J Biochem Tech (2020) 11(4): 36-41
ISSN: 0974-2328

The Genotypic Peculiarities of The Consumption And The Use Of Nutrients And Energy From The Fodder By The Purebred And Crossbred Heifers

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Received: 21 July 2020 / Received in revised form: 30 October 2020, Accepted: 05 November 2020, Published online: 28 November 2020

Abstract

The article shows the results of studying the consumption and use of essential nutrients and energy from the fodder in the diet of the purebred heifers and the heifers obtained by crossing the Kazakh white-headed and Hereford breeds. The objects of the study were the heifers of the following genotypes: I — Kazakh white-headed, II — ½ Hereford x ½ Kazakh white-headed, and III — ¾ Kazakh white-headed x ¼ Hereford. It has been found that the crossbred young animals featured greater consumption of all types of fodders in the diet than the purebred animals. Typically, the leading place in the consumption of all types of fodder is occupied by the half-breed heifers in group II (½ Hereford x ½ Kazakh white-headed). The experimental materials obtained during the physiological (balance) experiment are evidence of the effect of the genotype of the heifers on the consumption and digestion of certain types of nutrients in the diet. It should be noted that the purebred heifers were inferior to the crossbreeds in groups II and III in the consumption of dry matter, respectively, by 126.90 g (2.0 %) and 52.9 g (0.8 %), organic matter — by 139.24 g (2.4 %) and 71.35 g (1.2 %), crude protein — by 42.35 g (4.3 %) and 31.1 g (3.1 %), crude fat — by 4.59 g (2.1 %) and 1.92 g (0.9 %), crude fiber — by 36.41 g (2.4 %) and 15.14 g (1.0 %), and nitrogen-free extractive substances (NFES) — by 55.89 g (1.8 %) and 22.86 g (0.7 %). The purebred heifers of the Kazakh white-headed breed were inferior to their crossbred analogs in groups II and III by the amount of digested dry matter, respectively, by 150.62 g (3.6 %) and 68.97 g (1.6 %), organic matter — by 146.41 g (3.7 %) and 69.35 g (1.7 %), crude protein — by 35.24 g (5.6 %) and 27.00 g (4.3 %), crude fat — by 35.24 g (5.6 %) and 2.15 g (1.4 %), crude fiber — by 28.53 g (3.2 %) and 13.07 g (1.5%), and NFES — by 77.59 g (3.3 %) and 27.13 g (1.2 %). The leading position of the heifers in experimental group II (1/2 Hereford x 1/2 Kazakh white-headed) by the value of the analyzed parameter was established. Due to the greater amount of nutrients consumed and digested from the diet, the crossbred heifers in groups II and III were superior to the purebred Kazakh white-headed heifers in terms of the digestibility coefficient. A similar situation was observed in the use of energy. For instance, the heifers in groups II and III were superior to their peers in group I by the consumption of gross energy, respectively, by 2.90 MJ (2.5 %) and 1.53 MJ (1.3 %). A similar pattern was also observed for other types of consumed energy. During the experiments, it was found that the Kazakh white-headed heifers in group I were inferior to their crossbred peers in groups II and III in nitrogen consumption by 6.78 g (4.3 %) and 5.03 g (3.2 %). Typically, almost equal amounts of nitrogen were excreted in the feces of the heifers of various genotypes: 57.76 — 58.78 g. At the same time, the crossbred heifers in groups II and III showed better digestibility of proteins nitrogen from the feed diet.

Keywords: beef cattle breeding, the Kazakh white-headed breed, the Hereford breed, crossing, crossbreeds, heifers, consumption and utilization of fodder and nutrients, the coefficient of feed digestibility, energy and nitrogen balance.

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Introduction

Currently, the problem of increasing the beef production growth rate has become one of the most important problems of the agricultural sector in the Russian Federation.

