Impact of Valopro and Ruprocol fodder additives on meat productivity of Kalmyk bull calves

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Abstract. The study concerns the influence of Valopro and Ruprocol fodder additives on the change of the growth energy and formation of meat productivity of Kalmyk bull calves during their nursery from 9 to 18 months of age. The addition of Valopro at a rate of 20 grams and Ruprocol at a rate of 50 grams per head per day to the basic diet during 273 days contributed to a daily gain of 1580–1560 g, which is 200–250 g higher than the control animals. The bull calves of the experimental group used 2.0 % more daily time for eating fodders and 1.6 % less for their chewing, besides, they had less rest standing and moved in a pen, and during the whole experimental period gave 426 kg of absolute gain, or 76 kg more than the herdmates of the control group. The experienced bull calves showed higher resistance to upper respiratory tract diseases, eye diseases, laminitis and hepatosis. During the control slaughter, the body weight and heavy carcasses of bull calves of both groups met the requirements of the current GOST category Super. The hot carcass weight of the bull calves of the experimental group averaged a little more than 362 kg, i.e. 62 kg more than the control group (P≤0.01). Each bull calf gave 11488 rubles profit, which is almost 4.5 thousand rubles more than the herdmates of the control group. Therefore, the latter have almost 5 % lower profitability.

1. Introduction
In solving the food problem in Russia, the cattle breeding industry is important, the demand for dairy and meat products of which is showing stable growth. The strategy for its development is set out in the state legislation acts, which provide for a significant increase in the share of domestic production to supply biologically complete products to the population [1, 7]. However, due to annual cattle reduction beef production is still decreasing and its per capita demand in Russia is on average met by 64 %, and in Rostov region – by 52 % [2, 6, 8].

The specialty of beef production in the country is multifaceted and its specialization is based on the presence of mother stock, natural pastures and power supply. Beef production enterprises are divided into reproductive, full and incomplete herd turnover and beef feeding enterprises. The main task of the former one is to maximize the production and raise breeding and commercial young cattle when using, most often, stall-pasture technology with the growth energy of young cattle at the level of up to 900 grams per day. Therefore, for earlier preslaughter body weight of 550–600 kg it is expedient to supply super-replacement young cattle of these enterprises for nursery to industrial feeding complexes. Since in order to obtain the maximum high quality meat productivity, it is necessary to use age patterns of its formation. Before the age of one year young cattle uses feed nitrogen most intensively and provides the maximum growth of muscle tissue. With age, the use and nitrogen retention of young
cattle decreases. At the same time, with increase of the animal age, the level of fat in the body weight gain increases almost 7 times, and protein content decreases together with the growth energy [2–5].

However, this depends on the energy, which 80 % depends on the amount of cellulolytic microflora, the intensity of synthesis of volatile fatty acids, the level and ratio of substrates available for metabolism. Therefore, by introducing feed supplements based on the principle of introducing “transit phytogenic nutrients” accessible for the animals’ intestine, the intensity of digestion can be improved thus affecting the growth energy and body composition [6, 8, 9].

The Valopro fodder additive (France) is a type of chemical and microbiological synthesis and comprises a mixture of tannins, essential oils, mineral salts, cobalt and sulfur. Their reasoned combination is designed to protect rumen feed proteins, improve energy exchange by stabilizing the pH and increasing the rumen microflora. It improves fiber cleavage, slows the degradation of starch and reduces the formation of ammonia in the rumen and urea in the liver [https://f8f.by item_valopro/].

The Ruprocol fodder additive (Italy) is a protected microencapsulated choline chloride (vitamin B4) that resists in a triglyceride matrix and passes the rumen without losing any active ingredient. Once its individual particles are in the small part of the intestine, lipases begin to cleave the lipid matrix, and the released choline chloride becomes available throughout the intestine. It is a source of free methyl groups, has lipotropic properties, participates in the exchange of phospholipids, reduces the risk of clinical ketosis, reduces the risk of liver obesity and improves its functional capabilities [https://vetagro.com/ru/ruprocol/].

