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Efficiency of Utilization of Nutrients and Energy from Forages with the Addition of Felutsen Carbohydrate Complex to the Diet of the Kazakh White-Headed Breed Steers

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Authors' Contribution
VK and DK presented the concept of the study, performed the experiments and wrote the manuscript. VK and GK supervised the study and edited the manuscript. BK performed the data analyses. BB helped in editing the manuscript. EN and LM helped in the analysis with constructive discussions. IM did the formal data analysis and raw materials supply.

Key words
Feed additive, Feed ration, Cattle, Nutrient, Digestion

ABSTRACT

The purpose of this study was to investigate the specific features of consumption and utilization of nutrients, energy and nitrogen in the diet of steers of the Kazakh white-headed breed while feeding with a balanced carbohydrate complex Felutsen for beef cattle. A beneficial effect of including a balanced carbohydrate complex Felutsen into the ration of steers of experimental groups on the level of intake of nutrients from the feed rations has been established: There was an advantage of young bulls of groups II-IV over bulls of group I (control) on the consumption of dry matter 215.0-302.5 g (2.4 – 3.4%), of organic matter 177.1 – 330.7 g (2. 2 – 4.0%), crude protein 14.4 – 44.3 g (1.3 – 4.0%), crude fat 3.7 – 6.5 g (1.3 – 2.3%), crude fiber 26.4 – 46.6 g (1.3 – 2.3%), nitrogen-free extractive substances 100.0 – 200.7 g (2.1 – 4.2%). The positive effect on the utilization of all types of nutrients was also established, so the bulls of I (control) group were inferior to the young animals of II-IV experimental groups in terms of the coefficient of digestibility of dry matter by 1.15-2.11%, organic matter 0.98-2.88%, crude protein 0.85-1.19%, crude fat 1.13-2.11%, crude fiber 0.36-0.67%, nitrogen-free extractive substances (NES)-1.16-4.22%. The results indicated the outperformance of the II-IV experimental groups over the I (control) group in terms of energy consumption with feed protein by 0.35-1.06 MJ (1.3-4.0%), Fats energy - by 0.15-0.26 MJ (1.3-2.3%), fiber energy - by 0.52-0.93 MJ (1.3-2.2%), nitrogen-free extractive substances energy - by 1.75-3.51 MJ (2.1-4.2%). Bulls of the II-IV experimental groups exceeded their peers of the I (control) group in nitrogen intake by 2.30-11.63 g (1.3-6.5%). Similar intergroup differences were observed in terms of digested nitrogen.

INTRODUCTION

It is known that the animal's body receives nutrients from feed, which also serve as a source of energy. They participate in metabolic processes, providing the course of metabolic processes and all physiological functions. By its chemical structure and composition, the nutrients of the feed are a complex of high-molecular-weight compounds (Bindari *et al*., 2013; Smakuyev *et al*., 2021; Gorelik *et al*., 2020; Khabirov *et al*., 2020).

In this regard, in their native form they cannot freely pass through the walls of the gastrointestinal tract. This prevents their participation in assimilation and dissimilation processes (Bargo *et al*., 2002; Grieb, 2001). Therefore, feed nutrients must be highly transformed and only then they can participate in bioconversion processes in body tissues. Only by changing the nutrients into simpler structures and soluble compounds they can take part in metabolic processes in the animal's body due to penetration through the gastrointestinal tract walls. Subsequently, during assimilation and dissimilation processes, they can be used by the animal organism for synthesis of body tissues

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(Lawlor *et al*., 1984; Faverdin, 1999). In this regard, to organize the rational use of genetic resources of fattening young animals it is necessary to know about the amount of nutrients coming into the body of the animal with feed. This will allow timely optimization of the feeding ration taking into account the expected average daily growth rate of live weight of fattened young animals.

