

Carcass Quality and Yield Attributes of Bull Calves Fed on Fodder Concentrate “Zolotoi Felutsen”

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Abstract: The results of the studies showed a positive effect of a new multicomponent concentrate “Zolotoi Felutsen” on meat productivity of black-and-white bull calves. Bull calves, consuming fodder concentrate at the dose of 50 g, 75 and 100 g/1 kg of mixed fodder had different live weight gain compared to the control animals. The average daily gain was 41, 106 and 118 g. Live weight gain at the age of a year and a half was 16.0, 39.7 and 42.7 kg. Visual evaluation proves good body development of animals of all the groups. At the same time, bull calves of the 1-3 groups had better meat production traits. Compared to the control animals their height at the shoulder was more by 1.7-2.1 %; chest width by 3.6-4.9%; chest depth by 1.7-2.1%; chest girth by 1.4%; body length by 2.7-3.0%; quarter size by 3.5-3.7%. The results of the sample slaughter of young animals at the age of 18 months in comparison with those of the control stock were as follows.

Key words: Bull calves, fodder concentrate, live weight, growth rate, beef production, beef, beef quality

INTRODUCTION

Currently, there is a shortage of edible protein throughout the world. The World Health Organization and the UN Food and Agriculture Organization claim that there are about 60 g of protein for daily intake with the required amount of 70 g. The total protein balance is presented by 80% of plant protein and 20% of animal protein. Russia faces the same problem. According to the data of the the Russian Academy of Medical Sciences the daily protein requirement for adults is 65-117 g for men and 58-87 g for women. Consumption of food with animal based protein in Russia has been decreased by 25-35% since 1992. Thus, there is need to increase beef production and improve its quality in order to rise competitiveness of domestic meat production.

This issue is currently solved by breeding dairy and dual-purpose animals. Therefore, there is need in developed and implemented activities to promote full realization of genetic potential of cattle in terms of beef production. Bioactive additives being used in the diet of animals can also contribute to this process (Gorlov *et al.*, 2016; Omarov *et al.*, 2018; Sharipova *et al.*, 2017; Shlykov *et al.*, 2016a, b).

Moreover, when beef cattle breeding is developed in the territory of the Russian Federation it is necessary to

consider experience of foreign countries as well as advantages of growing cattle (Smolentsev *et al.*, 2018).

Current scientific theoretical evidence and practical experience indicate prospects of fodder additives introduced in the diet of farm animals to enhance their productive qualities. It should be noted that additives with foreign-made enzymes recommended at doses averaged for different climatic zones, animal species and ages aren't always very efficient and economically feasible. In this regard, domestic fodder additives are considered to be better adapt to the bioclimatic characteristics of forage production in regions. Their chemical composition meets requirements of diets (Mironova *et al.*, 2016; Khaziakhmetov and Khabirov, 2017).

There are many fodder products used in animal breeding. Compound fodder of Felutsen type is a special one in this list. It is produced by an open joint-stock company “Kapital-Prok”, one of the leading companies in the Russian Federation engaged in development and production of feed additives.

Fodder of “Felutsen” type contains a full set of purely natural elements. They meet all the feeding rate requirements for each species and age, level and nature of animal performance. It makes possible to eliminate impact

of subjective factors resulting in negative consequences (Ilyin *et al.*, 2011; Kharlamov *et al.*, 2011).

By the current time, there is some evidence on effect of protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” on the growth and development of young cattle. Thus, scientists of the Orenburg State Agrarian University, Ilyin *et al.* (2011) and others proved that bull calves fed on protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” No. 3092 showed average daily gains of body weight throughout all stages of the conducted research and by 18 months, the difference was 9.47%. Whereby the optimal rate of the additive applied to the mixed fodder was the dose of 7.5% (Ilyin *et al.*, 2011).

Another relationship was found by the research conducted by Kharlamov and others. They argue that applying protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” to the diet of Kazakh Whiteheaded bull calves up to 15 months had no significant effect on their live weight. Distinction in live weight became evident only at the age of 16 months. There were little differences between groups when concentrate feed was replaced with protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” No. 3092 at the dose of 200, 250 and 300 g (Kharlamov *et al.*, 2011).

To sum up research results of different scholars on support and application of fodder additive “Zolotoi Felutsen” in feeding farm animals we can make the following conclusion. The discussed additives are very promising though some of their characteristics are very diverse (Halirahmanov *et al.*, 2017; Khalgaeva *et al.*, 2017; Senchenko *et al.*, 2017).