The purpose of the study was to make a comparative assessment of the growth, development and productivity of Kalmyk bull calves when fed with Valopro and Ruprokol fodder additives together with the basic diet in the conditions of the industrial feeding complex of LLC Agropark-Razvilnoe of Rostov region.

2. Materials and methods
The industrial complex with the volume of more than 2500 heads acquires bull calves and dairy and meat heifers with body weight from 150 to 300 kg from farms of different regions of the Russian Federation for intensive nursery. The animals are mixed into unisexual groups (70–90 heads) and placed for 20–25 days into a quarantine housing with free exit to an outdoor-feeding pen, where they are getting used to eating fodder. For this purpose, there is a starting feed mixture, which structure contains 10–15 % mixture of concentrates and 85-90 % coarse feed, on a feed table.

After acclimatization to new conditions we formed two groups of 9-month-old Kalmyk bull calves (20 heads each) and transferred them to another building, where self-feed with coarse fodders and a mixture of concentrates were installed on an outdoor-feeding pen.

Valopro at a rate of 20 grams and Ruprocol at a rate of 50 grams per head per day was added to the mixture of concentrates. The bull calves of the control group did not receive any fodder additives. The bull calves of the experimental and control groups were kept without prejudice in light-type rooms with free access to an outdoor-feeding pen. There under the canopy they used water from automatic water bowls, and from automatic feeders they ate coarse fodders (barley and pea straw, mixed herbs and lucerne hay) and a mixture of concentrates (ground barley and maize by 40 % and wheat by 20 %).

In addition to the basic diet, Valopro and Ruprocol fodder additives were added to the mixture of concentrates throughout 9 months. The composition of the feed diets of both groups was similar (Table 1). On average, depending on the weight and daily gain they consumed 8.5–14.5 kg of dry matter and 95–145 MJ of exchange energy per head per day.

The accounting of eatability and uneaten orts was defined in accordance with the standard practice – group method, weekly when changing fodders in automatic feeders. According to the actual consumption of fodder per 1 kg of the body weight gain and per 1 animal, the payment of fodder efficiency was established.
Table 1. Applied basic ration for experimental bull calves

| Fodder                          | Body weight, kg |
|---------------------------------|-----------------|
| Daily live weight gain, g       |                 |
| Mixed herbs hay, grass hay, kg  |                 |
| Legume hay, kg                  |                 |
| Barley grass, kg                |                 |
| Legume grass, kg                |                 |
| Mixture of concentrates, kg     |                 |
| Beet molasses                   |                 |
| Cooking salt, g                 |                 |
| Total : feed units              |                 |
| Crude protein, g                |                 |
| Digestible protein, g           |                 |
| Dry matter, kg                  |                 |
| Exchange energy, MJ             |                 |
| Fibre, kg                       |                 |
| Calcium, g                      |                 |
| Phosphorus, g                   |                 |
| Sulphur, g                      |                 |
| Iron, mg                        |                 |
| Copper, mg                      |                 |
| Zinc, mg                        |                 |
| Manganese, mg                   |                 |
| Cobalt, mg                      |                 |
| Carotene, mg                    |                 |
| Vitamin D, th. IU               |                 |
| Vitamin E, mg                   |                 |

In order to study the age dynamics of the body weight and growth energy, the animals were weighed on electronic scales every 30-60 days, at 18 months of age and before slaughter, after daily fasting. Absolute, relative and average daily gains for individual periods and for the entire growing cycle were calculated from the obtained animal growth data. In order to determine the daily behavior, the length of ethological actions was taken into account within 24 hours from 3 of bull calves from each group in the middle of the experiment. At the end of the experiment, the blood samples were taken from 5 bull calves of each group from the jugular vein for biochemical studies.

The slaughter of experimental animals was carried out at a meat processing plant of the feeding complex according to the methods of the All-Russian Institute of Animal Husbandry. Each group individually accounted for 5 animals at 18 months of age. After the toilet, veterinary inspection, marking and weighing of carcasses, the inner fat, slaughter weight and slaughter yield were taken into account. After daily cooling and finishing of three half-pieces from the group, the morphological composition of a carcass was determined.

