Calves’ exchange of nitrogen while feeding protein-mineral-vitamin additive

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Abstract. The article describes experiments with four groups of calves of Kalmyk breed. The second group was fed with controlled diet and mineral-vitamin additive of 1.5 mg potassium iodide, 5 mg of cobalt chloride, 50 mg copper sulphate and 2 mg vitamin E. The third group was fed with the same amount of salts of micro elements without α-tocopherol and 35 g ammonium sulphate, animals of the fourth group got the same amount of feed as group number three with additional 2 mg of vitamin E. Animals fed with all test drugs showed the highest nitrogen digestibility of 36.1 % and it is 14.4 % more compared to the control group and 8.6 % more compared with the group that got only ammonium sulphate and salts of microelements. It was observed that the choice of vitamins and mineral additives has a significant impact on the digestibility of sulphur from all diets. When tested animals feed additives there was an increase of nitrogen in their blood. The highest amount of nitrogen (3.11 to 3.34 %) was observed in groups fed with ammonium sulfate. Sugar concentration in all animals remained at optimal physiological level. Changes in the diet of experimental groups increased the rate of growth of calves and the ratio of protein conversion in group IV to 6.24 % which is 1.85 % higher than in controlled group I and on 0.41% higher than in group IV which got ammonium sulfate.

1. Introduction

Mineral substances, proteins and vitamins are essential for maintaining life of animals, their high productivity and fertility. Issues of providing full-fledged feeding in the arid territories have a great significance as cattle diet lacks 15–35 % of exchange energy, digestible protein, phosphate, sulphur, cobalt, copper and vitamins [1, 2].

All these minerals play a significant role in the body of animals. They improve the use of oxygen by tissues; participate in the process of protein exchange, oxidative phosphorylation, in metabolism of nucleic and sulfur-containing amino acids, protein, carbs and lipids, normalizes the action of a number of enzyme systems, plays an important role (as an antioxidant) in the process of stabilizing fat in the body of animals and promotes the utilization of fatty acids [3,4,5].

Different species of animals react differently to the lack of substances in the diet. Regardless of this, everyone has a disorder of skeletal muscle functions, their dystrophy, degenerative changes [6, 7].

It is impossible to provide cattle when raising all the necessary food elements without the use of feed mixtures, protein-vitamin-mineral additives, premixes, trace element salts and additional synthetic food sources [8, 9].

The need of young cattle of meat breeds for protein, minerals when grown on hay-concentrate feeding is not satisfied [10]. We propose to enrich the diet with vitamin E (α-tocopherol) together with nitrogen,
sulfur, iodine and copper compounds necessary for dietary balance. Protein-mineral-vitamin supplements in the diet of animals increase the metabolism of protein, the leading element of metabolism, as well as establish optimal recipes for balancing additives for young cattle.

2. Materials and methods
Experiments were carried out on four groups of calves of the Kalmyk breed; each group included 10 calves of age varying from 13 to 17 months old.

The first control group was fed with diet consisting of 5 kg of multi herbal hay, 4 kg of barley residues, 35 g of defluorinated phosphate, 28 g of sodium salt. The second group was fed with controlled diet and mineral-vitamin additive of 1.5 mg potassium iodide, 5 mg of cobalt chloride, 50 mg copper sulphate and 2 mg vitamin E. The third group was fed with the same amount of salts of micro elements without α-tocopherol and 35 g ammonium sulphate; animals of the fourth group got the same amount of feed as group number three with additional 2 mg of vitamin E.

Investigation of patterns for containing nitrogen and sulphur was carried out in the laboratory of the Kalmyk State University named after B.B.Gorodovikov on an atomic absorption spectrometer “MGA-915 MD”.

Morphological and biochemical blood values for additional animals were studied before staging and at the end of the experiment.

Balance experiments were performed on three animals from the group. Each experience lasted 20 days: 10 preliminary and 10 accounting.