In this regard, a feasibility study on use and influence of the new protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” on growth, development and performance of black-and-white bull calves is of theoretical and practical relevance. It is also economically important in developing production of meat products in the country.

The research goal. The aim of investigation is to study an effect of the protein-carbohydrate-vitamin-mineral forage concentrate “Zolotoi Felutsen” on beef production and quality of the end products of bull calves grown for meat.

MATERIALS AND METHODS

The scientific and economic experience was conducted in the Chekmagush District of the Bashkortostan Republic (namely, agricultural production

cooperative “Geroi”) located on the territory of the Volga Federal district of the Russian Federation from 2016-2017. The research targets were 60 black-and-white bull calves at the age of 6 months. Animals were divided into 4 equal groups with 15 calves in each based on the analogue principle. All the experimental young cattle was kept and fed under the same conditions throughout the observation time. Including fodder concentrate “Zolotoi Felutsen” to the diet of the bull calves of the experimental groups (1-3) at the dose of 50 g, 75 and 100 g/1 kg of mixed fodder was a distinct feature.

Animals were kept in accordance with instructions and recommendations of the Russian Regulations, 1987 (Order of the USSR Ministry of Health No.755 on 12.08.1977) as well as “The Guide for Care and Use of Laboratory Animals (Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council, National Academy Press Washington, 1996)”. The study was conducted in conditions aimed to minimize animal suffering and reduce the number of used samples.

Protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” used in the experience is intended for feeding calves over 7 months and calves for fattening. It includes vegetable protein (feed urea), dextrins, fermentable carbohydrates, ultra pure salt, vitamins (A, D₃, E), minerals (calcium, phosphorus, magnesium, sulfur, copper, zinc, cobalt, iodine, selenium), prebiotic. 1 kg of fodder concentrate contains 0.65 fodder units, 279.2 g of fermentable carbohydrates, 435.1 g crude protein, 5.54 MJ of metabolizable energy.

Throughout the whole experience (from 6-18 months), all animals were kept on deep litter in the feedlot. In winter feeding was arranged in the following way, hay was given out in the outdoor feedlot, haylage, silage and concentrated feed in feed rooms. In summer all fodders were given to young cattle outdoors. Animals were watered with an automatic livestock waterer of the AGK-4 type. The mound of the barn yard was prepared as the place for animals to rest. Diets for all the experimental animals were created according to the laboratory diagnosis on forage chemical composition and actual nutritional value as instructed by detailed feeding standards to get 850-1000 g of average daily weight gain.

Growth indicators of the experimental bull calves were recorded by individual weighing before morning feeding and watering. Digital scale NPV 1000 labelled “Massa-K”, a livestock squeeze chute and holder were used to weight animals. According to the received data an absolute and average daily gains as well as relative growth rate of the experimental bull calves were calculated (Senchenko *et al.*,

2017). The main body measurements of animals were taken at the age of 6, 12 and 18 months to assess their exterior features. The received data was used to calculate body built indices.

Beef production of the experimental young cattle was estimated on the basis of the sample slaughter of three animals from each group in accordance with the Russian State standards GOST R 54315-2011 (Brody, 1945). The slaughter was performed by the bleeding method with preliminary anesthesia as instructed by Article 7.6.1. of "Sanitary Code for terrestrial animals" (2009) and Russian state standard GOST 31777-2012. At slaughter carcass weight and internal slaughter fat were taken into account. Carcass category was assessed visually on the 5-point scale in five areas (shoulder, back, loin, rump, round).

Chemical analysis of average samples of flesh, rib eye and internal slaughter fat was carried out after the samples had been kept in the refrigerator for two days. They were examined to determine moisture (according to Russian state standard GOST 9793-74), protein (according to the Kjeldahl method to determine nitrogen content), fat (by extracting dry sample with the Soxhlet apparatus) and ash. Slaughter fat was studied to determine an iodine value (according to Huebl) and melting point (with the capillary method). Based on these data nutrient output in carcass and energy value of beef were found.

Biological value of meat was determined according to the ratio of tryptophane (Neuman and Logan's method) and oxyproline (Snize and Chamber's method) in rib eye samples (Aleksandrov, 1951; Logan and Neumann, 1950).

Statistical processing of the experimental data was performed with software package Statistica 10.0 ("Stat Soft Inc.", USA) (Plokhinskii, 1969).

