment duration | Scheme of feeding                          |
|------------------|-------------------|------------------|---------------------|------------------------------------------|
| Bull-calves      | Control           | 15               | 7 months            | Basic diet                               |
| Bull-calves      | The first experimental | 15               | 7 months            | Basic diet + zeolite 0,5 g/kg of live body weight + 150 g of putrid mud + 0/04 g of potassium iodide |
| Bull-calves      | The second        | 15               | 7 months            | Basic diet + zeolite 0,7                  |
Accountancy of feed intake was conducted individually. Fodder was defined by its composition: crude protein, fat, fiber, carotene, ash content, calcium, and phosphorus.

Digestibility of nutrient materials in a diet was studied by the method of Tomme M.F. (1969) [13] and Ovsyannikov A.I. (1976) [14]. Studying of nutrient materials digestibility in experimental groups of bull-calves was conducted in accordance with the method of three heads from each group. Coefficients of nutrient materials in the diet were calculated by a quantity of nutrient digestible materials against consumed and were expressed in percentage.

Results of researches were processed with a usage of mathematical statistics method.

3. Results and discussions
In summer season animals were kept in pastures. Daily consumption of fodder and their nutrient value for bull-calves at the age of 12-15 months is indicated in the table 2.

**Table 2.** Bull-calves’ daily consumption of fodder and nutrient materials in pasture season.

| Fodder                      | Unit of measurement | Control group | The first experimental group | The second experimental group |
|-----------------------------|---------------------|---------------|------------------------------|------------------------------|
| Meadow pasture grass        | kg                  | 19.0          | 19.0                         | 19.0                         |
| Combined feed               | kg                  | 2.0           | 2.0                          | 2.0                          |
| Sodium chloride             | g                   | 37.0          | 37.0                         | 37.0                         |
| Zeolite                     | g                   | -             | 95.0                         | 195.0                        |
| Putrid mud                  | g                   | -             | 150.0                        | 200.0                        |
| Potassium iodide            | g                   | -             | 0.04                         | -                            |
| Copper sulfate              | g                   | -             | -                            | 10.0                         |
| Diet contains:              |                     |               |                              |                              |
| Energetic feed unit         | EFU                 | 6.7           | 6.7                          | 6.7                          |
| Energy metabolism           | mJ                  | 67.0          | 66.2                         | 68.1                         |
| Solid matters               | kg                  | 8.4           | 8.4                          | 8.5                          |
| Digestible protein          | g                   | 540.0         | 537.7                        | 552.1                        |
| Crude fiber                 | g                   | 1950.0        | 1936.1                       | 1982.7                       |
| Sugar                       | g                   | 370.0         | 366.0                        | 378.0                        |
| Calcium                     | g                   | 42.0          | 45.2                         | 44.6                         |
| Phosphorus                  | g                   | 28.3          | 31.8                         | 33.2                         |
| Carotene                    | mg                  | 531.0         | 529.4                        | 539.6                        |
| Sulfur                      | g                   | 26.0          | 24.0                         | 58.1                         |
| Ferrum                      | mg                  | 525.0         | 532.7                        | 534.1                        |
| Cuprum                      | mg                  | 76.0          | 78.4                         | 83.9                         |
| Zinetum                     | mg                  | 340.0         | 362.1                        | 360.9                        |
| Manganese                   | mg                  | 375.0         | 375.0                        | 375.0                        |
| Cobalt                      | mg                  | 7.3           | 7.3                          | 7.3                          |
| Iodine                      | mg                  | 3.7           | 33.6                         | 12.2                         |
| Vitamin D                   | thous. UI           | 3.4           | 3.4                          | 3.4                          |
| Vitamin E                   | thous. UI           | 208.0         | 208.0                        | 208.0                        |
| Diet structure by nutrient value, % |             |               |                              |                              |
| Meadow pasture grass        | %                   | 70            | 70                           | 70                           |
| Combined feed               | %                   | 30            | 30                           | 30                           |
| Total                       | %                   | 100           | 100                          | 100                          |

Specifics of natural and climatic conditions and fodder conditions of the Central Yakutia cause a problem of imbalance of nutritional and mineral parts in agricultural animals’ diet. Practical
experience of breeding and fattening of cattle youngsters in different geographical latitudes of the state showed reasonability of usage of different natural mineral feed supplements (zeolite, putrid mud, and mineral salt) which have good qualities for stabilizers of metabolic exchange that complete missing elements of mineral part of the diet that enhances digestibility and accessibility of nutrient materials.

Therefore, for implementation of the Hereford breed cattle’s genetic potential under conditions of the Central Yakutia it is necessary to study the influence of inclusion in their diet the local mineral feed supplements.

Dynamics of live body weight of bull-calves from experimental groups demonstrate positive influence of feeding with the local mineral feed supplements on growth of youngsters in the table 3.