A promising feed additive for fattening young cattle is a balanced carbohydrate feed complex Felutsen. It is a powder which is used in growing young cattle of beef breeds (Trukhachev *et al*., 2017; Kosilov *et al*., 2012). The effectiveness of its use contributes to the reproduction of the rumen microflora and the formation of microbial protein, increases the digestibility and assimilation of nutrients and energy of the feed and productivity, improves the quality of meat products and allows to get beef with a marbled pattern (Sayfullin *et al*., 2017). Fodder concentrate "Felutsen" contains vitamins: A, D_3, E, K_3, B_2, B_3, B_5 and B_{12}, trace elements: iron, manganese, copper, zinc, iodine, cobalt, selenium. In addition, Felutsen boosts the immunity of animals, which in modern conditions is an important condition for maintaining the health of productive animals and obtaining a high level of meat productivity (Kosilov *et al*., 2017; Mironova *et al*., 2018).

The aim of the research was to study the specifics of consumption and utilization of nutrients, energy and nitrogen in the diet of Kazakh white-headed breed steers while feeding with balanced carbohydrate complex Felutsen for beef cattle.

MATERIALS AND METHODS

To perform the experimental part of the work, 4 groups of 6-month old Kazakh white-headed bulls were formed after weaning from their mothers, 15 animals in each group. Bulls of experimental groups were housed in separate sections in the feeding platform until the end of breeding at 18 months of age.

Bulls of group I (control) received the main ration consisting of fodder of own production. Group II (experimental) bulls were fed with Felutsen at a dose of 100 g per animal per day, Group III (experimental) - 125 g/head, Group IV (experimental) -150 g/head per day.

Balanced carbohydrate complex Felutsen was added to the diet of growing young animals for 7 days by mixing it with concentrates and feeding it until 18 months of age. The dose of Felutsen was divided into two feedings.

To determine the effect of feeding of Felutsen to steers of experimental groups a physiological (balance) experiment was carried out according to the common methodology of VIJ (Ovsyannikov, 1976). The consumption and utilization of nutrients and energy in the diet, as well as nitrogen balance in five steers of each group at the age of 12 months were determined.

Assessment of animals on the efficiency of feed bioconversion, including the transformation of main nutrients and energy of feed into edible body parts, will be carried out according to (Slozhenkina *et al*., 2020).

RESULTS AND DISCUSSION

Experimental results obtained during the balance experiment show the positive effect of including a balanced carbohydrate complex Felutsen into the diet of steers of experimental groups on the level of consumption of nutrients of diets (Fig. 1A).

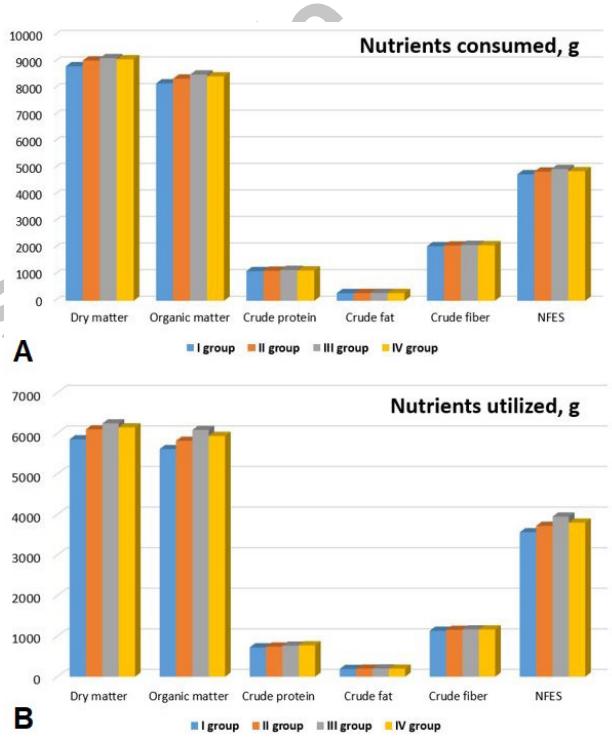

Fig. 1. Quantity of nutrients consumed (A) and utilized (B) by bulls, (g).

By the intake of all types of nutrients bulls of group I (control) were inferior to their peers of groups II-IV. Thus, the prevalence of young bulls of groups II-IV over bulls of group I (control) on the consumption of dry matter was 215.0-302.5 g (2.4 - 3.4%), organic matter 177.1-330.7 g (2.2% - 4.0%), crude protein 14.4 – 44.3 g (1.3 – 4.0%), crude fat 3.7 – 6.5 g (1.3 – 2.3%), crude fiber 26.4 – 46.6 g (1.3 – 2.3%), nitrogen-free extractive substances (NFES) 100.0 – 200.7 g (2.1 – 4.2%).