The cost recovery of nursery using fodder additives was defined through the comparison of the cost of fodders, labor, energy resources and other components with the income from their sale for slaughter.

3. Results and discussion

It is not always possible to intensify the growing of super-replacement young cattle in order to obtain an average daily gain of more than 1000 grams in the reproductive farms specializing in the breeding of meat livestock. Therefore, 8-month-old bull calves arrive at the feeding complex with a body weight of 180–220 kg and in the conditions of eating feed, they show high activity of feeding behavior for a long period of time. They ate for almost 7 hours and chewed feed for more than 10 hours a day. At the same time, despite the same housing conditions and the equivalent basic diet, the bull calves of the experimental group spent 2.0 % more per day eating fodder, and 1.6 % less on its chewing, besides, they were less resting standing and moved along the pen than their herdmates from the control
group. However, the bull calves of the experimental and control groups spent 17.6 % (4.2 hours) of daily time sleeping. Significant differences between the bull calves of the analyzed groups were not identified when performing other behavioral actions. This shows that the animal ethology in equal housing and feeding conditions does not cause any reliable differences in behavior and they do not show negative rank relations to the choice of the place of rest or a place near the feeder. These effects did not change even with a new supply of feed into the automatic feeder.

It should be taken into account that together with feed additives the bull calves of the experimental groups received zinc sulfate – 371 mg, manganese sulfate – 372 mg, cobalt acetate – 2 mg, sodium sulfate – 3.1 g, calcium carbonate – 1.6 g and tannins – 764 mg as active substances. The ions of these components, while maintaining constant medium in the rumen at pH 6.4–7.5, stimulate microflora expansion, increase fermentation and energy generation from complex carbohydrates contained in fiber. These processes help to accelerate and better nutrients from feed. Probably, that is why the bull calves of the experimental group consumed more and spent less time burning food.

As a result, over a 9-month period of growth (273 days) the bull calves of the experimental group on average consumed 11.45 kg, and in the control – 10.59 kg of dry matter per head per day. Besides, due to more consumption of minerals, tannins, essential oils, chloride choline the metabolic processes, synthesis of the group vitamins B, use of free fatty acids of rumen for energy generation and prevention of fat accumulation in the liver were more active in the bull calves of the experimental group. At the same time, while interacting with proteins, enzymes, sugars and cell walls of microorganisms, tannins form complexes with stable fodder proteins and preserve them from destruction in rumen. These complexes are broken down and absorbed in rennet and intestine at pH less than 5, which decreases proteolytic microorganisms, reduces deamination and ammonia production [https://f8f.by item_valopro).

In addition, rumen microorganisms use non-protein feed nitrogen to form protein of their own cells, which is then used to form the animal protein, thereby increasing productivity.

The intensification of digestive and metabolic processes with fodder additives in the bull calves of the experimental group resulted in higher growth energy, absolute gain and body weight than in the herdmates of the control group (Table 2). In comparison with the previous period, the average daily gains of the bull calves of the experimental group during the first month increased by 218, and the control – by 198 %. Subsequently, the difference between the (and control bull calves increased from 8.8 to 42.8 %. At the same time, it should be noted that the average daily gains of the bull calves of the experimental group during the entire accounting period did not fall below 1500 grams and was higher by 200-450 grams than in the herdmates of the control group. Therefore, the average growth energy of the former was 1560 g and the absolute gain was more than 2 times (426 kg) higher than their production body weight. The average daily gain of the bull calves in the control group was at the level of 1282 grams, and the absolute gain made 350 kg, which is a highly significant difference.

| Period, days | Group and growth energy | experimental (n=20) | control (n=20) |
|-------------|-------------------------|-------------------|--------------|
|             | Absolute gain, kg       | Daily gain, g     | Absolute gain, kg  | Daily gain, g |
| 1-274       | 199±1.2                 | 723               | 201±6.1       | 731           |
| 275-306     | 49±0.61                 | 1581              | 45±0.89       | 1452          |
| 307-367     | 96±0.82                 | 1574              | 80±0.96       | 1312          |
| 368-428     | 96±1.30                 | 1574              | 80±1.08       | 1312          |
| 429-488     | 94±1.21                 | 1566              | 77±0.97       | 1284          |
| 489-518     | 46±0.86                 | 1533              | 34±0.62       | 1050          |
| 519-548     | 45±0.75                 | 1500              | 34±0.77       | 1050          |
| 275-548     | 426±0.48                | 1560              | 350±0.32      | 1282          |