RESULTS AND DISCUSSION

The results of control weighings demonstrated that during all the stages of data registration higher rates were shown by bull calves receiving the diet with forage concentrate "Zolotoi Felutsen" (Table 1).

At the age of 18 months bull calves of the 1 experimental group were heavier by 16.0 kg (3.2%; $p < 0.05$), bull calves of the 2 experimental group were heavier by 39.7 (8.0%; $p < 0.001$) and bull calves of the 3 experimental group were heavier by 42.7 kg (8.6%; $p < 0.001$) compared to the control animals. Their overall liveweight gain was higher at 14.8 (4.7%; $p < 0.01$), 38.3 (12.3%; $p < 0.001$) and 39.5 kg (13.6%; $p < 0.001$), respectively. It should be noted that bull calves consuming the studied additive in a dose of 75 and 100 g per 1 kg of mixed fodder were heavier by 23.7 kg (4.6%; $p < 0.01$) and 26.7 kg (5.2%; $p < 0.01$), respectively than animals of the I experimental group.

Table 1: Live weight change and gain of growing experimental bull calves (kg)

Age (months)	Group Experimental			
	Control	1	2	3
6	185.4±0.78	186.6±0.62	186.8±0.83	185.6±0.64
9	258.8±1.59	263.2±1.76	270.1±1.64	269.7±1.86
12	337.1±2.59	345.3±2.64	358.8±2.43	359.4±2.63
15	417.7±3.63	430.3±3.42	448.7±3.11	450.6±3.34
18	497.2±3.85	513.2±3.74	536.9±3.24	539.9±3.06
Overall liveweight gain	311.8±2.84	326.6±2.31	350.1±2.52	354.3±2.75
Average daily liveweight gain (g)	866±11.88	907±12.37	972±12.02	984±11.92

Young cattle of the 3 experimental group had the highest average daily gain in live weight. It was more by 118 g (13.63%) compared to the control group, more by 77 g (8.49%) compared to the 1 experimental group and more by 12 g (1.23%) compared to the the 2 experimental group.

Calculation of relative growth rate over the period of the experiment showed that in Fig. 1 for calves in the control group was 91.36 and 93.34% for animals of the 1 experimental group, 96.75% for the 2 experimental group and 97.67% for the 3 one.

The results of exterior evaluation indicate a change in some body measurements of bull calves under the effect of the studied preparation. In particular, at the age from 6-18 months bull calves of the control, 1-3 experimental groups experienced the following changes. Withers height grew at 19.7, 20.5, 21.0 and 20.9%, hips became higher at 6.5, 17.6, 18.7 and 18.6%, chest width increased at 39.5, 41.3, 43.1 and 44.4%, chest depth at 37.8, 38.8, 40.5 and 40.8%, chest girth at 43.5, 44.1, 44.9 and 44.9%, hip width at 45.8, 48.9, 49.5 and 50.2%, quarter size at 26.0, 27.9, 29.5 and 29.7%, pastern width at 35.9, 36.3, 34.8 and 34.4%.

At the age of 18 months the highest measurements were observed for young animals of the 2 and 3 experimental groups. Compared to the control animals their height at the shoulder was more by 1.7-2.1%; chest width by 3.6-4.9%, chest depth by 1.7-2.1%, chest girth by 1.4%, oblique body length by 2.7-3.0%, quarter size by 3.5-3.7%.

It's necessary to point out that regardless of the age characteristics and introduced dose of the studied fodder concentrate to the diet of bull calves, there was an intensive body growth in width rather than in height.

Feeding forage concentrate "Zolotoi Felutsen" to black-and-white bull-calves during their growing and fattening period improved slaughter qualities of animals (Table 2).

Increased dose of the fodder additive was found to result in higher slaughter indicators. It suffices to say that bull calves of the 2 and 3 experimental groups

Table 2: Sample slaughter of experimental bull calves

Indicators	Group			
	Control	Experimental		
		1	2	3
Weight (kg)				
Preslaughter	480.1±2.14	495.4±2.32	518.2±2.11	521.1±2.08
Hot carcass	266.5±1.78	277.5±1.92	292.5±1.54	294.4±1.66
Internal fat	13.3±0.21	14.2±0.22	15.0±0.28	15.1±0.260
Slaughter	279.8±1.92	291.7±1.98	307.5±1.72	309.5±1.95
Yield (%)				
Carcass	55.51	56.02	56.45	56.49
Internal fat	2.76	2.86	2.89	2.90
Slaughter	58.20	58.88	59.34	59.39