3. Discussion and results
Total nitrogen from the hay-concentrate diet of calves was digested by an average of 30.9-36.1% (table 1). When micronutrient salts were added to the diet treated with α-tocopherol or ammonium sulfate, nitrogen variability increased compared to control group I and amounted to 35.2 and 36.1%.

Table 1. Use of nitrogen and sulphur feed by calves.

| Object of research | Group | Indicators Entered with feed, g | Nitrogen released with feces, g | Nitrogen released with urine, g | Deposited in body, g | Nitrogen used, % |
|--------------------|-------|--------------------------------|--------------------------------|--------------------------------|---------------------|-----------------|
| Nitrogen           | I     | 193.4±1.82                    | 72.4±1.01                      | 61.1±2.52                      | 59.8±1.72           | 30.9±0.83       |
|                    | II    | 189.2±1.07                    | 71.5±1.28                      | 58.0±1.42                      | 59.7±1.58           | 32.5±0.68       |
|                    | III   | 212.4±0.86                    | 75.1±1.29                      | 62.3±0.47                      | 74.9±0.61           | 35.2±0.43       |
|                    | IV    | 206.6±0.74                    | 71.6±1.38                      | 59.7±1.01                      | 75.3±0.81           | 36.4±0.34       |
| Sulphur            | I     | 22.10±0.36                    | 8.30±0.26                      | 7.93±0.15                      | 5.87±0.21           | 26.67±0.47      |
|                    | II    | 21.93±0.25                    | 8.60±0.52                      | 7.57±0.42                      | 5.77±0.21           | 26.27±0.57      |
|                    | III   | 22.33±0.40                    | 8.27±0.32                      | 7.57±0.25                      | 6.50±0.26           | 29.17±0.59      |
|                    | IV    | 22.73±0.32                    | 8.37±0.15                      | 7.70±0.20                      | 6.67±0.15           | 29.33±0.40      |

Animals fed simultaneously with all the test drugs (micro element salts, ammonium sulfate and vitamin E) showed the highest nitrogen digestibility of 36.1% which is 14.4% more compared to the control group and 8.6% with the group fed only with ammonium sulfate and with one or more microelements.

Depositing nitrogen in the body of animals was also different depending on the type of supplements to the main diet. It was higher in group IV, the lowest in calves receiving a control diet.

Sulphur is one of the factors affecting the exchange of nitrogen in the digestive tract and controlling the final digestion products since the cost-effectiveness of the exchange of nitrogen in the rumen is of great significance. It is very important to include non-protein nitrogen compounds.
All groups of calves consumed sulphur with feed at a high level in our experiments. At the same time, it was established that the choice of protein-vitamin-mineral feeding elements has a significant effect on the absorption of sulfur from diets.

The percentage of sulfur used in group I for the hay-concentrate type was higher by 0.40% than for the similar group of calves of group II.

Calves from groups III and IV consumed the sulfur feed better than the animals of groups I and II which received unbalanced feeding by 2.66%, and 2.90% more.

The nature of nitrogen exchange in animals largely depended on the type of tested additives. The urine released by calves of the control group had slightly more nitrogen in the form of ammonia in the amount of 6.7% of the total nitrogen (table 2).

Table 2. Some biochemical indicators of urine.

| Group | Total nitrogen, % | Nitrogen of fractions, % | Acetone, g/daily |
|-------|------------------|-------------------------|-----------------|
| I     | 0.75             | 6.7                     | 1.2             |
| II    | 0.93             | 6.0                     | 1.6             |
| III   | 0.85             | 5.9                     | 1.0             |
| IV    | 0.98             | 4.9                     | 1.2             |

The concentration of total nitrogen in the urine of animals fed with ammonium sulfate alone and with vitamin E was higher at 1.1-1.3 p than in group I (0.85 and 0.98 vs. 0.75%). Higher urea synthesis was observed in group II (84%) and the lowest synthesis was in group IV (44%).