*P≤0.01

It should be noted that under equal conditions of housing and feeding the change of the absolute gain and body weight of the bull calves of both groups was compact with very low variability, but
with high reliability of these signs (Table 3). Already after 3-month nursery in the complex the reliability of the body weight lag in the control group constantly increased. In the middle of the experiment (age of 14 months) the average body weight of the bull calves of the experimental group was 466 kg, and at 18-month age – 652 kg, or by 33 and 74 kg respectively higher than that of their control herdmates ($P \leq 0.01$).

| Age, days | Body weight, kg | Limit | CV, % | Body weight, kg | Limit | CV, % |
|-----------|-----------------|-------|-------|-----------------|-------|-------|
| 1         | 27±0.91         | 24-31 | 4.3   | 27±0.29         | 24-32 | 4.9   |
| 275       | 226±0.56        | 219-235 | 1.18 | 228±0.74        | 220-236 | 1.37 |
| 306       | 275±0.19        | 260-292 | 1.19 | 273±1.00        | 257-284 | 1.64 |
| 367       | 381**±1.04      | 367-395 | 1.22 | 353±0.96        | 340-366 | 1.22 |
| 428       | 466*±1.08       | 452-481 | 1.04 | 433±1.15        | 418-449 | 1.19 |
| 488       | 565*±0.67       | 553-571 | 0.55 | 510±0.89        | 496-520 | 0.79 |
| 518       | 615*±0.59       | 606-622 | 0.44 | 544±0.56        | 537-552 | 0.46 |
| 548       | 652*±0.89       | 640-664 | 0.61 | 578±0.86        | 563-586 | 0.66 |

Table 3. Change of the body weight of Kalmyk bull calves

*P≤0.01; **P≤0.05

However, the maximum and minimum deviations of the body weight from the average value within each group were almost the same ($M \pm 3\sigma$). This confirms that the higher growth energy and body weight in the bull calves of the experimental group is not caused by the housing conditions, but by the influence of biologically active substances of Valopro and Ruprocol. Besides, they have higher resistance to diseases of the upper respiratory tract, eye glands, laminitis and hepatosis. A higher blood content of total protein and glucose, as well as lactate dehydrogenase and gamma-glutamyltranspeptidase enzymes, contributed to the reduction of starch degradation in the rumen and intensification of muscle tissue synthesis (Tables 4, 6).

Lower content of amylase enzyme in blood and higher content of asparagineaminotransferase and creatine phosphokinase are associated with the catalysis of lactic acid oxidation processes, acceleration of fat cleavage processes in liver and biochemical transformation of creatine and adenosine triphosphate into creatine phosphate. These transformations fostered the increase in the amount of exchange energy ensuring complete metabolic processes in all systems of the body of experimental bull calves.

High content of alkaline phosphatase in the blood of the bull calves of the control group is caused by liver parenchyma dystrophy with cholestatic hepatosis due to insufficient protein entry into this organ. The choline chloride of Ruprocol fodder additive normalizes phospholipid metabolism in the liver and prevents hepatosis in the herdmates of the experimental group.

Therefore, the content of alkaline phosphatase in the blood of the experimental group was almost normal. The noted metabolic processes contributed to better ratio of the tissue and the heavy carcass at 18-months age (Table 5). Before slaughter, the bull calves of the experimental group had rounded body, well-muscled, wide, flat back and coupling, wide and deep chest, as well as a well-developed pelvic belt, which pin and hook bones are slightly marked, but not protruding. These body parts and sharp vertebral processes of the control group are more clearly marked and less covered with muscles. However, by the body weight and heavy-weight carcasses they all met the requirements of category Super (GOST 34120-2017).