By the biological and nutritional value, it is an important source of complete nutrition for humans (Ilona et al., 2018). This is due to the content of all essential amino acids, trace elements, and vitamins in beef in the most accessible form (Privalo et al., 2018; Amina et al., 2018). Therefore, measures are being taken around the world for improving the livestock productivity, the use of highly productive breeds is expanding, new breeds and types are created, which are characterized by large body size, high growth rate with an optimal ratio of the main nutrients in the meat, and its high biological value (Al Mazroea et al., 2018).

Along with that, much attention is paid to the genetic improvement of the existing breeds of the livestock and maximized use of the potential of their meat productivity (Mironenko et al., 2012; Kosilov and Mironenko, 2005; Kosilov et al., 2012; Fatkullin et al., 2018; Sedykh et al., 2018; Mironova et al., 2018; Tyulebaev et al., 2019).

It is known that the degree of commercialization of the genetic potential of meat productivity significantly depends on the paratypical or environmental factors, the most important of which is feeding. It is the organization of full-fledged balanced feeding of young animals from an early age that makes it possible to obtain animals with high meat productivity and the quality of meat products (Kosilov et al., 2010; Kosilov et al., 2017; Kubatbekov et al., 2017; Nikonova et al., 2014; Zadnepryansky et al., 2012; Vilver et al., 2017; Kharlamov et al., 2006).

Materials and Methods

The objects of the study were the heifers of three genotypes: I — Kazakh white-headed, II — ½ Hereford x ½ Kazakh white-headed, and III — ¾ Kazakh white-headed x ¼ Hereford. During the suckling period from birth to the age of six months, the young animals were kept in complete suckling under the mothers in the "Cow-Calf" system.

In the winter, after weaning from cows, the heifers were kept in a lightened room with feeding and watering in the walking yard, while in the summer — in the pasture. During the experiment, the monthly fodder consumption was monitored; in the summer, it was done by reverse calculation. During the balance experiment, the fodder consumption was monitored every day.

During the winter stall period, the young heifers were fed in the walking yard; they also received water therefrom an automatic drinker of the AGK-4 type electrically heated in the winter. For the rest of the animals, a mound, and indoors — a deep nonremovable litter were used.

Fodder of own production was used for feeding the young animals.

Results

It was found that due to the unequal palatability, in feeding the same diet to the heifers of all genotypes, differences were observed among the groups in the intake of feed, nutrients, and energy (Table 1).

Table 1: Consumption of fodder, nutrients, and energy by the experimental heifers during the growth period from birth to 18 months of age (per one animal), kg

Parameter	Group		
	I	II	III
Milk food	881.2	984.8	939.6
Hay	738	792	754
Haylage	1,746	1,881	1,798
Maize silage	348	377	367
Green mass	2,812	3,082	3,034
Concentrates	660	660	660
The fodder contains:dry matter	2,664.1	2,827.9	2,756.0
Feed units	2,638.8	2,811.6	2,749.2
Energetic feed unit (EFU)	2,674.8	2,836.4	2,764.3
Metabolizable energy, MJ	26,748.1	28,364.2	27,643.1
Digestible protein	246.0	296.1	289.2
Crude protein	350.9	365.2	362.1
Digestible protein per a feed unit, g	105.2	105.3	105.2
The concentration of metabolizable energy in 1 kg of dry matter (CME), MJ	10.04	10.03	10.03

With that, the crossbred young animals featured greater consumption of all types of fodders in the diet, compared to the purebred animals. For instance, the crossbred heifers in groups II and III were superior to their purebred peers in terms of the consumption of hay by 54 kg (7.3 %) and 16 kg (2.2 %), haylage — by 135 kg (7.7 %) and 52 kg (3.0 %), maize silage — by 29 kg (8.3 %) and 19 kg (5.5 %), green mass — by 270 kg (9.6 %) and 222 kg (7.9 %), dry matter — by 163.8 kg (6.1 %) and 91.9 kg (3.4 %), feed units — by 172.8 kg (6.5 %) and 110.4 kg (4.2 %), metabolizable energy — by 1,616.1 MJ (6.0 %) and 895.0 MJ (3.3 %), and digestible protein — by 50.1 kg (20.4 %) and 43.2 kg (17.6 %).

