Physiological Characteristics of Young Cattle in Central Yakutia When Using Local Non-Traditional Feed Additives in Their Rations

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Abstract. Results of conducted experimental research on studying of the influence of the local mineral feed supplements on growth, development and physiological indicators of the Hereford breed bull-calves allow making the next conclusions: Feeding of the local mineral feed supplements to the Hereford breed bull-calves allow increasing gaining in live body weight by 7.79 and 11.17%. Live body weight at the age of 15 months was amounted to 328.3-345.2 kg with daily average weight gaining at the entirety of the period of the experiment of 705.7-784.5 g. The usage of the local mineral feed supplements in feeding of the Hereford breed youngsters contributed to more intensive growth and development. In the background of the usage of the local mineral feed supplements in the diet of the experimental groups it was established that elevated concentration of hemoglobin in blood and all physiological indicators were within established normal limits. Increasing of productiveness in the experimental groups of animals was accompanied by reliable changes to the side of normalization of biochemical indicators of blood. Therefore, inclusion of the local natural mineral feed supplements to the diet provides increasing of beef productivity of the Hereford breed bull-calves and increases economical effectiveness of their breeding and fattening.

1. Introduction

A beef cattle husbandry is important part of agroindustrial complex of Russia, but, unfortunately, recent decrease of beef production is observed due to the decrease of the number of cattle. One of the primary tasks of agroindustrial complex of the state is to increase beef production (Wegren S.K., 2011; Soldatova, I.Y., Ovchinnikov, V.N., Kuznesov, N.G., Lisochenko A.A., 2012; Schierhorn F., Meyfroidt P., Kastner T., Kuemmerle T., Prischepov A.V., Müller D., 2016) [1, 2, 3].

Imported animals face with such conditions of feeding and management that are different from their usual agricultural climatic conditions, and this leads to the problem of their adaptation (Mirkena
Most widely available and effective mineral feed supplements are the putrid mud – lacustris dy, which is rich with different nutrient and mineral elements, and zeolite, which has high ion-exchangeable capability (Mishra M., Jain S.K., 2011; Ghaemnia L., Bojarpour M., Mirzadeh K.H., Chaji M., Eslam M., 2010; Grigoriev M. F. 2018) [4, 5, 6, 7]. Usage of these mineral feed supplements allows decreasing influence of stress factors on organism and provides increasing of productivity of agricultural animals (Ipek H., Avci M., Aydilek N., Yerturk M., 2012; Ulitko V.E., Pykhtina L.A., Erisanova O.E., Gulyaeva L.Yu. 2017) [11, 12].

In the Republic of Sakha (Yakutia), Suntar district, Hongurin deposit was found in 1978 by researchers of the Institute of Geology at Yakut branch of the Academy of Sciences of the USSR. From that time the first experimental studies on possibility of the use of Hongurin’s zeolite in different industrial approaches and economics had begun. By the results of the research the scientific and practical importance of the mineral was justified, and, moreover, special importance was in natural gas purification (Novgorodov P.G., Kondratieva N.I., 2005) [13]. Composition of chemical elements in zeolite at Honguru deposit is introduced in the Table 1.

| №  | Element                              | Contained in % |
|----|-------------------------------------|----------------|
| 1  | Clinoptilolite                       | 75-84          |
|    | Associate minerals:                 |                |
| 2  | Montmorillonite                      | up to 10       |
| 3  | Mica + hydromica                     | 8-9            |
| 4  | Quartz                              | 4              |
| 5  | SiO₂                                 | 65,79          |
| 6  | Al₂O₃                                | 12,20          |
| 7  | CaO                                 | 0,32           |
| 8  | MgO                                 | 1,15           |
| 9  | K₂O                                 | 1,11           |
| 10 | Na₂O                                | 3,73           |
| 11 | Fe₂O₃                               | 1,04           |
| 12 | TiO₂                                 | 0,19           |

Analysis of scientific publications showed that there is a lack of data about an influence of feeding of local mineral feed supplements (zeolite, putrid mud, and mineral salt) on clinical and physiological indicators, growth and development of bred beef cattle breeds’ youngsters in a period of stress factors impact under conditions of sharp continental climate of the Central Yakutia, which led to a reason of the research conduction.