The hot carcass weight of the bull-calves of the experimental group averaged a little more than 362 kg, which is 62 kg more than their control herdmates ($P \leq 0.01$). For them, all considered indicators of the control slaughter in absolute and relative values were significantly lower than for the bull calves receiving fodder additives. Their slaughter yield exceeded 61 %, and for herdmates it was 5 % lower ($P \leq 0.05$). It should be noted that the bull calves of both groups having relatively high growth energy did not have large accumulation and yield of internal and intermuscular fat (Table 6).
### Table 4. Biochemical blood test

| Indicator          | MU     | Norm (M±m) | Lim | Experimental group (M±m) | Lim | Control group (M±m) | Lim |
|--------------------|--------|------------|-----|--------------------------|-----|---------------------|-----|
| Crude protein      | g/l    | 62-82      |     | 90.42                    | 83.15 | 79.3-87.1           |     |
| Albumen            | g/l    | 28-39      | 35.16 | 30.1-43.6                | 38.14 | 32.7-41.4           |     |
| Glucose            | ol/l   | 2.3-4.1    | 3.38 | 2.15-3.59                | 3.00  | 2.3-3.3             |     |
| Amylase            | u/l    | 41-98      | 109.2 | 88-124                   | 110.6 | 82-134              |     |
| Bilirubin          | umol/l | 0.7-14     | 2.14 | 1.8-2.6                  | 2.53  | 1.3-3.5             |     |
| Alkaline phosphatase| mol/l  | 18-153     | 158.0 | 126-209                  | 186.6 | 156-214            |     |
| ALT                | u/l    | 6.9-35     | 28.31 | 19.2-31.0                | 30.17 | 26.3-36.2           |     |
| AST                | u/l    | 45-110     | 46.7 | 37.7-54.7                | 44.3  | 21.3-52.6           |     |
| GGTP               | u/l    | 4.9-26     | 26.0 | 21-36                    | 19.2  | 13-25               |     |
| LDH                | u/l    | 309-938    | 723.1 | 612-842                  | 589.4 | 381-695            |     |
| K-kinase           | u/l    | 14-107     | 126.3 | 110-171                  | 121.1 | 98-156             |     |
| Creatinine         | umol/l | 56-162     | 59.82 | 56.8-62.9                | 74.21 | 63.1-94.5           |     |
| Urea               | mol/l  | 2.8-8.8    | 3.3  | 3.0-4.1                  | 3.88  | 3.6-4.6            |     |
| Uric acid          | umol/l | 37.5-119   | 59.16 | 43.15-75.4               | 56.18 | 55.5-64.9          |     |
| Cholesterol        | mol/l  | 1.39-4.7   | 2.40 | 1.78-3.0                 | 2.34  | 1.9-3.5            |     |
| Triglycerides      | mol/l  | 0.22-0.6   | 0.20 | 0.15-0.23                | 0.17  | 0.13-0.25          |     |
| Calcium            | mol/l  | 1.62-3.37  | 2.15 | 1.61-2.34                | 2.38  | 2.30-2.46          |     |
| Phosphorus         | mol/l  | 0.81-2.72  | 1.35 | 1.16-1.56                | 1.50  | 1.0-1.7            |     |
| Magnesium          | mol/l  | 0.7-1.2    | 1.81 | 1.5-2.0                  | 1.70  | 1.31-2.11          |     |
| Iron               | umol/l | 10-29      | 17.11 | 12.9-21.3               | 18.0  | 13.1-21.1          |     |

### Table 5. Bull calves slaughter rates at 18 months

| Indicator                        | Group          |
|----------------------------------|----------------|
| Preslaughter body weight, kg     | experimental   | control       |
| Hot carcass weight, kg           | 362.65±0.67    | 300.64±0.73   |
| Hot carcass weight, %            | 57.2           | 53.4          |
| Internal fat weight, kg          | 24.73±0.6      | 17.45±0.4     |
| Internal fat weight, %           | 3.9            | 3.1           |
| Slaughter weight, kg             | 387.38±0.9     | 318.09±0.6    |
| Slaughter yield, %               | 61.1           | 56.5          |

