Consumption of fodder nutrients and energy by Kazakh white-headed breed steers and its crossbreeds with Herefords

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Abstract. The article presents the results of the study of the characteristics of consumption and intake of nutrients, energy, and nitrogen by steers of the Kazakh white-headed breed and its different generations crossbreeds with Herefords. The purpose of the study was to identify the most potentially productive crossbreeds of the Kazakh white-headed breed for the meat industry and a detailed study of their nutrient intake. Analysis of the obtained experimental data confirms the dominant influence of young cattle's genotype on the assimilation of nutrients and energy. According to the results of the experiment, crossbreeds of the first generation (½ Hereford x ½ Kazakh white-headed breed) of the II experimental group and crossbreeds of the second generation (¾ Hereford x ¼ Kazakh white-headed breed) of the III experimental group surpassed their purebred steers of the Kazakh white-headed breed I (control) group in the assimilability of all types of nutrients. However, the best results were shown by the III experimental group.

1. Introduction

A successful development of the meat industry in the Russian Federation is based on the rational use of genetic resources of domestic breeds and the disclosure of their best qualities by crossing with European beef cattle breeds to obtain animals with the best indicators of productivity and product quality. The study of nutrient intake in Russian breeds and their crossbreeds are significant and actual since it allows to identify the most successful combinations for breeding. The benefits of beef cattle crossbreeding systems, mainly related to heterosis and breed complementarity, are already well understood [1-2]. The scientific literature documents improvements in reproduction, growth, maternal ability, carcass, and meat quality traits through crossbreeding [3]. Further enhancements on the genetic merit of adaptation and productive efficiency traits in Russian cattle populations is of utmost value to maintain the competitiveness of the beef cattle industry [4].

Due to the manifestation of the crossbreeding effect, crossbred young animals are characterized by increased feed intake, which leads to more intensive growth and a higher level of meat productivity. The dominant paratypical factor contributing to steers' intensive growth is the organization of a
complete, balanced in all nutrients diet and optimal energy concentration per unit of dry matter of feed [5-8].

2. Materials and methods
During the scientific experiment 3 groups of bulls were formed: group I — Kazakh white-headed breed, group II — crossbreeds ½ Hereford x ½ Kazakh white-headed, Group III — crossbreeds ¾ Hereford x ¼ Kazakh white-headed.

To assess the effectiveness of the digestion in crossbreeds of Kazakh white-headed cattle with Hereford, optimal conditions for feeding and maintenance were created for young animals of all groups [9]. In the suction period, calves were kept at full suction according to the technology adopted in beef cattle breeding - the "cow-calf" technology. Calves of all groups were neutered at the age of 2.5-3 months in an open way.

After weaning from mothers at the age of 6 months, steers of all groups were transferred to the feedlot, where they were kept in one paddock until the end of the experiment (18 months). A balance experiment was carried out in one-year-old steers. The use and consumption of nutrients were determined according to the balance experiment results, considering the chemical composition of the diet. The digestibility of the nutrients was determined by the difference between the amount ingested with feed and excreted in feces and was characterized by the digestibility coefficient.

The data proceeded with the help of the Statistica Statgraf software package. Arithmetic means with standard deviations are presented in tables 1-5.

3. Results
Crossbred steers of II and III experimental groups exceeded purebred steers of the same age from the I (control) group in milk consumption by 58.1-96.4 kg (6.3-10.4%), cereal and grass hay - 12.2-23.1 kg (1.9-3.6%), grain haylage - 51.1-69.0 kg (2.9-4.0), corn silage - 24.3-60.1 kg (3.0-6.8%), green mass consumption - by 41.7-121.4 kg (1.4-4.1%).

Intergroup differences in feed intake led to unequal consumption of nutrients and energy by steers of different genotypes. Animals from I (control) group were inferior to crossbred steers of II and III experimental groups in terms of dry matter consumption by 61.5-99.8 kg (1.7-2.8%), fodder units - by 56.0-90.8 kg (1.9-3.0%), NFE - by 57.1-93.5 MJ (1.8-2.9%), crude protein - by 25.7-30.4 kg (6.2-7.3%), digestible protein - 4.9-8.0 kg (1.7-2.7 kg).