It is notable that the leading position in the consumption of all types of nutrients was demonstrated

by steers of experimental group III, whose diet was supplemented with the tested feed additive at the dose of 125 g per animal per day. The young animals of the 2nd and 4th experimental groups were lower by 87.5 g (1.0%) and 42.5 g (0.5%) on dry matter consumption, by 153.6 g (1.8%) and 69.6 g (0.8%) on organic matter and by 29.9 g (2.6%) and 21.6 g (1.9%) on crude protein consumption respectively, crude fat: 2.8 g (1.0%) and 1.4 g (0.5%), crude fiber: 20.2 g (1.0%) and 9.9 g (0.5%), nitrogenous extractive substances (NBP): 100.7 g (2.1%) and 86.7 g (1.8%).

It is known that nutrients from the feed ration are partially digested when they enter the animal's body and are eventually used for synthesis of body tissues (Kohn *et al*., 2005; Valente *et al*., 2013). The rest is excreted in the feces. Therefore, the amount of digested nutrients in the animal's body is determined by the difference between the mass of the nutrients coming from the feed and excreted in the feces (Yupakarn *et al*., 2015).

It is important to keep in mind that the digestibility of nutrients of the diet is significantly influenced by the breed, sex, age, individual characteristics of the animal, conditions of housing and feeding, including the composition and properties of forages, their preparation for feeding (Klinger *et al*., 2007; Van Soest, 1994).

The data we obtained and their analysis indicate a positive effect of introducing the balanced carbohydrate complex Felutsen into the diet on the utilization of all types of nutrients of forages (Fig. 1B).

As a result, steers of groups II-IV exceeded their peers of group I (control) by 246.5 - 393.1 g (4.2% - 6.7%) in mass of the digested dry matter, by 203.4 - 472.0 g (3.6% - 8.4%) in organic matter, by 19.0-42.6 g (2.6-5.9%) - crude protein, crude fat, by 5.7-10.5 g (3.0-5.5%), by 22.1-33.4 g (1.9-2.9%) crude fiber and by 156.6-385.5 g (4.4-10.8%) in nitrogen-free extractive substances.

Typically, the obtained experimental data indicate that the bulls of experimental group III, whose diet was supplemented with a balanced carbohydrate complex Felutsen at the dose of 125 g per animal per day, were more efficient in utilizing all types of nutrients of the feed ration. The young bulls of the experimental group II and IV exceeded their analogues by 146.6 g (2.4%) and 99.0 g (1.6%) of digestible dry matter and by 268.6 g (4.6%) and 149.4 g (2.5%) of organic matter, crude protein 23.6 g (3.2%) and 11.6 g (1.5%), crude fat - 4.8 g (2.4%) and 3.5 g (0.5%), crude fiber by 11.3 g (1.0%) and 3.7 g (0.3%), and in nitrogen-free extractive substances by 228.9 g (6.1%) and 150.6 g (4.0%), respectively.

During the digestion of the nutrients of the diet, their specific properties and features are removed. At the same time, simple organic structures with the ability to penetrate through the walls of the gastrointestinal tract are created (Benchaar *et al*., 2008). This allows them to enter the processes of assimilation and dissimilation and participate in the synthesis of body tissues and organs of the animal.

The digestibility of nutrients of the diet is characterized by the coefficient of digestibility, the rate of which is expressed as a percentage. Its value in terms of specific types of nutrients gives a generalized characteristic of the nutritional value of individual feeds in the diets of animals (Beisenov *et al*., 2016; Sainz and Vernazza, 2004). The level of digestibility coefficient expresses the percentage ratio of nutrients digested in the animal's body during redox processes from their total mass received with feeds of the diet during a day.

The data obtained and their analysis indicate intergroup differences in the coefficient of digestibility of individual types of nutrients of the diet (Table I).

In all cases, there was an advantage of steers of groups II-IV over their peers of group I (control) in the value of the measured parameter. This is due to the introduction of a balanced carbohydrate complex Felutsen into the diet of steers of experimental groups. Thereupon the bulls of the Group I (control) were 1.15-2.11% less than the young animals of the groups II-IV regarding the digestibility

Table I. Nutrient digestibility ratios of bulls, %.