In connection with it the objectives of the research are:
- study of average daily gain in live weight;
- definition of an effectiveness of the Hereford breed bull-calves feeding with the local mineral feed supplements, the effectiveness on increasing of beef productivity.

2. Materials and methods of the researches

Experiment was conducted by the method of analogous groups bull-calves of the Hereford breed of Siberian selection. Animals of experimental groups were selected by analogue selection according to such criteria as physiological state, live body weight, and age. Bull-calves of the control group had basic diet, but the diet of the first experimental group additionally got Hongurin’s zeolite in a dose of 0.5 g/kg of live body weight with 150 g of putrid mud, and 0.04 g of potassium iodide per one bull-
calf. The second experimental group, at a norm, had Hongurin’s zeolite in a dose of 0.7 g/kg of live body weight with 200 g of putrid mud, and 10 g of copper sulfate.

Conditions of experiments conduction for each group were equal, feeding was held twice a day. For monitoring of physiological state of animals, three heads per group, we examined blood: crude protein, hemoglobin, calcium, phosphorus, albumins, globulins, and alkalinity that were defined according to relevant methodical regulations of Azaubaeva G.S. (2004) [14]. The blood for analysis was taken from bull-calves at a morning feeding.

Furthermore we conducted temperature measurements, respiratory rates, and pulse. Gaining of live body weight was controlled by weighting of each animal once in a month at morning before feeding two days in a row.

The obtained data was processed by variation method with definition of significant test by Plokhinskiy N.A. (1969) [15-16]. Significance of differences in indicators was assessed by criteria of Student.

3. Results and discussions
In winter and spring time animals were kept in cattle-houses with group and yard housing with daily paddock. In summer period of time animals were in pastures. Feed consumption of bred bull-calves, which is introduced in the table 2, responded to biological needs of bred animals (Kalashnikov A.P., 2003).

| Fodder              | Age in months | 8-12 months | 12-15 months |
|---------------------|---------------|--------------|--------------|
|                     | %             | For the entire of period, kg | %             | For the entire of period, kg |
| Meadow hay          | 32.9          | 306.8        | 451.2        | 32.9          | 282.1        | 408.9        |
| Haylage             | 10.7          | 73.1         | 212.5        | 10.7          | 59.7         | 192.6        |
| Meadow grass        | 23.2          | 160.0        | 581.0        | 23.2          | 147.3        | 526.5        |
| Combined feed       | 33.2          | 200.0        | 187.5        | 33.2          | 203.9        | 169.9        |
| Consists totally in a diet | 100       | 739.9        |              | 100          | 693.0        |              |

During intensive breeding of bull-calves for beef at the age of 8-14 months they burnt 1432.9 energetic feed units. For the entirety of the period of bull-calves breeding they consumed a dry matter in the number of 1588.2 g, digestible protein – 122.23 g, concentration of exchange energy on dry matter was amounted to 8.4 mJ.

Churapcha district, where cattle of the Hereford breed was imported, belongs to the group of districts of the Central Yakutia. A climate of Churapcha district, in general as in all districts that belong to the group of the Central Yakutia, is characterized as sharp continental. In the district the lowest annual average temperature is observed in January: -40 ... -50°C. Winter season lasts 220 days. The warmest month is July, when the temperature in average is 21-24 (18-19°C). Basis for fodder base of animal husbandry in Yakutia depends on vegetal productivity of meadows. Harsh climate impacts on mineral composition of flora and soil.
Soils of meadow were characterized with different content of macro- and microelements. The number of phosphorus and potassium was higher than in soils of bottomland meadows. By content of microelements the soils were fully provided with significant number except cuprum. Significant number of crude protein and fat can be found in fodder grass of meadows, in bottomland meadows this indicator was 1.5-2.3 times lower. High content of crude fiber and water-soluble carbohydrates was detected in grass of bottomland meadow. Grass is characterized with relatively high content of calcium in relation to phosphorus, therefore, their ratio is imbalanced.