It was established that the advantage in the consumption of feed, nutrients, and energy was on the side of second-generation crossbreeds (¾ Hereford x ¼ Kazakh white-headed) of the III group. Crossbreeds of the first generation (½ Hereford x ½ Kazakh white-headed) of the II group were 38.3 kg (3.9%) inferior to them in milk consumption, and 10.9 kg (1.6%) of cereal and grass hay, corn silage - by 17.9 kg (1.0%), green mass - by 80.5 (2.7%), dry matter - by 38.3 kg (1.0%), feed units - by 34, 5 kg (1.1%), NFE - by 36.4 MJ (1.1%), crude protein - by 4.7 kg (1.1%), digestible protein - by 3.1 kg (1, 0%).

The analysis of the data obtained during the balance experiment indicates a significant effect of the genotype on nutrient intake pattern (table 1).

The advantage of animals from the III experimental group over animals from the I group in the consumption of nutrients was the most significant and amounted to 251.4 g (3.0% in dry matter), organic matter - 245.1 g (3.3%), crude protein - 44.8 g (3.7%), crude fat - 8.7 g (3.1%), crude fiber - 59.9 g (3.3%), NFE - 131.7 g (3.3%).

It was established that second-generation crossbreeds of the III group were superior to first-generation crossbreeds of the II group in consuming all types of nutrients.

Crossbred animals from the II group were inferior to crossbred steers from the III group in the consumption of dry matter by 57.3 g (0.7%), organic matter - by 54.7 g (0.7%), crude protein - by 10.2 g (0.8%), crude fat - by 2.0 g (0.7%), crude fiber - by 17.7 g (0.9%), nitrogen-free extractive substances (NFE) - 24.9 g (0.6%).
Table 1. Average daily nutrient intake by steers, g (X ± Se).

| Indicator       | Group I         | Group II        | Group III        |
|-----------------|-----------------|-----------------|------------------|
| Dry matter      | 8255.7±29.45    | 8449.8±30.42    | 8507.1±33.29     |
| Organic matter  | 7377.3±31.53    | 7567.6±31.38    | 7622.4±31.62     |
| Crude protein   | 1221.0±18.48    | 1255.6±17.23    | 1265.8±18.61     |
| Crude fat       | 284.8±3.07      | 291.5±4.31      | 293.5±3.58       |
| Crude fiber     | 1826.9±23.85    | 1869.1±25.43    | 1886.8±25.71     |
| NFE             | 4044.6±34.14    | 4151.4±34.98    | 4176.3±27.78     |

The analysis of the obtained experimental materials indicates the genotype's dominant influence on the digestion of nutrients. Crossbred animals of the II and III groups also showed the best results in feed digestibility (table 2).

Table 2. The number of nutrients digested (on average per 1 animal per day), g (X ± Se).

| Indicator       | Group I         | Group II        | Group III        |
|-----------------|-----------------|-----------------|------------------|
| Dry matter      | 5498.3±31.44    | 570.2±29.39     | 5749.9±36.04     |
| Organic matter  | 5082.2±34.04    | 5273.9±32.41    | 5330.3±37.04     |
| Crude protein   | 783.5±14.23     | 822.9±15.17     | 833.3±16.05      |
| Crude fat       | 195.1±3.37      | 201.3±4.33      | 204.0±4.68       |
| Crude fiber     | 1018.5±18.59    | 1051.6±2049     | 1065.5±21.60     |
| NFE             | 3085.1±28.76    | 3198.1±30.33    | 3227.5±32.84     |

Crossbreeds (II and III groups) were superior to purebred steers of the I group in terms of dry matter digestion by 201.9 g (3.7%) and 251.6 g (4.6%), respectively, and organic matter - by 191.7 g (3.8%) and 248.1 g (4.9%), crude protein - 39.4 g (5.0%) and 49.8 g (6.4%), crude fat - by 6.2 g (3.2%) and 8.9 g (4.6%), crude fiber - by 33.1 g (3.2%), NFE - by 113.0 g (3.7%) and 142.4 g (4.6%).