Indicator	Group							
	I		II		III		IV	
	Mean±SEM	Cv	Mean±SEM	Cv	Mean±SEM	Cv	Mean±SEM	Cv
Dry matter	66.32±0.13	0.28	67.46±0.48	1.01	68.43±0.22	0.46	67.66±0.25	0.52
Organic matter	68.62±0.40	0.82	69.59±0.38	0.77	71.49±0.14	0.28	70.31±0.11	0.22
Crude protein	64.92±1.98	4.3	65.7±0.80	1.73	66.17±2.48	5.3	65.18±1.43	3.11
Crude fat	67.28±1.11	2.33	68.34±0.29	0.6	69.32±0.21	0.43	68.56±4.21	8.68
Crude fiber	55.25±0.54	1.38	55.61±0.20	0.51	55.6±1.32	3.35	55.73±2.23	5.67
NES	74.89±0.67	1.27	76.55±0.17	0.31	79.63±0.50	0.89	77.95±1.66	3.00

coefficient of dry matter, 0.98-2.88% for organic matter, 0.85-1.19% for crude protein, 1.13-2.11% for crude fat, 0.36-0.67% for crude fiber, 1.16-4.22% for non-nitrogenous extractive compounds.

It was found that due to the high amount of consumed and digested nutrients in the diet of bulls of experimental group III, whose diet contained the tested additive at a dose of 125 g per animal per day, was characterized by the maximum value of the coefficient of digestibility. The young animals of experimental groups II and IV were inferior in the level of the analyzed indicator. The advantage of steers of experimental group III over their peers of groups II and IV in terms of the coefficient of digestibility of dry matter was 0.96% and 0.77%, of organic matter 1.90% and 1.18%, of crude protein 0.34% and 0.87%, of crude fat 0.98% and 0.89%, of crude fiber 0.31% and 22%, of non-nitrogenous extractive substances 3.08% and 1.68%.

It should be noted that the coefficient of digestibility of certain types of nutrients of the diet in steers of all experimental groups was at a rather high level.

The fodder eaten by the animals is a source of nutrients. It, through biochemical reactions occurring in the animal's body, releases energy. This energy is converted into energy for life support, the energy of macroenergetic compounds serving as its reserve form in the organism (Tanuwiria and Mushawwir, 2020; Kholif *et al*., 2021). In growing and fattening young animals this energy is synthesized in the body in the form of muscle tissue proteins.

The analysis of the data obtained indicates the positive effect of introducing a balanced carbohydrate complex Felutsen into the diet of steers of experimental groups on the intake and energy digestibility of all types of nutrients (Fig. 2).

The bulls of groups II-IV surpassed their age-mates of Group I (control) by 0.35-1.06 MJ (1.3-4.0%) in energy for fodder protein, by 0.15-0.26 MJ (1.3-2.3%) in fat energy, by 0.52-0.93 MJ (1.3-2.2%) in fiber energy and energy of non-nitrogenous extractive substances by 1.75-3.51 MJ (2.1-4.2%).

It is characteristic that the maximum energy consumption of all types of nutrients was observed in bulls of experimental group III. The young animals of experimental groups II and IV were inferior to them in terms of protein energy consumption by 0.71 MJ (2.6%) and 0.32 MJ (1.2%), fat energy by 0, 11 MJ (1.0%) and 0.05 MJ (0.4%), fiber energy by 0.41 MJ (1.0%) and 0.20 MJ (0.5%), nitrogen-free extractive substances (NPE) energy by 1.76 MJ (1.8%).

It was found that the feces of bulls of experimental group IV released more protein energy, young animals of experimental group III- fiber energy, animals of group I (control)- fat energy, non-nitrogenous extractive substances (NES).