Table 3. Chemical composition of putrid mud, which is used in feed supplement.

| №  | Material composition | Unit of measurement | Indicators |
|----|----------------------|---------------------|------------|
| 1  | Humidity             | %                   | 92         |
| 2  | Protein              | %                   | 0.71       |
| 3  | Fat                  | %                   | 0.52       |
| 4  | Fiber                | %                   | 0.35       |
| 5  | Ash                  | %                   | 5.73       |
| 6  | Calcium              | %                   | 0.20       |
| 7  | Phosphorus           | %                   | 0.006      |
| 8  | pH-hydrous           | %                   | 9.10       |
| 9  | pH-saline            | %                   | 8.50       |
| 10 | Nitrate nitrogen     | mg/100 g            | traces     |
| 11 | Humus                | %                   | 5.20       |
| 12 | Alkalinity           | mg/100 g            | 0.56       |
| 13 | Chlorides            | mg/100 g            | 0.54       |
| 14 | Phosphorus           | mg/kg               | traces     |
| 15 | Potassium            | mg/kg               | 489.15     |
| 16 | Total nitrogen       | %                   | 0.27       |
| 17 | Mn                   | mg/kg               | 4.97       |
| 18 | Cu                   | mg/kg               | 145.28     |
| 19 | Zn                   | mg/kg               | 328.40     |
| 20 | Fe                   | mg/kg               | 278.60     |
| 21 | Co                   | mg/kg               | 58.70      |
| 22 | J                    | mg/kg               | 1.20       |
| 23 | Se                   | mg/kg               | 55.72      |
| 24 | Mo                   | mg/kg               | 23.80      |
In addition to other mineral fossil resources there is also widespread and an equally effective natural resource – putrid mud (lacustris dy). Importance of its usage in animal and poultry husbandry is defined by its biological advantages, relevance of which is justified by an inexhaustible supply of this recourse in regions with numerous lakes. Chemical composition of putrid mud which was used in the experiment is indicated in the table 3.

While weighting bull-calves in different months, an absolute growth rate was defined. The absolute growth rate, which is defined in daily average gain, is introduced in the table 4.

**Table 4. Daily average gaining of bull-calves, g (M ± m).**

| Growth period, months | Control     | The first experimental | The second experimental |
|-----------------------|-------------|------------------------|------------------------|
| 8-12                  | 752,2±5,4   | 825,5±10,7             | 863,8±7,6              |
| 12-15                 | 644,0±8,5   | 675,5±9,3*             | 680,0±10,2*            |
| 8-15                  | 705,7±2,9   | 760,7±2,8*             | 784,5±2,9*             |

Note: *P>0.95 **P>0.99

For the entirety of the period the largest daily average gaining of live body weight was observed at the age of 8-12 moths in the second experimental group (863.8 g), which was higher than indicators of the control group by 12,91% (P>0.99).

During the process of the researches conduction a positive influence of additional fodder in conjunction with Hongurin’s zeolite 0,7 g for 1 kg of live body weight + 200 g of putrid mud and copper sulfate on growth and development of bull-calves was established. Analysis of the data determined that higher daily average weight gaining was in the first and the second experimental groups of bull-calves, which, at the end of experiment, exceeded average daily weight gaining of the control group by 7,79% and 11,17% (P>0.95).