The leading position of the III group in the number of all types of digested nutrients was noted. The crossbreeds of group II were inferior to them in the amount of digested dry matter by 49.7 g (0.9%), organic matter - by 56.4 g (1.1%), raw protein - by 10.4 g (1.3%), crude fat - by 2.7 g (1.3%), crude fiber - by 13.9 g (1.3%), NFE - by 29.4 g (0.9%).

An analysis of the physiological experiment materials indicates that the II and III groups' crossbreeds exceeded purebred steers of the I group by the digestibility coefficient (table 3).

| Indicator       | Group I         | Group II        | Group III        |
|-----------------|-----------------|-----------------|------------------|
| Dry matter      | 5498.3±31.44    | 570.2±29.39     | 5749.9±36.04     |
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The advantage of crossbreeds of the II and III groups over purebred steers of the I group in terms of the digestibility coefficient of dry matter was 0.86% and 0.99%, respectively, of organic matter - 0.80 and 1.04%, crude protein - 1.37%, and 1.66%, crude fat - 0.55% and 1.00%, crude fiber - 0.51% and 0.72%, NFE - 0.76% and 1.00%.

An analysis of the physiological (balance) experiment materials indicates a positive effect of crossbreeding of Kazakh white-headed and Hereford breed livestock on the consumption and use of energy in the synthesis of body tissues (table 4).
Table 3. The coefficient of digestibility of dietary nutrients by experimental steers, % (X ± Se).

| Indicator     | Group I     | Group II    | Group III    |
|---------------|-------------|-------------|--------------|
| Dry matter    | 66.60±0.18  | 67.46±0.23  | 67.59±0.21   |
| Organic matter| 68.89±0.23  | 69.69±0.19  | 69.93±0.17   |
| Crude protein | 64.17±0.21  | 65.54±0.15  | 65.83±0.18   |
| Crude fat     | 68.51±0.14  | 69.06±0.08  | 69.51±0.11   |
| Crude fiber   | 55.75±0.27  | 56.26±0.39  | 56.47±0.36   |
| NFE           | 76.28±0.76  | 77.04±0.64  | 77.28±0.68   |

In this regard, crossbreed steers of the II and III experimental groups exceeded animals from the I group in terms of gross energy consumption by 3.79 MJ (2.6%) and 4.86 MJ (3.2%), respectively - by 3.67 MJ (3.8%) and 4.80 MJ (5.0%), exchange - by 3.08 MJ (3.8%) and 3.99 MJ (4.9%).

Table 4. The consumption and usage pattern of fodder energy in experimental steers, MJ.

| Indicator                  | Group I     | Group II    | Group III    |
|----------------------------|-------------|-------------|--------------|
| Energy: gross              | 147.82±2.38 | 151.61±3.00 | 152.68±4.10  |
| Digestible                 | 96.90±1.92  | 100.57±2.01 | 101.70±2.12  |
| Exchange                   | 81.26±1.23  | 84.34±1.30  | 85.25±1.42   |
| The exchange rate of gross energy, % | 53.66±0.94 | 54.31±1.04 | 54.53±1.23   |
| Metabolic energy: to maintain life | 35.46±0.61 | 37.13±0.73 | 37.80±0.89   |
| Metabolic energy: over-maintenance | 45.80±0.63 | 47.21±0.80 | 47.45±0.88   |
| Growth energy              | 15.77±0.22  | 16.49±0.28  | 16.64±0.30   |

The coefficient of productive energy use, %

| Indicator                  | Group I     | Group II    | Group III    |
|----------------------------|-------------|-------------|--------------|
| Gross (CPUGE)              | 10.66±0.18  | 10.88±0.20  | 10.90±0.24   |
| Exchange (CPUEE)           | 34.43±0.22  | 34.93±0.28  | 35.07±0.33   |

Second-generation crossbreeds (¾ Hereford x ¼ Kazakh white-headed) differed in the maximal consumption of energy. This advantage over the first-generation crossbreeds in terms of gross energy consumption was 1.07 MJ (0.7%), digestible - 1.13 MJ (1.1%), exchange - 0.91 MJ (1.1%).

Regarding the exchange of gross energy, the advantage was on the side of crossbreeds of the II and III experimental groups. The I group's steers breed were inferior to them by 3.02% and 3.93%, respectively.