*P<0.01

### Table 6. Morphological composition

| Indicator                                | Group          |
|------------------------------------------|----------------|
| Chilled carcass weight, kg               | experimental   | control       |
| Muscular tissue weight, kg               | 271.26±1.0     | 221.48±1.2    |
| Muscular tissue yield, %                 | 75.9           | 74.8          |
| Fat mass, kg                             | 17.51±0.5      | 13.92±0.2     |
| Fat yield, %                             | 4.9            | 4.7           |
| Muscular and fat tissue weight from one carcass, kg | 288.77±1.3 | 235.40±1.1 |
| Bone weight, kg                          | 61.12±0.4      | 52.41±0.5     |
| Bone yield, %                            | 17.1           | 17.7          |
| Weight of cartilages and cords, kg       | 7.51±0.1       | 8.29±0.2      |
| Yield of cartilages and cords, %         | 2.1            | 2.8           |
| Weight of bones, cartilages and cords from one carcass, kg | 68.63 | 60.70 |
| Fleshing index                          | 4.72           | 4.49          |
| Ratio of edible/inedible parts of a carcass | 4.21         | 3.88          |

*P<0.01
It is known that the morphological composition of the carcass is mainly influenced by breed, age and body weight. In this experiment, the bull calves of the same breed and age were analyzed. Therefore, the genetic and age effects on the morphological composition of the carcass will be insignificant, as opposed to the effects of the body weight. Its superiority and carcass components in the experimental bull calves are obtained through the use of feed additives.

As a result of external inspection of hot carcasses it was found that all parts of the carcass in the experimental bull calves are covered with a solid fat layer. In the control animals this layer in the area of a neck, abdominal walls and calves has small bright spots. Therefore, the dissection showed that their fat mass is by 4, muscle tissue – by almost 50 kg, and bones – by 9 kg less than the herdmates of the experimental group, although the yield of bones, cartilages and cords from the carcass of experimental bull calves is 1 % less. This provided them with a higher meat index and a ratio of edible to inedible parts of the carcass.

The organization and introduction of 18 months of intensive nursery of Kalmyk bull calves under the same housing and feeding conditions, using the Valopro and Ruprocol feed additives increased the cost efficiency of experimental animals and reduced the cost of beef production (Table 7).

Table 7. Economic indicators (average per bull calf)

| Indicator                                      | Group          |
|------------------------------------------------|----------------|
|                                               | Experimental   | Control       |
| Headcount                                     | 20             | 20            |
| Body weight at 8 months, kg                   | 200±0.79       | 202±0.87      |
| Body weight at 18 months, kg                  | 652±0.89       | 578±0.86      |
| Absolute gain, kg                             | 426±0.48       | 350±0.32      |
| Total consumed dry matter of feed per 1 head over the accounting period, kg | 3126           | 2891          |
| Dry matter consumption per 1 kg of gain, kg   | 7.34           | 8.26          |
| Price of 1 kg of body weight, rub.            | 190            | 190           |
| Price of purchased bull calf, rub.            | 38000          | 38380         |
| Cost of 1 kg of gain, rub.                    | 118            | 123           |
| Cost of nursery, rub.                         | 50268          | 43050         |
| Total costs, rub.                             | 88268          | 81430         |
| Sales price of 1 kg of body weight, rub.      | 153            | 153           |
| Sales revenue, rub.                           | 99756          | 88434         |
| Revenues, rub.                                | 11488          | 7004          |
| Profit margin, %                              | 13.01          | 8.60          |

At the same time, over the accounting period they consumed on average 235 kg of dry matter of fodder more, but its cost per 1 kg of gain was slightly lower. But since from the bull calves of the experimental group it was received 76 kg of the absolute gain more, the cost of 1 kg was 5 rubles lower than from the herdmates of the control group. Thus, at the same sales price of one kg of body weight from each bull of the experimental group, 11488 rubles of revenues was received, which is almost 4.5 thousand rubles more than from the herdmates of the control group. Therefore, the latter have almost 5 % lower profit margin. Consequently, the inclusion of relatively low-cost Valopro and Ruprocol fodder additives in the ration of meat bull calves contributes to more intensive use of nutrients. This makes it possible to obtain more than 1500 g of daily gain and more than 650 kg of body weight at 18-month age.

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