It was typical that the leading place in the consumption of all types of fodder was occupied by the half-breed heifers in group II (½ Hereford x ½ Kazakh white-headed). The heifers in group III (¾ Kazakh white-headed x ¼ Hereford) were inferior to them in the consumption of hay by 38 kg (5.0 %), haylage — by 83 kg (4.6 %), maize silage — by 10 kg (2.6 %), green mass — by 48 kg (1.6 %), dry matter — by 71.9 kg (2.6 %), fodder units — by 62.4 kg (2.3 %), metabolizable energy — by 721.1 MJ (2.6 %), and digestible protein – by 6.9 kg (1.9 %).

The share of the concentrated fodder in the structure of the diet was 23.5 – 25.0 % (Table 2).

Table 2: Consumption of nutrients by the experimental heifers, g x ± SX

Parameter	Group		
	I	II	III
Dry matter	6,402.10 ± 20.13	6,529.00 ± 22.40	6,455.00 ± 23.18
Organic matter	5,857.56 ± 26.42	5,996.80 ± 24.38	5,928.91 ± 25.60
Crude protein	988.90 ± 19.16	1,031.25 ± 18.43	1,020.33 ± 19.22
Crude fat	221.38 ± 5.43	225.97 ± 5.88	223.30 ± 6.11
Crude fiber	1,543.19 ± 22.83	1,579.60 ± 23.80	1,558.33 ± 24.31
NFES	3,104.09 ± 34.52	3,159.98 ± 38.10	3,126.95 ± 37.22

At the same time, the crossbred heifers exceeded their peers of the Kazakh white-headed breed for this trait. It should be noted that the purebred heifers in group I were inferior to the crossbreeds in groups II and III in the consumption of dry matter, respectively, by 126.90 g (2.0 %) and 52.9 g (0.8 %), organic matter — by 139.24 g (2.4 %) and 71.35 g (1.2 %), crude protein — by 42.35 g (4.3 %) and 31.1 g (3.1 %), crude fat — by 4.59 g (2.1 %) and 1.92 g (0.9 %), crude fiber — by 36.41 g (2.4 %) and 15.14 g (1.0 %), and NFES — by 55.89 g (1.8 %) and 22.86 g (0.7 %).

The leading position of the heifers in experimental group II ($^1/_2$ Hereford x $^1/_2$ Kazakh white-headed) by the value of the analyzed parameter was established. The peers in experimental group III ($^3/_4$ Kazakh white-headed x $^1/_4$ Hereford) were inferior to them in terms of the amount of the consumed dry matter by 74 g (1.2 %), organic matter — by 67.89 g (1.1 %), crude protein — by 10.92 g (1.1 %), crude fat — by 2.67 g (1.2 %), crude fiber — by 21.27 g (1.4 %), and NFES — by 33.03 g (1.1 %).

The obtained data and their analysis showed that the crossbred heifers in groups II and III were superior to their purebred peers in group I in terms of the use of all kinds of nutrients from the diet (Table 3).

Table 3: Digested nutrients by the experimental heifers, g x ± SX

Parameter	Group		
	I	II	III
Dry matter	4,206.18 ± 30.48	4,356.80 ± 32.38	4,275.15 ± 31.88
Organic matter	3,989.58 ± 29.30	4,135.99 ± 28.56	4,058.93 ± 29.44
Crude protein	627.85 ± 18.26	663.09 ± 19.34	654.85 ± 18.36
Crude fat	149.76 ± 5.43	154.81 ± 5.2	151.91 ± 6.18
Crude fiber	887.80 ± 17.43	916.33 ± 16.48	900.87 ± 17.33
NFES	2,324.17 ± 21.40	2,401.76 ± 22.36	2,351.30 ± 20.26