The most complete oxidation of organic substances was noted in the body of animals receiving ammonium sulfate and lower oxidation had calves which were fed vitamin E with salt of microelements. So, the urine of animals of these groups released 1.0 and 1.6 g of acetone per day respectively and group I released 1.2 g of acetone.

The amount of hemoglobin, the number of red blood cells and white blood cells were within normal range both before and after the experiment, in general there is a slight increase in the number of white blood cells when the mineral and vitamin nutrition of animals was improved (table 3).

When calves were fed the test additives, an increase in total nitrogen in the blood was observed. The largest amount (3.11-3.34%) was in the groups receiving ammonium sulfate. The amount of residual, protein-free nitrogen is directly related to the amount of proteins entering with the feed, therefore, in groups III and IV receiving ammonium sulfate, the concentration of residual nitrogen is increased by 7.1 and 8.4 mg%, respectively. Sugar concentration in all animals remained at optimal physiological level.

Table 3. Some morphological indicators of blood.

| Group | Blood sampling time | Hemoglobin, g% | Red blood cells, bln. | White blood cells, thousands | Erythrocyte dimentation test, mm after 24 hours |
|-------|---------------------|----------------|----------------------|-----------------------------|---------------------------------------------|
| I     | Before the experiment | 12.71          | 11.85                | 9.65                        | 11.0                                       |
|       | After the experiment | 11.74          | 10.99                | 10.21                       | 11.0                                       |
| II    | Before the experiment | 12.23          | 11.42                | 9.24                        | 8.0                                        |
|       | After the experiment | 10.87          | 10.68                | 10.31                       | 10.0                                       |
| III   | Before the experiment | 11.86          | 11.54                | 10.05                       | 9.0                                        |
Inorganic phosphorus is found mainly in bone tissue, as well as in muscle and nervous tissues, blood, participates in the regulation of acid-alkaline balance, in fat and protein metabolism. The concentration of inorganic phosphorus increased in all groups, which seems to be related to the introduction of defluorinated phosphate into the diet. The control group I showed 8.26 mg% of inorganic phosphorus and calves of group IV treated additionally with vitamin E ammonium sulfate increased the concentration by 1.52 mg%, reflecting protein exchange intensity.

### Table 4. Biochemical indicators of calves’ blood.

| Group | Blood sampling time | Nitrogen total, g/% | Nitrogen residual, mg/% | Phosphate, g/% inorganic | Sugar mg/% |
|-------|---------------------|---------------------|------------------------|--------------------------|-----------|
| I     | Before the experiment | 2.71 | 32.4 | 34.5 | 7.71 | 69.3 |
|       | After the experiment | 2.36 | 31.8 | 36.7 | 8.26 | 64.9 |
| II    | Before the experiment | 2.97 | 32.6 | 35.1 | 7.30 | 68.3 |
|       | After the experiment | 2.65 | 35.4 | 36.1 | 10.22 | 67.8 |
| III   | Before the experiment | 2.83 | 34.6 | 34.9 | 7.34 | 70.1 |
|       | After the experiment | 3.11 | 38.9 | 40.2 | 10.83 | 73.8 |
| IV    | Before the experiment | 2.72 | 36.7 | 36.6 | 6.59 | 69.3 |
|       | After the experiment | 3.34 | 40.2 | 42.3 | 9.78 | 74.8 |

General trends of the change of metabolism and the content of energy, protein in the body of the animal, increases in living mass during development should be confirmed by the quality of the obtained products. The improvement of the mineral composition of the feeding diet had a significant impact on the formation of meat productivity of calves while they were raised.

