The effect of mineral complexes on the growth intensity of young bulls for sustainable agriculture

S I Nikolaev, A V Randelin, A K Karapetyan, S N Kupriyanov, S V Chekhranova and E A Morozova

Volgograd State Agrarian University, 26 University Avenue, Volgograd, 400002, Russia

E-mail: kafedra-kormlenie@volgau.com

Abstract. The article presents the material on the study of the influence of mineral granular complexes developed from mineral raw materials at the enterprise of JSC "United Chemical Company "URALCHEM" according to different recipes on the growth intensity, clinical-physiological and hematological parameters of Ayshir bulls. It was found that the young animals that received a mineral granular complex, developed according to four recipes, surpassed the analogues from the control in live weight by 7.17, 5.44, 6.01 and 8.56%, average daily growth by 17.61, 13.19, 14.74 and 19.82%. In the blood of young animals of the experimental groups, in comparison with analogues from the control, an increase in the content of erythrocytes by 0.53-5.74% and hemoglobin by 2.8, 0.4, 1.6 and 3.3 g/l were noted. The total protein in their blood serum contained more by 4.79, 1.67, 2.47 and 8.97% and albumins, respectively, by 10.15, 6.25, 3.82 and 17.02%. The use of mineral granular complexes in the feeding of bulls is economically expedient. Additional products for 32844-49368 rubles were obtained for groups of bulls who consumed mineral granular complex. The complexes developed according to recipes No. 1 and 4 showed the highest efficiency.

1. Introduction

One of the important factors contributing to increasing the productivity of farm animals and preserving their health can be considered a full feeding that ensures their nutritional needs [1, 2, 3]. According to scientists [4, 5, 6, 7], in the diets of animals, especially highly productive animals, as a rule, there is a deficiency of individual or a whole complex of nutrients, which negatively affects the intensity of growth, productivity, increases feed costs and production costs.

Such substances include trace elements. Balancing rations for missing minerals can significantly increase the efficiency of livestock production [8, 9, 10, 11, 12].

In the works of a number of scientists, the high efficiency of the use of complex mineral feedings in animal husbandry, including mineral granular complexes, is noted [13, 14, 15, 16].

Since their use allows not only to balance the diet in terms of minerals, but also simplifies the technology of their use.

The purpose of the research was to study the effect of mineral granular complexes developed at the JSC "United Chemical Company "URALCHEM" on the growth intensity, clinical-physiological parameters, morphological and biochemical composition of the blood of bulls raised for meat.
2. Materials and methods

Experimental work on the study of the effectiveness of feeding mineral granular complexes to bulls based on domestic raw materials, including urea, monoammonium phosphate, chemical chalk, brucite, sodium chloride, was carried out on the farm of JSC “Agrofirm “Vostok” of the Nikolaevsky district of the Volgograd region.

In preparation for the experiment, a zootechnical analysis of feed was carried out. The study of the chemical composition of feed and mineral granular complex was carried out according to generally accepted and original methods.

The formation of experimental groups of bulls was carried out by the method of pairs of analogues. The experimental bulls were kept loosely separately into groups, the study was carried out according to the scheme presented in Table 1.

| Group       | n  | Feeding features                                           | Introduced mineral granular complex, g/head |
|-------------|----|-----------------------------------------------------------|--------------------------------------------|
| Control     | 12 | Basic diet (BD)                                           |                                            |
| Experimental: |    |                                                            |                                            |
| I           | 12 | BD + mineral granular complex (developed according to recipe 1) | 50.0                                       |
| II          | 12 | BD + mineral granular complex (developed according to recipe 2) | 75.0                                       |
| III         | 12 | BD + mineral granular complex (developed according to recipe 3) | 62.5                                       |
| IV          | 12 | BD + mineral granular complex (developed according to recipe 4) | 75.0                                       |

The bulls of the experimental groups consumed a basic diet (BD) consisting of: alfalfa hay 1.3-1.5 kg, grain-legume haylage 2.5-5.0 kg, corn silage 5-9 kg, grain mixtures 1.5-2.5 kg and mixed feed 1.5-2.5 kg.