The purebred heifers of the Kazakh white-headed breed were inferior to the crossbred analogs in groups II and III by the amount of digested dry matter, respectively, by 150.62 g (3.6 %) and 68.97 g (1.6 %), organic matter — by 146.41 g (3.7 %) and 69.35 g (1.7 %), crude protein — by 35.24 g (5.6 %) and 27.00 g (4.3 %), crude fat — by 35.24 g (5.6 %) and 2.15 g (1.4 %), crude fiber — by 28.53 g (3.2 %) and 13.07 g (1.5%), and NFES — by 77.59 g (3.3 %) and 27.13 g (1.2 %).

The obtained experimental material and its analysis showed that the half-breed heifers in group II were characterized by more efficient use of the nutrients from the diet. For instance, the young animals in experimental group III were inferior to them in terms of the amount of digested dry matter from the fodder by 81.65 g (2.0 %), organic matter — by 77.06 g (1.9 %), crude protein — by 8.24 g (1.3 %), crude fat — by 2.90 g (1.9 %), crude fiber — by 15.46 (1.7 %), and NFES — by 50.46 g (2.1 %).

The obtained data and their analysis showed that due to the greater amount of nutrients consumed and digested from the diet, the crossbred heifers in groups II and III were superior to the purebred Kazakh white-headed heifers in terms of the digestibility coefficient (Table 4).

For instance, the purebred Kazakh white-headed heifers were inferior to their half-breed peers in groups II and III in terms of the coefficient of dry matter digestibility from the diet by 1.03 % and 0.53 %, organic matter — by 0.86 % and 0.69 %, crude protein — by 0.81 % and 0.69 %, crude fat — by 0.86 % and 0.38 %, crude fiber — by 0.48 % and 0.28 %, and NFES — by 1.13 % and 0.32 %.

Table 4: The coefficients of nutrients digestibility from the diet by the heifers in the experimental groups, % x ± SX

Parameter	Group		
	I	II	III
Dry matter	65.70 ± 0.26	66.73 ± 0.37	66.23 ± 0.99
Organic matter	68.11 ± 0.31	68.97 ± 0.34	68.46 ± 0.48
Crude protein	63.49 ± 0.51	64.30 ± 0.74	64.18 ± 0.63
Crude fat	67.65 ± 0.13	68.51 ± 0.11	68.03 ± 0.09
Crude fiber	57.53 ± 1.01	58.01 ± 1.05	57.81 ± 1.34
NFES	74.87 ± 0.92	76.00 ± 0.67	75.19 ± 0.78

The leading position of the half-breed crossbred heifers ($^1/_2$ Hereford x $^1/_2$ Kazakh white-headed) in group II over their crossbred peers ($^3/_4$ Kazakh white-headed x $^1/_4$ Hereford) in group III was established in terms of the magnitude of the studied parameter. For instance, the superiority of the heifers in group II over their peers in group III in terms of the digestibility coefficient of dry matter from the diet amounted to 0.50 %, in terms of the digestibility coefficient of organic matter — to 0.51 %, in terms of the digestibility coefficient of crude protein — to 0.20 %, in terms of the digestibility coefficient of crude fat — to 0.48 %, in terms of the digestibility coefficient of crude fiber — to 0.20 %, and in terms of the digestibility coefficient of NFES — to 0.81 %.

The analysis of the data obtained from the balance experiment showed an advantage of the crossbred heifers in groups II and III in terms of the consumption and the use of the energy of the diet over their purebred peers of the Kazakh white-headed breed (Group I) (Table 5).

For instance, the heifers in groups II and III were superior to their peers in group I by the consumption of gross energy, respectively, by 2.90 MJ (2.5 %) and 1.53 MJ (1.3 %).