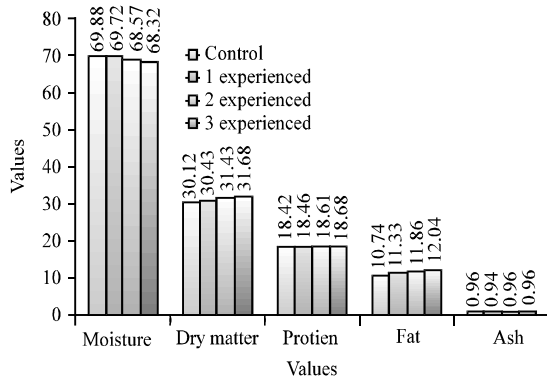


Fig. 1: Chemical composition of average carcass flesh samples of the experimental bull calves (%)

demonstrated higher records than animals of the control and 1 experimental groups. Their hot carcass weight was more by 27.0 and 16.0 kg or 10.1% ($p < 0.001$) and 5.8% ($p < 0.01$), the internal fat was more by 1.75 and 0.85 kg or 13.1% ($p < 0.01$) and 5.9% ($p < 0.05$), carcass weight by 28.7 and 16.8 kg or 10.2% ($p < 0.001$) and 5.7% ($p < 0.05$), carcass yield by 1.16 and 0.48%.

Meat quality evaluation of the experimental bull calves at sample slaughter was also supplemented with carcass deboning. This operation made it possible to find out that flesh weight in carcasses of bull calves on the basic diet was 206.3 kg. It is lower by 4.7% ($p < 0.05$) than that in the 1 experimental group by 10.7% ($p < 0.01$) in the 2 experimental group and by 11.4% ($p < 0.01$) in the 3 experimental group. Specific flesh weight in carcasses of the base variant animals reached 78.02% bones weight 18.42%, ligaments and tendons 3.56%. The same indicators for the experimental groups were 78.49-78.70%, 17.95-18.10% and 3.34 of 3.41%, respectively. Young animals consuming forage concentrate “Zolotoi Felutsen” had the highest fleshing index compared to the control livestock by 2.35-3.54%.

To determine effect of different doses of preparation “Zolotoi Felutsen” on chemical composition of muscle tissue, average carcass flesh samples of bull calves were taken (Fig. 1).

There was higher content of dry substance and fat in carcass flesh of calves of the experimental groups compared to the control ones. Thus, the first indicator for young cattle of the 1 experimental group increased by 0.61%, the second by 0.59%. These indicators were higher by 1.31 and 1.12%, respectively for the 2 experimental group and by 0.56 and 1.30% for the 3 experimental group. The similar regularity was observed for protein content and it was opposite for moisture content.

Dry matter and moisture ratio in meat of animals of the control group was 0.43:1 and 0.44:1, 0.46:1 and 0.46:1 respectively in meat of the experimental animals. Energy value of 1 kg of carcass flesh for cattle on the basic diet was of 7.34 MJ while energy value of the whole carcass amounted 1514.24 MJ. It is lower than that for animals of the experimental groups by 0.24-0.55 MJ (3.27-7.49%) and 120.88-298.88 MJ (7.98-of 19.35%), respectively. It should be noted that the highest energy value of carcass was found for bull calves consuming forage concentrate “Zolotoi Felutsen” at the dose of 100 g of additive per 1 kg of mixed fodder.

Under the influence of introduced fodder concentrate to the diet of young male cattle there was increased concentration of tryptophan by 3.15, 6.16 and 5.43% and reduced level of oxyproline by 1.31, 1.63 and 1.96% in their muscle tissue. Based on the content of tryptophan and oxyproline protein quality indicator was calculated. Protein quality indicator in animals of the 2 and 3 experimental groups was higher by 7.75 and 3.13% than that of the control and the 1 experimental groups, respectively.

Acid and base equilibrium degree in bodies is judged according to concentration of hydrogen ions (pH). This indicator reflects glycogen concentration in meat muscle weight at the time of animal slaughter. It characterizes post-slaughter processes in carcasses. The amount of hydrogen ions (pH) in the muscle tissue of animals of the 1-3 experimental groups was lower than in the control one by 2.83 ($p < 0.05$), 3.72 ($p < 0.01$) and 2.12% ($p < 0.05$), respectively.