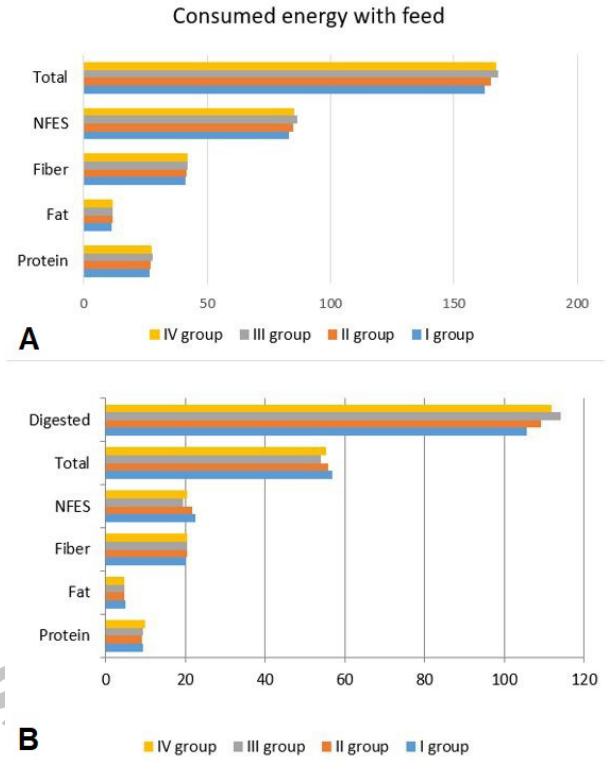

Fig. 2. Consumption (A) and digestibility (B) of energy and nutrients in diets of bulls of experimental groups, (MJ).

The intergroup differences in energy consumption of individual types of nutrients in the diet had an effect on the consumption and nature of the use of all types of energy: gross, digestible and metabolizable (Table II).

At the same time, there was an advantage of bulls of groups II - IV in consumption and use of all types of energy. Thus, bulls of group I (control) were inferior to young animals of groups II-IV in gross energy intake by 2.74-5.73 MJ (1.75-3.5%). Similar intergroup differences were found in the consumption of other types of energy. Suffice it to note that the young animals of the II-IV experimental groups exceeded their counterparts in the consumption of digestible energy by 3.61-8.54 MJ (3.4-8.1%) and exchange energy by 3.13-7.27 MJ (3.6-8.4%). Bulls of the experimental group III receiving a balanced feed complex Felutsen at the rate of 125 g per one animal per day had the highest consumption of all kinds of energy. The young animals of the II-IV experimental groups were inferior to them in the consumption of gross energy by 2.99 MJ (1.8%) and 1.09 MJ (0.7%), digestible energy by 4.93 MJ (4.5%) and 2.55 MJ (2.3%), exchange energy by 4.10 MJ (4.6%) and 2.25 MJ (2.4%), respectively.

Table II. Consumption and energy utilization efficiency of the feed ration, (MJ).

Indicator	Group							
	I		II		III		IV	
	Mean±SEM	Cv	Mean±SEM	Cv	Mean±SEM	Cv	Mean±SEM	Cv
Energy: gross	162.31±1.37	1.19	162.31±2.65	2.31	168.04±1.11	0.93	166.95±0.87	0.74
digestible	105.65±1.02	1.36	109.26±0.87	1.12	114.19±1.49	1.84	111.64±0.77	0.98
urine and methane	18.91±0.43	3.23	19.39±0.49	3.59	20.22±0.67	4.71	19.92±0.41	2.93
metabolizable	86.74±0.66	1.08	89.87±0.79	1.25	93.97±0.66	1	91.72±0.47	0.73
Gross energy exchange,%	86.74±0.66	1.08	89.87±0.79	1.25	93.97±0.66	1	91.72±0.47	0.73
Exchangeable energy								
For life support	38.81±0.59	2.16	39.10±0.54	1.97	39.08±0.79	2.86	38.68±0.46	1.68
Over maintenance	47.93±0.57	1.69	50.77±0.85	2.37	54.89±0.85	2.19	53.04±0.66	1.75
Growth energy	16.48±0.34	2.93	17.69±0.25	2.01	19.79±0.51	3.68	17.88±0.37	2.96
Concentration of metabolizable energy in 1 kg of dry matter	9.83±0.34	4.91	9.95±0.17	2.46	10.3±0.22	3.09	9.63±0.32	4.63
Coefficient of productive energy use,%								
Gross energy	10.15		10.72		11.78		10.78	
Metabolizable energy	34.38		34.84		36.05		34.91	

The minimum consumption of all types of energy among the animals of experimental groups was observed in bulls of experimental group II, which ration was supplemented with the tested additive in the dose of 100 g per animal per day.