**Table 5. Morphological and biochemical blood parameters.**

| Group                | Protein, g/ % | Alkaline reserve amount in % CO2 | Albumins % | Globulins % | Protein coefficient |
|----------------------|---------------|---------------------------------|------------|-------------|---------------------|
|                      | 8 months      | 15 months                        |            |             |                     |
| Control              | 6,93±0,09     | 45,33±0,88                       | 29,67±1    | 11,87±0     | 25,27±0.42          | 0,90±0,08          |
| The first experimental | 6,87±0,12     | 45,30±0,35                       | 30,00±0    | 12,77±0     | 24,4±0.45           | 0,90±0,05          |
| The second experimental | 6,93±0,15     | 45,00±0,58                       | 30,00±0    | 12,40±0     | 25,63±0.29          | 0,96±0,04          |
| Control              | 7,50±0,06     | 48,00±1,00                       | 32,33±1    | 13,77±0     | 26,57±0.44          | 1,00±0,01          |
| The first experimental | 7,93±0,09*    | 54,67±1,86*                      | 38,00±1    | 15,00±0     | 31,20±0.46**        | 1,08±0,06          |
| The second experimental | 8,23±0,20*    | 59,00±0,58*                      | 40,00±1    | 15,97±0     | 32,73±0.82**        | 1,12±0,04          |

Note: *P>0.95 **P>0.99 ***P>0.999
Blood parameters demonstrate inner state of an organism. Its biochemical composition defines content of mineral elements, and their general aggregate picture defines adaptive and productive qualities of animals. The blood is universal and identification tool for definition of metabolism of animals’ organisms because it responds to the slightest changes in external and internal factors that are visible at the level of morphological and biochemical indicators. Additional feeding of the animals from the experimental groups with mineral feed supplements had an influence on morphological and biochemical blood parameters in the table 5.

Biochemical researches of blood serum determined that the level of protein, alkaline reserve, general protein fractions, and protein coefficient were within normal limits. High concentration of protein level indicators in blood serum is usually characterized in animals with good growth. Indicators were within physiological norms. A content of globulins in blood increases with ageing. Therefore, it was established that all biochemical indicators of blood serums in bull-calves were within normal limits and this reflected satisfactory level of health. Change in feeding conditions, drift, repositioning, and natural conditions are complicated technological processes and are main stress factors for breeding cattle youngsters. This is evidenced by changes in rates of clinical indicators. As a general rule they occur due to stressful situations caused by drastic change of feeding conditions and changes in conditions of management.

Under the influence of external environment constant of homeostasis that are reflected in clinical indicators changes. Thus, along with researches on blood indicators, there were studied general clinical indicators of animals’ organisms: body’s temperature, pulse and respiratory rates (the table 6). Studying of clinical indicators was hold at the morning time before feeding.

### Table 6. Clinical indicators (M±m).

| Indicator          | Group                  |
|--------------------|------------------------|
|                    | Control                | The first experimental | The second experimental |
| Preliminary period | Body temperature (°C)  | 39,2±0,4               | 39,1±0,7               | 39,0±0,5               |
|                    | Pulse rate (1 min.)    | 70,3±0,3               | 70,0±0,6               | 69,6±0,3               |
|                    | Respiratory rate (1 min.) | 31,3±0,3           | 30,6±0,7               | 30,7±0,7               |
| Accounting period  | Body temperature (°C)  | 39,1±0,3               | 38,9±0,1               | 38,8±0,2               |
|                    | Pulse rate (1 min.)    | 71,6±0,3               | 70,3±0,3*              | 70,0±0,3*              |
|                    | Respiratory rate (1 min.) | 32,6±0,3          | 31,3±0,3*              | 31,0±0,3*              |

Note: *P>0.95

Average body temperature in all groups of experimental animals was sustainable and amounted to 39°C. Difference in indicators of pulse rate in bull-calves of the experimental groups is explained by an influence of the local mineral feed supplements on them. Behavior of bull-calves of the experimental groups was calmer. Changes of clinical indicators were mainly caused by stressful influence on animals in new ecological conditions.