The superiority of crossbred young animals of II and III experimental groups in exchange energy for maintaining life was 1.67 MJ (4.7%) and 2.34 MJ (6.6%), respectively, and super-support energy by 1.41 MJ (3.1%) and 1.65 MJ (3.6%). Moreover, the crossing of the Kazakh white-headed cattle with Herefords contributed to more efficient use of the exchange energy. In this regard, second-generation crossbred steers exceeded half-blood crossbreeds on exchange energy costs for maintaining life by 0.67%, for super-maintenance - 0.24%.
The obtained data indicate that the crossbreed steers were characterized by more efficient use of the fodder energy, both gross and exchange. This is evidenced by the assessment of the coefficients of a productive energy. It is enough to note that the crossbreeds exceeded purebred steers in terms of the coefficient of productive use of gross energy (CPUGE) by 0.22% and 0.24%, respectively. The advantage of crossbreeds in the coefficient of productive use of exchange energy (CPUEE) was 0.50% and 0.64%. In turn, half-breed crossbred steers were inferior to second-generation crossbred young animals (¾ Hereford x ¼ Kazakh white-headed) of the third experimental group in CPUGE by 0.02%, CPUEE - by 0.14%.

An analysis of the experimental data obtained by the balance experiment shows that the advantage in the consumption and digestion of dietary proteins was on the side of young crossbreeds (table 5).

| Indicator                | Group I         | Group II        | Group III        |
|--------------------------|-----------------|-----------------|------------------|
| Consumed with food       | 195.4±2.55      | 200.9±2.68      | 202.5±2.91       |
| Discharged with feces    | 74.8±0.66       | 73.9±0.71       | 73.8±0.82        |
| Absorbed                 | 120.6±1.99      | 127.0±2.10      | 128.7±2.31       |
| Deposited in the body    | 25.7±0.44       | 27.5±0.51       | 28.2±0.58        |
| Utilization rate, %      |                 |                 |                  |
| from intake              | 13.15±0.28      | 13.69±0.35      | 13.93±0.37       |
| from absorption          | 21.31±0.34      | 21.65±0.41      | 21.91±0.43       |

Animals from II and III experimental groups exceeded purebred steers in nitrogen consumption with feed proteins by 5.5 (2.8%) and 7.1 (3.6%). Crossbreeds were also distinguished by better digestibility of nitrogen.

The leading position both in the consumption of nitrogen of feed proteins and in its deposition in the body was occupied by crossbred steers of the III experimental group. Steers of the II group were inferior to them in the consumption of feed protein nitrogen by 1.6 g (0.8%), by the weight of digested nitrogen - by 1.7 g (1.3%).

The maximum value of the nitrogen utilization coefficient was observed in crossbreeds of the III experimental group. Animals from the II group were inferior to them in terms of the utilization ratio of nitrogen of feed proteins from intake by 0.24%, from absorbed - by 0.26%.

4. Discussion
Crossbreeding systems in the beef cattle industry aim to exploit heterosis and complementarity to improve the efficiency of production under different environmental conditions [3; 10]. Targeted selection of animals from different breeds for crossbreeding results in better nutrient intake and productivity, which opens new perspectives for the meat industry [11].

A sufficient amount of nutrients and energy entering the body of growing animals with feed is an essential and indispensable condition for the active course of anabolism, ensuring the effective implementation of the basic physiological functions [12].

This ultimately leads to high growth intensity, live weight, quality, and biological usefulness of meat products obtained from the slaughtered animals. In this regard, to fully realize the bioresource potential of meat productivity and obtain high-quality biologically high-grade beef with intensive rearing and fattening of young cattle, it is necessary to achieve a high level of animal feeding. Crossbreeding with the successful selection of breeds and compatibility of their genotypes is
characterized by the manifestation of the effect of crossing with more efficient use of nutrients in the diet, which is extremely important for beef cattle breeding [6-8].

5. Conclusion
In general, crossbred steers were distinguished by a large consumption of all types of nutrients, energy, and nitrogen of feed proteins, their best digestibility, and the synthesis of meat products. But second-generation crossbreeds (¾ Hereford x ¼ Kazakh white-headed) showed the highest results for all studied indicators.

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