### Table 5. Bioconversion of protein and energy of feed into the calves’ meat food protein.

| Indicators | Group | I | II | III | IV |
|------------|-------|---|----|-----|----|
| Output per 1 kg of live weight before slaughter: |       |   |    |     |    |
| protein, g | 62.0  | 63.6 | 76.5 | 78.1 |
| fat, gr    | 44.9  | 46.1 | 46.9 | 49.4 |
| energy, mJ | 2.73  | 2.79 | 3.05 | 3.16 |
| Ratio of protein conversion, % | 4.45  | 4.39 | 5.83 | 6.24 |
| Ratio of energy conversion, % | 2.90  | 2.88 | 3.48 | 3.63 |
Changes in the diet of the experimental groups increased the calves’ growth rate and increased the protein conversion rate in group IV to 6.24%, which is 1.85% higher than in control group I and 0.41% higher than in group III of ammonium sulfate-treated group (table 5). The bioconversion of feed energy into flesh pulp in calves of group IV was 0.73% higher, respectively, than in the control group. The amount of protein increased in all tested groups. The most protein-rich was the meat of calves that received ammonium sulfate separately and together with tocopherol. The enrichment of the diet with α-tocopherol in pure form and with salts of microelements increased the amount of protein by 20.6%.

4. Conclusion

Animals fed simultaneously with all the test additives (microelement salts, ammonium sulfate and Vitamin E) showed the highest nitrogen digestibility of 36.1%, which is 14.4% more compared to the control group and 8.6% more compared with the group that received ammonium sulfate alone and with microelement salts.

All groups of calves consumed sulphur with feed at a high level in our experiments. At the same time, it was established that the choice of protein-vitamin-mineral feeding elements has a significant effect on the absorption of sulfur from diet. Calves of groups III and IV consumed sulphur with feed better than calves of groups I and II which received unbalanced feeding by 2.66% and 2.90 % more.

The increase of nitrogen in blood was observed when tested calves received additives. The biggest increase (3.11- 3.34%) was seen in groups that received ammonium sulfate. The amount of residual, protein-free nitrogen is directly connected with the amount of protein fed, so in groups III and IV which received ammonium sulfate the concentration of residual nitrogen was 7.1 and 8.4 mg% more. All animals maintained the sugar concentration on optimal physiological level.

Changes in the diet of the experimental groups increased the calves’ growth rate and increased the protein conversion rate in group IV to 6.24%, which is 1.85% higher than in control group I and 0.41% higher than in group III of ammonium sulfate-treated group. The bioconversion of feed energy into flesh pulp in calves of group IV was 0.73% higher, respectively, than in the control group.

References
[1] Draganov I F 2016 Exchange of cobalt in the body of calves while fattening on the bard depending on receiving different dose of microelements Zootechnology 3 5-8
[2] Mamonov A P 2014 Effect of high protein concentrate together with antioxidant and lipotropic factor on the calves’ intensive rate of growth and beef quality Milk and meat cattle breeding 8 23-5
[3] Aliev A A 2007 Advance in Digestive Physiology of Farm Animals in the XXth century Farm Biology 2 12-22
[4] Bolaev B K 2016 Peculiarities of consumption, digestion and availability of nutrient substances of feed by pure breed and crossbreeding Bulletin of Lower Volga Agricultural university complex: science and higher professional education 4(44) 198-204
[5] Cullison A 1961 Effect of physical form of the ration on steer performance certain rumen phenomena J. Animal Sci 20
[6] Zaripov F R 2014 Efficiency of using specific mineral additives in the diet of cattle Veterinary doctor 1 64-6
[7] Spivak M E 2017 Effect of feed with high concentration of exchange energy on hematological composition and natural calves resistance Bulletin of Lower Volga Agricultural university complex: science and higher professional education 1(45) 103-8
[8] Gorlov I F 2014 Impact of new feed additive on meat productivity and slaughter quality of calves Bulletin of Altai state agrarian university 4(114) 68-72
[9] Levachin V I 2010 Effect of drugs on calves’ cicatrice metabolism Bulletin of meat cattle breeding 3(1) 110-3
[10] Faritov T A Animal feed and feed supplements St.Petersburg Lan 304