Table 5: Consumption and use of energy from the diets by the experimental heifers, MJ ($\bar{o} \pm S\bar{o}$)

Parameter	Group		
	I	II	III
Energy: Gross	117.63 ± 2.52	120.53 ± 2.10	119.16 ± 2.36
- digestible	76.27 ± 1.88	79.15 ± 1.86	77.70 ± 1.92
- metabolizable	62.11 ± 1.23	64.43 ± 1.40	63.22 ± 1.33
Metabolism of gross energy, %	52.80 ± 0.66	53.46 ± 0.70	53.05 ± 0.68
Metabolizable Energy(ME)			
- for life-sustaining	29.96 ± 0.43	31.88 ± 0.55	31.03 ± 0.49
- excessive life-sustaining	32.15 ± 0.503	32.55 ± 0.44	32.19 ± 0.51
Growth energy	10.91 ± 0.23	11.24 ± 0.24	11.03 ± 0.25
The coefficient of productive use of energy, %			
- gross (CPUGE)	9.27 ± 1.14	9.33 ± 10.17	9.30 ± 0.18
- metabolizable (CPUME)	33.93 ± 0.32	34.53 ± 0.36	34.27 ± 0.31

A similar pattern was also observed for other types of consumed energy. It should be noted that the purebred Kazakh white-headed heifers in group I were inferior to their crossbred peers in groups II and III in terms of the consumption of digestible energy by 2.88 MJ (3.8 %) and 1.43 MJ (1.8 %), and in terms of metabolizable energy – by 2.32 MJ (3.7 %) and 1.11 MJ (1.8 %), respectively.

The obtained data indicate the leading position of the crossbred heifers in group II in terms of the analyzed parameters. For instance, the crossbred heifers in group III ($^3/_4$ Kazakh white-headed x $^1/_4$ Hereford) were inferior to their crossbred peers in group II in terms of gross energy consumption by 1.37 MJ (1.1 %), digestible energy by 1.45 MJ (1.9 %), and metabolizable energy by 0.41 MJ (0.8 %).

The determined distribution ranking of the heifers in the experimental groups in terms of the consumption of various types of energy was also observed for metabolizable gross energy. With that, the young animals in group I were inferior to their peers in groups II and III in terms of the analyzed parameter by 0.66% and

0.25%, respectively. In their turn, the heifers in group II exceeded their peers in group III in terms of this parameter by 0.41%.

It is known that nutrients and energy of the fodder in the diet are used for maintaining the physiological processes aimed at ensuring the functioning of the organism, and for synthesizing the tissues in the animal body. With that, the purebred Kazakh white-headed heifers in group I were inferior to their crossbred peers in groups II and III in terms of the use of metabolizable energy for life-sustaining by 1.92 MJ (6.4 %) and 1.07 MJ (3.6 %), and in terms of metabolizable energy use for excessive life-sustaining – by 0.40 MJ (1.2 %) and 0.04 MJ (0.1 %), respectively.

Similar differences were observed between the groups in terms of the metabolizable energy use for the growth. It should be noted that the crossbred heifers in groups II and III were superior to their purebred Kazakh white-headed peers in terms of the studied parameter by 0.33 MJ (3.0 %) and 0.12 MJ (1.1 %).

It was typical that the crossbred heifers ($^1/_2$ Hereford x $^1/_2$ Kazakh white-headed) in group II were superior to the crossbred ($^3/_4$ Kazakh white-headed x $^1/_4$ Hereford) heifers in group III in terms of metabolizable energy use for life-sustaining by 0.85 MJ (2.7 %), in terms of metabolizable energy use for excessive life-sustaining — by 0.36 MJ (1,1 %), and in terms of metabolizable energy use for growth — by 0.21 MJ (1.9 %).

The analysis of the data showed that the crossbred heifers in experimental groups II and III had a higher ratio of productive use of both gross and metabolizable energy. The young Kazakh white-headed heifers in group I were inferior to their crossbred peers in groups II and III in terms of the coefficient of productive use of gross energy by 0.06 % and 0.03 %, and metabolizable energy — by 0.60 % and 0.34 %, respectively.