Table 3. Dynamics of bull-calves’ live body weight, kg (M ± m).

| Age in months | Control       | The first experimental | The second experimental |
|---------------|---------------|------------------------|------------------------|
| 8             | 180,0±0,8     | 180,4±0,7              | 180,3±0,7              |
| 12            | 270,3±0,9     | 279,5±0,9***           | 284,0±0,8***           |
| 15            | 328,3±0,9     | 340,3±0,9***           | 345,2±1,0***           |

Note: ***P>0.999

Dynamics of bull-calves’ growth and development showed that animals of the second experimental group developed better and had faster growth of live body weight than for bull-calves of other groups. At the end of the experiment live body weights of bull-calves from experimental groups amounted, in average, 340,3 and 345,2 kg, while bull-calves from control group had 328,3 kg, which was less in comparison with bull-calves of the first experimental group by 3,52% and the second experimental group by 4,89% (P>0,999).

On the basis of the data from physiological experiment the coefficient of digestibility of nutrient materials in the diet was determined in the table 4.

Table 4. Coefficient of digestibility of nutrient materials in the diet, % M±m.

| Group             | Dry matter  | Organic matter | Protein | Fat | Fiber | Nitrogen-free extractable substances |
|-------------------|-------------|----------------|---------|-----|-------|-------------------------------------|
|                   | 60,07±0,11  | 65,23±0,14     | 68,27±0,30 | 57,00±0,50 | 57,63±0,40 | 70,10±0,40 | 0 |
| The first experiment | 62,13±0,22* | 68,70±0,10**  | 70,90±0,60 | 59,32±0,70** | 59,40±0,23** | 75,22±0,12*** |
| The second experiment | 64,09±0,22** | 70,74±0,24**  | 71,05±0,25 | 60,24±0,14 | 60,90±0,14 | 78,50±0,5*** |

Note: *P>0.95 **P>0.99 ***P>0.999

During the period of conduction of the digestibility trial, it was established that after feeding of experimental bull-calves with the local mineral feed supplements, they had different coefficient of digestibility of nutrient materials in the diet. Higher coefficient of digestibility was in the first and the second experimental groups of bull-calves. They digested: dry matter – 62,13 and 64,09%, organic matter – 68,70 and 70,74%, crude protein – 70,90 and 71,05%, crude fat – 59,32 and 60,24%, crude fiber – 59,40 and 60,90%, nitrogen-free extractable substances – 74,22% and 78,50%.
Bull-calves of the first and the second experimental groups fixed fiber better than animals of the control group by 1.77 and 3.27%. By other nutrient materials (dry matter and protein) the experimental groups also had tendency to digest fuller (P>0.99).

On the basis of the results of digestibility trial in chemical composition of fodder and their remains the chemical composition of stool and urine, the balance of nitrogen, calcium and phosphorus was determined in the table 5.

| Indicator                               | The control group | The first experimental group | The second experimental group |
|-----------------------------------------|-------------------|------------------------------|------------------------------|
| Nitrogen that was eaten with fodder, g  | 73.96±0.02        | 74.16±0.01                   | 74.20±0.00                   |
| Nitrogen balance (+), (-)               | +7.48±1.22        | +15.80±0.66**                | +16.21±0.97**                |
| Fixed nitrogen, % from the fodder       |                   |                              |                              |
| From digested nitrogen                  | 14.74±2.43        | 29.89±1.00*                  | 30.62±1.71*                  |
| Calcium that was eaten with fodder, g   | 65.04±0.08        | 65.63±0.03                   | 65.69±0.03                   |
| Calcium balance (+), (-)                | +11.56±0.67       | +13.98±0.12*                 | +15.77±0.63**                |
| Fixed calcium, % from the fodder        | 17.77±1.03        | 21.29±0.19*                  | 24.0±0.96*                   |
| Phosphorus that was eaten with fodder, g| 33.66±0.01        | 33.79±0.01***                | 33.83±0.02**                 |
| Phosphorus balance (+), (-)             | +9.21±0.50        | +10.93±0.30*                 | +11.51±0.26*                 |
| Fixed phosphorus, % from the fodder     | 27.38±1.50        | 32.35±0.84*                  | 34.02±0.80*                  |

Note: *P>0.95 **P>0.99 ***P>0.999

Fixation of nitrogen in experimental groups was different. Nitrogen balance was positive and equaled in the control group 7.48, in the first experimental group – 15.80 g and in the second experimental group – 16.21 g. bull-calves of the control group fixed smaller quantity of nitrogen, thus they had less than in relation to the experimental groups by 8.32-8.73 g.

During conduction of the experiment it was established that higher indicators for digestibility of calcium fixation was in the experimental groups of bull-calves. Thus, calcium fixation for bull-calves was different and in average equaled 17.77% in the control group, the first experimental group – 21.29% and in the second experimental group – 24.00% (P>0.95).

Usage of fixed phosphorus was higher in the second experimental group – 34.02%, which is higher in comparison with the control group by 6.64% and the first experimental group by 1.67%.

In analysis of the obtained data it is necessary to define that balance of nitrogen, calcium, and phosphorus of all groups of experimental bull-calves was positive. Higher indicators of the usage of nitrogen, calcium, and phosphorus from fixed and digested were in the first and the second experimental groups.

Therefore, bull-calves of the experimental groups that had local mineral feed supplements fixed nitrogen, calcium, and phosphorus better.

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