The intergroup differences established in the consumption of all types of feed energy were also noted in the gross energy metabolism. The bulls of groups II-IV were superior to their peers of group I (control) in the value of the analyzed indicator by 1.01-2.48%. Characteristically, the highest gross energy metabolism was in the bulls of experimental group III, whose ration included a balanced carbohydrate complex Felutsen at the dose of 125 g per animal per day. The bulls of groups II and IV showed 1.47% and 0.98% less energy per day, respectively.

The analysis of the received experimental results shows the positive effect of the tested additive not only on energy intake, but also on its use for various purposes. The bulls of experimental groups II-IV exceeded their peers of group I (control) by 0.29 - 0.27 MJ (0.7%) in metabolic energy expenditure for life support. It should be noted that steers of the 2nd and 3rd experimental groups had the index practically at the same level, while the youngsters of the 4th experimental group had 0,4-0,42 MJ (1.2-1.1%) less than their counterparts.

The differences between the groups in the expenditures of metabolizable energy for overmaintenance were also established, with the predominance of bulls of groups II - IV of experimental groups. The young animals of group I (control) were by 2.84 - 6.96 MJ (5.9 - 14.5%) less than the control group.

The maximum value of metabolic energy expenses for overmaintenance was typical for bulls of experimental group III whose diet was supplemented with a balanced carbohydrate complex Felutsen at the dose of 125 g per animal per day. The young animals of experimental groups II and IV were inferior to them in the value of the measured parameter by 4.12 MJ (8.1%) and 1.85 MJ (3.5%), respectively.

As for the energy of growth, the rank of distribution of experimental groups of steers established by the expenditure of metabolic energy for over-growth was observed in this case as well. The bulls of the II-IV experimental groups exceeded their peers of the I (control) group by 1.21 - 3.31 MJ (7.3 - 20, 1%) in energy consumption for growth. The leading position in the value of the analyzed indicator was demonstrated by bulls of experimental group III. They exceeded their peers from groups II and IV in terms of energy input per growth by 2.10 MJ (11.9%) and 1.91 MJ (10.7%). The bulls of experimental group III were distinguished by a higher concentration of metabolizable energy in 1 kg of dry matter.

It was found that the introduction of a balanced carbohydrate complex Felutsen into the diet of steers of experimental groups had a positive effect on the efficiency of productive use of all types of energy. In this respect, the bulls of groups II-IV exceeded their counterparts of group I

(control) by 0.57-1.63% in gross energy productivity index (GEFP). A similar trend was observed in the coefficient of productive use of metabolizable energy (CPUE). At the same time, the bulls of the control group I were 0.46-1.67% inferior to their peers of experimental groups II-IV according to the value of the analyzed indicator. The leading position of bulls of experimental group III in the value of these indices was established. They surpassed their peers from the groups II and IV by 1.06% and 1% on the coefficient of productive use of gross energy, and by 1.21% and 1.14% on the coefficient of productive use of exchange energy, respectively.

Protein metabolism is the basis of all vital processes of the animal organism. The proteins of the feed ration when entering the gastrointestinal tract under the action of enzymes of the gastric juice are broken down into polypeptides and free amino acids (Poppi and McLennan, 1995; Van der Walt and Meyer, 1988). These simpler structured substances are transported with the blood stream to the organs and tissues and participate in the synthesis of proteins and biologically active substances.

It is known that nitrogen is the basis of protein structure. Therefore, when studying the nature and intensity of protein metabolism in animals, the method of nitrogen balance determination is used. It is established by determining the difference between the mass of nitrogen consumed by animals with feed proteins and nitrogen excreted with feces and urine. This highly characterizes the biological fullness of the feed ration used in animal breeding. It is necessary to keep in mind that the nitrogen balance is an objective indicator of the degree and character of utilization of nitrogenous substances in the diet of growing young animals (Dijkstra *et al*., 2013).

The obtained data and their analysis demonstrate the positive effect of introducing the balanced carbohydrate complex Felutsen into the diet of steers of experimental groups on the character of protein metabolism in the body of young animals (Table III).