The nutritional value of the BD was 4.4-5.4 energy feed units (EFU), metabolic energy 44-55 MJ, dry matter 5.3-6.4 kg, crude protein 860-900 g, digestible protein 561-586, crude fiber 1134-1326 g, sugars 505-522 g, crude fat 210-267 g, calcium 40-49 g, phosphorus 25-28 g.

The bulls of the I, II, III and IV experimental groups were additionally introduced mineral granular complexes developed for young cattle by the JSC “United Chemical Company “URALCHEM” according to separate recipes (Table 2).

When studying the effect of feed additives on the body of young animals, special attention is paid to its growth and development. The live weight of the bulls was determined by their weekly weighing. The absolute and average daily increase was determined by the calculation method.

The duration of the scientific and economic experience was 125 days. For the research, 5 groups of experimental Ayshir bulls were formed at the age of 6 months with 12 heads each.

| Composition of components | No. 1 | No. 2 | No. 3 | No. 4 |
|---------------------------|-------|-------|-------|-------|
| Urea, %                   | 23.30  | 20.30  | 27.80  | 29.40  |
| Monoammonium phosphate, % | 37.20  | 34.80  | 27.80  | 29.40  |
| Chalk, %                  | 18.60  | 23.20  | 33.30  | 29.40  |
| Brucite, %                | 7.00   | 7.20   | 11.10  | 11.80  |
During the research, it was found that mineral granular complexes introduced into the diet of animals had a growth-stimulating effect (Table 3).

**Table 3.** Indicators of growth intensity of experimental bulls (M ± m).

| Group       | Live weight indicators, kg | Growth          |
|-------------|-----------------------------|-----------------|
|             | At the beginning of the experience | At the end of the experience | Gross, kg | Average daily, g |
| Control     | 179.2 ± 2.1                 | 301.3 ± 3.1     | 122.1 ± 2.3 | 976.8 ± 32.9   |
| Experimental: |                             |                 |              |                |
| I           | 179.9 ± 1.9                 | 323.5 ± 2.4     | 143.6 ± 1.8  | 1148.8 ± 35.1  |
| II          | 179.5 ± 1.4                 | 317.7 ± 2.8     | 138.2 ± 2.6  | 1105.6 ± 38.3  |
| III         | 179.3 ± 1.7                 | 319.4 ± 3.0     | 140.1 ± 2.0  | 1120.8 ± 31.7  |
| IV          | 180.8 ± 1.5                 | 327.1 ± 2.1     | 146.3 ± 1.6  | 1170.4 ± 30.4  |

So, when setting up an experiment, the live weight indicators of experimental bulls varied within the sampling error.

At the end of the experiment, the young animals of the experimental groups who received a mineral granular complex with a diet exceeded the analogues from the control in live weight with a significant difference. Thus, the bulls of the I experimental group, when removed from the experiment, had a live weight of 323.5 kg and exceeded the analogues of the control group by 22.2 kg or 7.17% (P > 0.999). The live weight was greater than that of the control analogues by 16.4 kg or 5.44% (P > 0.99) in the bulls of the II experimental group, by 18.1 kg or 6.01% (P > 0.99) in the III experimental group and by 25.8 kg, or 8.56% (P > 0.999) in the IV experimental group.

The main indicators characterizing the intensity of growth of young animals are the gross and average daily growth in their live weight during a certain period of development. At the same time, the gross growth in live weight in young animals of the I experimental group was higher, compared with analogues from the control by 22.2 kg or 17.61% (P > 0.999), in the II experimental group - by 16.4 kg or 13.18% (P > 0.99), in the III experimental group - by 18.1 kg or 14.74% (P > 0.99) and in the IV experimental group - by 25.8 kg or 19.82% (P > 0.999).
The most informative indicator of the intensity of growth of young animals is the average daily growth in live weight. In our studies, the average daily growth of bulls was higher than that of analogues from the control group by 172.0 g or 17.61% (P > 0.95) in the I group, by 128.8 g or 13.19% (P > 0.95) in the II group, by 144.0 g or 14.74% (P > 0.99) in the III group and by 193.6 g or 19.82% (P > 0.99) in the IV group.