It was typical that in terms of the analyzed parameters, the leading position was taken by the half-breed crossbred ($^1/_2$ Hereford x $^1/_2$ Kazakh white-headed) heifers in experimental group II. Their crossbred peers ($^3/_4$ Kazakh white-headed x $^1/_4$ Hereford) in group III were inferior in terms of the productive use of gross energy (CPUGE) by 0.03 %, and exchange energy (CPUME) — by 0.26 %.

The analysis of the experimental data indicated the advantage of the crossbred heifers in groups II and III over their purebred Kazakh white-headed peers in group I in terms of the consumption and digestibility of nitrogen from the proteins in the diet fodder, as evidenced by its balance data (Table 6).

Table 6: The average daily nitrogen balance in the organisms of the experimental heifers, g/animal x ± Sx

Parameter	Group		
	I	II	III
Taken with fodder	158.22 ± 1.37	165.00 ± 1.22	163.25 ± 1.44
Excreted with feces	57.76 ± 0.43	58.78 ± 0.45	58.47 ± 0.51
Digested	100.46 ± 0.61	106.22 ± 0.53	104.78 ± 0.52
Assimilated: per one heifer	22.46 ± 0.34	24.32 ± 0.32	23.91 ± 0.21
Utilization rate, %			
- from the taken	14.19	14.74	14.64
- from the digested	22.35	22.89	22.81

For instance, the purebred Kazakh white-headed heifers in group I were inferior to their crossbred peers in groups II and III in nitrogen consumption from the fodder by 6.78 g (4.3 %) and 5.03 g (3.2 %). Typically, almost equal amounts of nitrogen were excreted in the feces of the heifers of various genotypes: 57.76 — 58.78 g.

At the same time, the crossbred heifers in groups II and III showed better digestibility of proteins nitrogen from the feed diet. It should be noted that the purebred Kazakh white-headed heifers were inferior to them in the amount of digested nitrogen from the proteins in the fodder by 5.76 g (5.7 %) and 4.32 g (4.3 %). Besides, the crossbred heifers in groups II and III showed the best absorption of protein and nitrogen from the fodder, and in terms of this parameter were superior to their Kazakh white-headed peers in group I by 1.86 g (8.3 %) and 1.45 g (6.4 %), respectively.

The obtained experimental materials and their analysis showed that the half-breed crossbred (½ Hereford x ½ Kazakh white-headed) heifers in group II differed from their crossbred peers in group III (3/4 Kazakh white-headed x ¼ Hereford) not only in terms of a greater amount of nitrogen taken with proteins in the fodder but also in terms of its better digestibility and assimilation. It should be noted that the advantage of the crossbred heifers in group II in terms of the amount of nitrogen taken with protein in the fodder was 1.75 g (1.1 %), in terms of digested nitrogen — 1.44 g (1.4 %), and in terms of assimilated nitrogen — 0.41 g (1.7 %).

Upon crossing of the Kazakh white-headed and Hereford cattle, increased nitrogen retention in the organisms of the crossbred heifers was noted. The Kazakh white-headed purebred heifers were inferior to their crossbred peers in groups II and III in terms of nitrogen utilization from the received nitrogen by 0.59 % and 0.45 %, in terms of nitrogen utilization from the digested nitrogen — by 0.54 % and 0.46 %. Characteristically, the heifers in group II featured higher nitrogen retention in the body. The crossbred peers in group III were inferior to them in terms of nitrogen utilization from the received nitrogen by 0.10 %, and in terms of nitrogen utilization from the digested nitrogen — by 0.07 %.

Conclusion

Thus, crossing the Kazakh white-headed and the Hereford cattle has contributed to obtaining crossbred heifers with higher consumption of all types of fodder, nutrients, energy, and nitrogen from proteins, and their better digestion and utilization for the synthesis of meat products. The greatest effect was observed upon using the first-generation crossbred (½ Hereford x ½ Kazakh white-headed) heifers.

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