Water holding ability of muscles and hence, technological properties of beef depend on the pH level. Meat of the experimental young cattle had higher water holding capacity by 0.91 ($p < 0.05$), 1.55 ($p < 0.01$) and 1.27% ($p < 0.05$) with less shrinkage by 1.08 ($p < 0.05$), 2.35 ($p < 0.01$) and 2.10% ($p < 0.01$). Thus, we can claim that meat in the cooking process will be less dried and the end product will be of higher moisture.

Suet fat composition for young cattle of the experimental groups was of higher dry matter content by 0.21-0.30% of more pure fat by 0.24-0.38% and less specific protein weight. Energy value of internal slaughter

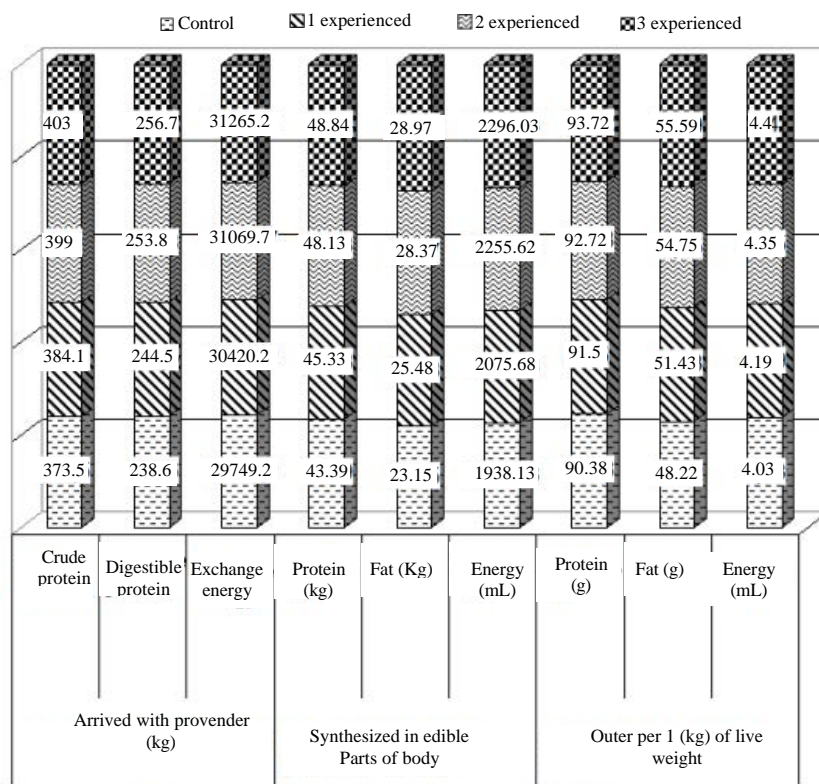


Fig. 2: Fodder protein and energy conversion into meat products

fat for bull calves of the 1-3 experimental groups increased respectively by 43.5 MJ (9.5%), 72.2 (15.7%) and 75.4 MJ (16.4%), iodine number was higher by 0.5-1.2% while the melting temperature decreased by 0.4-0.7% compared with the control animals.

Forage concentrate “Zolotoi Felutsen” being introduced to the diet of male calves contributed to better transformation of fodder nutrients in meat products (Fig. 2).

The results of the analysis revealed some between-group differences in the synthesizing ability of nutrients by young animals of the studied groups. Thus, bull calves of the 1 experimental group synthesized protein better than those of the base variant by 1.94 kg (4.5%), fat by 2.33 kg (10.1%), energy by 137.55 MJ (7.1%), animals of the 2 experimental group 2 by 4.74 kg (10.9%), 5.22 kg (22.5%) and 317.49 MJ (16.4%) and animals of the 3 experimental group by 5.45 kg (12.6%), of 5.82 kg (25.1%) and 357.9 MJ (18.5 %), respectively.

Due to this fact the calves of the experimental groups had larger output of protein, fat and energy per 1 kg of live weight than the control animals. These were as follows: more protein by 1.12 g (1.2%) the 1 group, 2.5 g (2.8%) the 2 group, 3.3 g (3.7%) the 3 group, more fat by 3.21 g (6.6%), 6.53 g (13.5%) and by 7.37 g (15.3%) as well as more energy by 0.16 MJ (4.0%), 0.32 (7.9%) and 0.37 MJ (9.2%), respectively.