Consequently, additional feeding with the diet of the studied mineral granular complexes to the bulls allowed to increase their growth rates, in comparison with analogues from the control. At the same time, the highest effect of increasing their growth intensity was observed in young animals of the IV experimental group who received a mineral granular complex in addition to the diet, developed according to recipe No. 4 and the II experimental group who received a mineral granular complex, developed according to recipe No. 2.

It is known that the effect of unfavorable factors on the body of animals, including the consumption of certain feed products, can change their physiological state (Table 4).

| Indicator                          | Group     | Control          | I         | II         | III        | IV         |
|-----------------------------------|-----------|------------------|-----------|-----------|-----------|-----------|
| Body temperature, °C              |           | 38.4 ± 0.9       | 38.6 ± 0.85 | 38.3 ± 1.1 | 38.6 ± 0.79 | 38.5 ± 0.95 |
| Heart rate per minute             |           | 55.5 ± 0.82      | 54.3 ± 1.12 | 55.8 ± 0.85 | 54.9 ± 0.96 | 56.1 ± 0.8  |
| Respiratory rate per minute       |           | 22.5 ± 0.88      | 22.0 ± 0.73 | 23.0 ± 0.92 | 22.0 ± 0.86 | 23.5 ± 0.78 |
| Rumination in 2 minutes           |           | 2.8 ± 0.38       | 2.5 ± 0.42  | 2.9 ± 0.35  | 2.8 ± 0.31  | 3.0 ± 0.51  |

We studied the effect of the mineral complexes used on the clinical-physiological state and hematological composition of experimental young animals. It was found that the indicators of body temperature, heart rate, respiratory rate and rumination in experimental bulls corresponded to physiological norms.

On average, by groups, the body temperature of bulls varied from 38.4-38.6 °C, heart rate - 54.3-56.1 beats, respiratory rate - 22.0-23.5 beats per minute.

At the same time, there was a slight tendency to increase body temperature, respiratory rate and heart in animals that consumed a mineral granular complex with a diet.

The study of the morphological composition of the blood of experimental bulls showed that it is within the physiological norm (Table 5).

| Group  | Indicator          | Erythrocyte, 10^{12}/l | Leukocyte, 10^{9}/l | Hemoglobin, g/l |
|--------|--------------------|-------------------------|---------------------|-----------------|
| Control|                    | 7.48 ± 1.22             | 6.69 ± 1.20         | 99.8 ± 3.90     |
|        | Experimental:      |                         |                     |                 |
| I      |                    | 7.80 ± 0.98             | 6.45 ± 1.22         | 102.6 ± 2.85    |
| II     |                    | 7.52 ± 1.64             | 6.58 ± 1.50         | 100.2 ± 3.76    |
| III    |                    | 7.68 ± 1.52             | 6.52 ± 1.36         | 101.4 ± 3.12    |
| IV     |                    | 7.91 ± 1.36             | 6.42 ± 1.61         | 103.1 ± 2.61    |

Thus, the content of erythrocytes in the blood of young animals of the experimental groups was higher than that of analogues from the control by 0.53-5.74%. Hemoglobin in the blood of bulls of the I, II, III and IV experimental groups contained more than in the control, respectively, by 2.8, 0.4, 1.6 and 3.3 g/l.
When studying the biochemical parameters of the blood of experimental young animals, certain differences were also established (Table 6).