This statement is confirmed by the balance of nitrogen in the body of experimental young animals. Herewith, steers of experimental groups II - IV exceeded their peers of group I (control) in terms of nitrogen intake by 2.30-11.63 g (1.3-6.5%). Similar intergroup differences were observed in terms of digested nitrogen. The bulls of group I (control) were inferior to the analogues of experimental groups II - IV in the value of the studied index by 3.04-8.16 g (2.6 -7.1). It was characteristic that the leading position both in terms of nitrogen intake with feed and mass of digested nitrogen was taken by steers of experimental group IV fed with a balanced carbohydrate complex Felutsen in the dosage of 150 g per animal per day. The young bulls of the II and III experimental groups inferior in the first parameter by 9.33 g (5.2%) and 4.54 g (2.4%), the second indicator by 5.12 g (4.3%) and 1.34 g (1.1%). The bulls of experimental group IV were also distinguished by higher nitrogen excretion both with feces and urine than its peers of experimental groups I - III.

Intergroup differences in nitrogen deposition in the bodies of steers of the experimental groups were also determined. The introduction of a balanced carbohydrate complex Felutsen into the diet of young animals had a positive effect on this indicator. Thereupon, the bulls of the groups II-IV exceeded their peers of the control group I in body nitrogen deposition by 1.55-4.49 g (6.5%-18.08%). The maximum value of the analyzed indicator was found in bulls of the group III (experimental) fed with the balanced carbohydrate complex in the dosage of 125 g per one animal per day. The young animals of groups II and IV were inferior to them in terms of nitrogen deposition into the body by 2,94 g (11.5%) and 0.92 g (3.30%), respectively.

Table III. Nitrogen balance in experimental bulls, (g).

Indicator	Group							
	I		II		III		IV	
	Mean±SEM	Cv	Mean±SEM	Cv	Mean±SEM	Cv	Mean±SEM	Cv
Received with feed	178.45±1.88	1.49	180.75±1.64	1.29	185.54±1.51	1.15	190.08±1.67	1.24
Excreted in feces	62.79±1.48	3.34	62.05±0.71	1.63	62.06±0.41	0.94	66.26±0.69	1.46
Digested	115.66±0.85	1.04	118.7±0.94	1.12	123.48±1.14	1.3	123.82±1.03	1.18
Excreted with urine	91.74±1.07	1.65	93.23±0.99	1.5	94.07±0.70	1.06	96.33±0.26	0.38
Deposited in the body	23.92±1.04	6.13	25.47±0.13	0.75	29.41±0.44	2.12	27.49±0.78	3.99
Utilization factor, %								
From received feed	13.40		14.09		15.31		14.46	
From digested feed	20.68		21.46		23.19		22.20	

The intergroup differences in the weight of nitrogen received with feed, the amount of nitrogen digested and deposited in the body resulted in unequal values of the nitrogen utilization coefficient. At the same time, steers of groups II-IV exceeded their analogues of group I (control) in terms of the coefficient of utilization of nitrogen from received feed by 0.69-1.91% and of digested nitrogen by 0.78 - 2.51%. The most efficient use of feed nitrogen for synthesis of body proteins was observed in bulls of experimental group III. The young animals of the groups II and IV were inferior to them in terms of the nitrogen use coefficient from taken with fodder by 1.22% and 0.85%, from digested - by 1.73% and 0.99%. The minimal level of the studied indices among steers of experimental groups was observed in young animals of experimental group II, in the diet of which the tested additive was introduced at the dose of 100 g per animal per day.

CONCLUSION

Thus, the experimental data obtained testify to the positive effect of including a balanced carbohydrate complex Felutsen into the diet of steers of Kazakh white-headed breed on the intake and use of nutrients, feed nitrogen energy. The nitrogen balance was positive. In all cases, the most positive effect was observed when the tested complex was included in the diet of fattened steers at the dose of 125 g per animal per day.

DECLARATIONS

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IRB approval

The animal study protocol was approved by the Institutional Review Board of Orenburg State Agrarian University (protocol code #3852 from 08.02.2021).

Ethical statement

All the procedures and methods used in this study followed the ethical guidelines approved by the Animals Ethics Committee of Orenburg State Agrarian University (2020-54).

Statement of conflict of interest

The authors have declared no conflict of interest.

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