Different amounts of fodder concentrate in the diets of bull calves grown for meat had a particular impact on protein and metabolizable energy conversion rate into products. Thus, the conversion ratio of protein (CCP) in the control group was 7.54% being higher by 0.24% for animals of the 1 experimental group by 0.61% for the 2 experimental group and by 0.70% for the 3 experimental group. Metabolizable energy was 4.22% being more by 0.27, 0.68 and 0.76%, respectively.

Using fodder concentrate “Zolotoi Felutsen” at the dose of 50 g, 75 and 100 g in diets of black-and-white bull calves contributed to their live weight gain at the age of a year and a half by 16.0, 39.7 kg and 42.7 kg or 3.2% (p<0.05), 8.0% (p<0.001) and 8.6% (p<0.001). Moreover, the tested additive has contributed to better development of linear growth measurements of animals. We believe that improved growth and development indicators of bull calves of the experimental groups is due to the supplemented level and ratio of deficient nutrients in the diet. As the result there is stimulated growth of body muscle and bone tissues. Fodder concentrate “Zolotoi Felutsen” contains readily available carbohydrates and feed urea covered with the dextrin shell and encased in the molasses capsule being a source of nutrients as well as a source to supply beneficent bacteria. Encapsulated

feed urea under the action of the rumen microorganisms is modified, releasing microbial protein and providing its synthesis.

The results of our experience indicate between-group changes in live weight of bull calves at the second stage of the data registration. It corresponds to 9 months while Kharlamov and others found differences when animals were 16 months aged. Our results are consistent with studies conducted by scientists of the Orenburg and Bashkir State Agricultural Universities. They proved effect of complex and probiotic additives on live weight growth and average daily gain of calves at an early age (Ilyin *et al.*, 2011; Kharlamov *et al.*, 2011; Halirahmanov *et al.*, 2017)

The studied feed additive contains readily accessible vitamins and minerals. They help to activate metabolic processes and as a result have a positive effect on beef production. This fact is confirmed by the data of scientific and economic experiences on applying vitamin and mineral preparations to the diet of young cattle (Mironova *et al.*, 2016).

The research of Khalgaeva and others indicate an improvement of the slaughter parameters of sheep under the influence of protein-carbohydrate-vitamin-mineral forage concentrate “Zolotoi Felutsen” (Khalgaeva *et al.*, 2017). The results of our experiment demonstrate a similar trend. It should be noted that application of the studied preparation according to Lunitsin and others didn't have a significant effect on the level of productive qualities of marals (Lunitsin *et al.*, 2011).

Enrichment of diets of bull calves grown for meat by fodder concentrate “Zolotoi Felutsen” of multi-component composition promotes synthesis of muscle tissue, fat, concentration of essential amino acids, energy value, protein quality indicator as well as cooking and technological characteristics of raw meat. All this testifies a positive effect of protein-carbohydrate-vitamin-mineral fodder concentrate “Zolotoi Felutsen” on meat composition and properties. These findings are consistent with the research results of Gorlov *et al.* (2016) and Shlykov *et al.* (2016).

Change indicators of fodder protein and energy conversion into protein and energy of the body in favor of the young cattle of the experimental groups are mainly due to the applied test additive to their diet. The obtained results indicate that the experimental animals are kept under favorable conditions of feeding and housing.

CONCLUSION

The results of comprehensive studies prove protein-carbohydrate-vitamin-mineral forage concentrate “Zolotoi Felutsen” in the diets of black-and-white bull calves to be effective.

RECOMMENDATION

Its application in the amount of 75 and 100 g per 1 kg of fodder promotes:

- Increased growth rate of bull calves by 12.3 and 13.6%
- Getting 536.9 kg and 539.9 kg of live weight by the age of 18 months
- Better development of width body measurements, characterizing higher meat content
- Increased slaughter indicators by 26 kg (9.76%) and 27.9 kg (up 10.47%) on hot carcass weight by 0.94 and 0.98% on carcass yield by 1.14 and 1.19% on slaughter yield
- Improved beef quality by 0.19 and 0.26% on protein content by 1.12 and 1.30% on fat content, 0.47 MJ (6.40%) and 0.55 MJ (7.49%) on energy value of 1 kg of flesh by 5.43% and 6.16% on tryptophan concentrations, protein quality indicator
- Better technological properties: decreased pH by 3.72 and 2.12%, increased water-holding capacity by 1.55 and 1.27%, less boling out by 2.35 and 2.10%
- Positive effect on fodder transformation into meat products, protein conversion ratio increased by 0.61 and 0.70%, conversion coefficient of metabolizable energy by 0.68 and 0.76%

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