### Table 6. Biochemical blood parameters of experimental bulls (M ± m).

| Indicator         | Control                  | Experimental          |
|-------------------|--------------------------|------------------------|
|                   | Group I                  | Group II               | Group III             | Group IV               |
| Total protein, g/l| 72.01 ± 1.64             | 75.46 ± 1.48           | 73.21 ± 1.83          | 73.79 ± 1.42           | 78.47 ± 1.36           |
| Albumins, g/l     | 32.91 ± 1.72             | 36.25 ± 1.27           | 34.97 ± 2.32          | 34.17 ± 1.31           | 38.51 ± 1.83           |
| Globulins, g/l    | 39.1 ± 2.15              | 39.21 ± 2.64           | 38.24 ± 2.41          | 39.62 ± 2.28           | 39.96 ± 2.32           |
| Glucose, mmol/l   | 2.75 ± 0.16              | 2.82 ± 0.14            | 2.76 ± 0.14           | 2.80 ± 0.16            | 2.94 ± 0.18            |
| Calcium, mmol/l   | 3.21 ± 0.15              | 3.39 ± 0.14            | 3.25 ± 0.11           | 3.36 ± 0.13            | 3.41 ± 0.12            |
| Phosphorus, mmol/l| 1.71 ± 0.06              | 1.81 ± 0.06            | 1.72 ± 0.06           | 1.78 ± 0.06            | 1.86 ± 0.06            |

In terms of the amount of total protein in the blood serum, young animals of the I, II, III and IV experimental groups were superior to control analogues by 3.45 g/l or 4.79%, 1.20 g/l or 1.67%, 1.78 g/l or 2.47% and 6.46 g/l or 8.97% (P > 0.95), respectively. In terms of albumin content, the superiority in animals of the experimental groups was, respectively, 3.34 g/l or 10.15%, 2.06 g/l or 6.25%, 1.26 g/l or 3.82% and 5.60 g/l or 17.02% (P > 0.95). The content of globulins, calcium, phosphorus in the blood varied less significantly among the groups of young animals.

Thus, the introduction of mineral granular complexes into the diet of bulls had a positive effect on the morphological, biochemical and mineral composition of blood.

The most important indicator of the expediency of using feed additives, premixes of growth-stimulating agents, in feeding young animals raised for meat remains economic efficiency. We will calculate the economic efficiency of the use of mineral granular complexes in the diets of bulls (Table 7).

### Table 7. Economic efficiency of the use of mineral granular complexes in the diets of bulls.

| Indicator                                      | Control | Group                          |
|------------------------------------------------|---------|--------------------------------|
|                                                |         | Опытные                        |
|                                                |         | I         | II         | III        | IV         |
| Number of heads                                | 12      | 12      | 12       | 12        | 12        |
| Safety of livestock, %                         | 100     | 100    | 100      | 100       | 100       |
| Duration of the experience, days               | 125     | 125    | 125      | 125       | 125       |
| Live weight of one head, kg:                   |         |        |
| at the beginning of the experience             | 179.2   | 179.9  | 179.5    | 179.3     | 180.8     |
| at the end of the experience                   | 301.3   | 323.5  | 317.7    | 319.4     | 327.1     |
| Gross body weight growth of 1 head             | 122.1   | 143.6  | 138.2    | 140.1     | 146.3     |
| during the period of experience, kg            |         |        |
| The selling price of 1 kg of live weight, RUB  | 170.0   | 170.0  | 170.0    | 170.0     | 170.0     |
| Additionally, a live weight gain was obtained, kg: |         |        |
| per one head                                   | -       | 21.5   | 16.1     | 18.0      | 24.2      |
| per group                                      | -       | 258    | 193.2    | 216.0     | 290.4     |
| The cost of additional weight growth, RUB:     |         |        |
| per one head                                   | -       | 3655   | 2737     | 3060      | 4114      |
| per group                                      | -       | 43860  | 32844    | 36720     | 49368     |
The calculation showed that the introduction of mineral granular complexes into the diet of bulls provided additional products and income. The cost of additional products amounted in the I, II, III and IV experimental groups, respectively, 43860, 32844, 36720 and 49368 rubles (based per 12 heads).

4. Conclusion
Consequently, the additional introduction of new mineral granular complexes into the diet of bulls contributed to an increase in their live weight by 16.4-25.8 kg and an average daily increase by 13.19-19.82%.