During conduction of the researches it was established that clinical indicators of bull-calves from the experimental groups that got local mineral feed supplements did not have significant differences and were within normal limits.

Stabilization of general clinical indicators during conduction of researches demonstrates positive influence of the local mineral feed supplements on animals’ physiology. Therefore, it was established that the Hereford breed bull-calves under conditions of the Central Yakutia with optimal specified conditions of feeding, breeding, and management with a usage of the local mineral feed supplements had clinical indicators within normal limits.
4. References

[1] Wegren S K 2011 Food security and Russia’s 2010 drought Eurasian Geography and Economics 52(1) pp 140-156

[2] Soldatova I Y, Ovchinnikov V N, Kuznesov N G, Lisochenko A A 2012 State support of Russian agro-industrial complex at the federal and regional levels on entering the global market Journal of Food Science and Engineering 2(2) p 118

[3] Schierhorn F, Meyfroidt P, Kastner T, Kuemmerle T, Prischepov A V, Müller D 2016 The dynamics of beef trade between Brazil and Russia and their environmental implications Global Food Security 11 pp 84-92

[4] Mirkena T, Duguma G, Haile A, Tibbo M, Okeyo A M, Wurzinger M, Sölkner J 2010 Genetics of adaptation in domestic farm animals: A review Livestock Science 2(2) pp 118

[5] Boquier F, González-García E 2010 Sustainability of ruminant agriculture in the new context: feeding strategies and features of animal adaptability into the necessary holistic approach Animal 4(7) pp 1258-1273

[6] Katmakov P S, Gavriilenko V P, Bushov A V, Stenkin N I, Zelenov G N, Prokofyev A N 2018 THE REALIZATION OF BLACK-AND-WHITE CATTLE’S PRODUCTIVE POTENTIAL Research Journal of Pharmaceutical, Biological and Chemical Sciences Vol. 9 3 476-480

[7] Ulitko V E 2018 The use of metabolizable energy and cow productivity depending on the level of dairy feeds fed during their raising period Research Journal of Pharmaceutical, Biological and Chemical Sciences 9(4) 76-80

[8] Mishra M, Jain S K 2011 Properties and applications of zeolites: A Review Proceedings of the National Academy of Sciences India Section B-Biological Sciences 81 pp 250-259

[9] Ghaemnia L, Bojarpour M, Mirzadeh K H, Chaji M, Eslami M 2010 Effects of Different Levels of Zeolite on Digestibility Journal of Animal and Veterinary Advances 9(4) pp 779-781

[10] Grigorev M F 2018 Influence of local mineral feed additives on growth, development and meat productivity of bulls Hereford breed in the conditions of Central Yakutia Ph.D. thesis in agricultural sciences Yakut State Agricultural Academy (Yakutsk) p146

[11] Ipek H, Avci M, Aydilek N, Yerturk M 2012 The effect of zeolite on oxidant/antioxidant status in healthy dairy cows Acta Veterinaria Brno 81(1) pp 43-47

[12] Ulitko V E, Pykhtina L A, Erispanova O E, Gulyaeva L Yu 2017 Influence of sorbent additives on quality indicators of meat as raw materials for food production in broiler diet Research Journal of Pharmaceutical, Biological and Chemical Sciences 8(2) 2155-2160

[13] Novgorodov P G 2005 Discoverer of zeolite deposit in Honguruu Science and engineering in Yakutia 2 pp 76-79

[14] Azaubaeva G S 2004 Blood picture of animals and birds: monograph (Kurgan) p 167

[15] Plokhinskiy N A 1969 Manual in biometry for zootechnician (Moscow) p 256

[16] Absimetov V E, Solovev D B 2020 The Use of Effective Design Solutions and High-Tech Building Materials for Reconstructing Residential Buildings of Mass Development in 1960-1990 IOP Conf. Ser.: Mater. Sci. Eng. 753 Paper № 032027. [Online]. Available: https://doi.org/10.1088/1757-899X/753/3/032027