The hematological and clinical parameters of the experimental young animals varied within the physiological norm. At the same time, an increase in the concentration of erythrocytes, hemoglobin, total protein, calcium and phosphorus in the blood to the level of the upper limit of norms was found, which indicates an intensification of metabolic processes in the body. The use of granular mineral complexes in the diets provided additional products on average for 1 head of bulls from 2737 rubles which indicates an intensification of metabolic processes in the body. The use of granular mineral complexes developed according to recipes No. 1 and 4 showed the highest economic efficiency.

References
[1] Shagaliev F, Shamsutdinov D and Ardashirov S 2019 Mineral nutrition of ruminants Animal Husbandry of Russia S1 41-42
[2] Duborezov V M 2020 Feeding dairy cows according to detailed norms Dairy and Meat Cattle Breeding 4 52-54
[3] Buryakov N and Hardik I 2021 About the balance of rations for dairy cattle Compound Feed 3 42-46
[4] Abilov A I, Dunin M I and Bogolyubova N V 2021 Mineral exchange in bulls-producers of dairy breeds after a long winter period of exploitation Animal Husbandry 2 20-25
[5] Faber V, Akmaliev T and Guseva O 2020 Mineral nutrition of ruminants Animal Husbandry of Russia 5 30-33
[6] Merphy R 2019 Trace elements, feed and lack of elements in the diet: how the form of a trace element affects the quality of feed and animal health Animal Husbandry of Russia 4 41-44
[7] Ardashirov S, Shagaliev F and Shamsutdinov D 2018 Macronutrients and livestock productivity Animal Husbandry of Russia 7 51-53
[8] Sabitov M T, Malikova M G and Farkhutdinova A R 2019 Influence of the complex mineral and vitamin feed additive "Nadezhda" on the growth of calves Dairy and Meat Cattle Breeding 4 31-34
[9] Gorlov I F, Slozhkenina M I, Randelin A V, Randelina V V, Sutorma O A, Garyaeva Kh B and Mosolova D A 2019 Effect of a new feed additive on meat productivity and quality of meat of bulls Bulletin of Russian Agricultural Science 4 57-60
[10] Nikolaev S I, Karapetyan A K, Chekhranova S V, Danilenko Y I, Rabadanov S R and Struk M V 2019 Premixes and protein vitamin-mineral concentrates in livestock and poultry breeding: technological properties Int. J. of Engineering and Advanced Technology 8(6) 5307-5312
[11] Gorlov I F, Slozhkenina M I, Mosolov A A, Garyaeva Kh B, Randelina V V and Randelin A V 2018 Influence of silicon-containing fodder additive on meat productivity of Kalmyk bulls on fattening News of Gorsky State Agricultural University 55(4) 77-83
[12] Gorlov I F, Slozhkenina M I, Mosolova N I, Zlobina E Y, Randelin A V, Bondarkova E Y, Sherstyuk B A and Belyaev A I 2020 New synbiotic-mineral complex in lactating cows' diets to improve their productivity and milk composition Iranian J. of Applied Animal Science 10(1) 31-43
[13] Sabitov M T 2021 Efficiency of using a complex mineral and vitamin feed additive in the diets of heifers Animal Husbandry 1 18-25
[14] Farkhutdinova A R and Sabitov M T 2021 Influence of a complex mineral and vitamin feed additive for calves on the digestibility of nutrients Dairy and Meat Cattle Breeding 2 40-45
[15] Gorshkov V 2019 Natural components - sources of energy, vitamins and minerals *Animal Husbandry of Russia* **S1** 23-24

[16] Nikolaev S I, Shkalenko V V, Randelin A V, Batrakova Yu M and Syuliev L A 2020 Influence of the mineral granular complex on meat productivity, quality indicators of meat of young pigs for fattening *Proc. of the Nizhnevolzhsky Agrouniversity Complex: Science and Higher Professional Education* **3(59)** 288-297