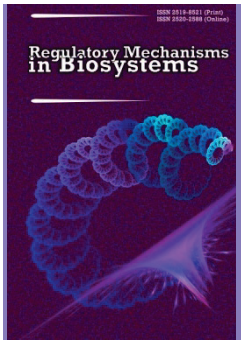

Regulatory Mechanisms in Biosystems

ISSN 2519-8521 (Print)
ISSN 2520-2588 (Online)
Regul. Mech. Biosyst.,
2022, 13(3), 219–224
doi: 10.15421/022228

Post-slaughter indicators of meat productivity and chemical composition of the muscular tissues of bulls receiving corrective diet with protein-vitamin premix

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Article info

Received 22.06.2022
Received in revised form 14.07.2022
Accepted 15.07.2022

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Yaremchuk, O. S., Razanova, O. P., Skoromna, O. I., Chudak, R. A., Holubenko, T. L., & Kravchenko, O. O. (2022). Post-slaughter indicators of meat productivity and chemical composition of the muscular tissues of bulls receiving corrective diet with protein-vitamin premix. Regulatory Mechanisms in Biosystems, 13(3), 219–224. doi:10.15421/022228

The problem of increasing the production of beef to provide the population with domestically-produced meat is mainly being solved by selective breeding of dairy and combined breeds. Therefore, there is a need for the development and introduction of complex measures to increase meat productivity of young cattle, especially regarding the completeness of diet and optimal content of mineral elements in it. The study was conducted on bulls of the Ukrainian Black-Spotted Dairy breed starting from the age of 6 up to the age of 15 months. At the end of the experiment, the animals were slaughtered, 5 from each group. The study was aimed at determining the effect of the protein-vitamin premix Intermix Fattening on the slaughter parameters, morphological composition of carcass and flesh composition by quality grades, chemical composition of the muscle tissue. Statistical analysis of the results revealed that feeding bulls with the supplement increased pre-slaughter live weight by 7.1% and slaughter weight by 9.8%. After meat separation, more edible parts of carcass were obtained in the absolute value. The weight of paired carcass was 9.5% higher. Intake of the diet with protein-vitamin premix influenced the bulls' characteristics of growth and development of musculature and bones, intensity of fat deposition, leading to 10.8% increase in flesh and no statistical decrease in the yield of bones compared with the carcass weight. Muscle-bone ratio equaled 4.27 in the control, and 4.56 in the experimental animals. Meatiness index of the young animals that had received the supplement with the diet was higher by 11.1%. Flesh of carcasses of bulls belonging to the experimental group had higher content of valuable grades of beef. We obtained 27.3% more flesh of the highest quality and 11.5% of the first-grade quality. In the muscle tissue and the longissimus of the bulls that had been consuming the premix, the concentration of dry matter was higher by 0.78%, and protein by 0.85%. Use of the Intermix protein-vitamin premix would lead to an increase in live weight of animals, and therefore significantly increase the yield of meat and improve the morphological composition of the bulls' carcasses.

Keywords: young cattle; mineral additive; feeding, diet; slaughter measurements; grades of beef; meat quality.

Introduction

Relevant tasks of animal husbandry are increasing the livestock production and improving its quality. The global production of meat has increased over the last 20 years on average by 2.1% per year, according to OECD-FAO Agricultural Outlook 2016–2025. However, increase in beef production was the slowest, equaling 1% a year. Therefore, intensification of livestock breeding should first of all be aimed at creating conditions that would promote more complete realization of the genetic potential of meat productivity of animals. In countries where the population of meat cattle is small, beef cattle are grown in herds of dairy cattle. Beef production is mainly based on young bulls, defective cows, and to the lowest degree heifers (Nogalski et al., 2014). In Ukraine, most livestock enterprises specialize in development of dairy cattle breeding. Therefore, increasing the production of beef exclusively as a result of intense development of meat cattle is currently impossible. In Ukraine, over 95% of beef is produced from slaughtered dairy and combined cattle (Dovgal, 2020). In the country's enterprises, the Ukrainian Black-Spotted breed is mostly raised, which is the most productive, with good fodder costs return. Young cattle that are grown for meat have satisfactory meat qualities. Having good diet, bulls reach 380–400 kg at the age of 12 months, and 500–520 kg at the age of 18 months. According to the Ukrainian State Statistics Service, the population of cattle has tended to decrease over the recent years. As of late 2021, the population has decreased by 230 thousand (8.0%) compared with the previous year, equaling 2,644 thousand animals. Also, decrease in the production of beef according to slaughter weight has continued, equaling 10.1%, to 310.5 thousand tons. Meat is the main product of nutrition of the population, its production is important for ensuring the country's food safety. This type of meat is valuable because it contains lower amount of cholesterol than pork and sheep meat, and therefore is useful for the human organism (Holubenko, 2018). Meat of cattle is well digested, particularly calf meat – 90%, beef – 75–85%. According to the statistical data of Ukraine, 243 thousand tons of beef was consumed, which is 1 thousand more than last year. The scientifically substantiated nutrition norm for a person is 32–36 kg of beef a year, or 40–45% of the overall amount of consumption of all types of meat. The actual level of satisfaction of the physiological need for beef is much lower (Seheda, 2020). Consumption of beef per capita is 6.4 kg on average around the world and 5.8 kg in Ukraine. Therefore, to satisfy the needs of the population, the Ukrainian meat market has increased the import of beef by 34% to the level of 2.78 thousand tons. The export of beef abroad has significantly increased as well, by 11%, or 27.55 thousand tons.

The problem of increasing the rates of beef production has become one of the most important among the various tasks facing the agroindustrial complex of the country. Therefore, in a complex of measures designed to increase the meat productivity of young cattle, significant atten-

tion is paid to organization of complete and balanced nutrition of the cattle that are being fattened, which is achieved by sufficient amount and optimal ratio of diet elements (Mikhur, 2015; Reddy et al., 2015; Purwin et al., 2016). For this purpose, various food supplements are used, which help to achieve a diet balanced by biologically active substances (Niedermayer et al., 2018; Tagirov et al., 2018; Razanova & Chudak, 2018). They are introduced in small amounts, but promote intensification of metabolic processes, stimulation of functional reserves of the animal organism, ultimately having a positive effect on the level of productivity (Cooke et al., 2009). Insufficient nutrition decreases the weight of animals, thereby causing rapid decrease in the meat yield, deterioration of quality parameters and nutritional value (Schaefer et al., 2006; Moriel & Arthington, 2013; Skoromna et al., 2019). In agricultural science and animal husbandry practice, development of new food supplements that would be able to improve nutritional value and completeness of diet, promoting increase in productivity and decrease in fodder expanses per unit of production, is constantly underway (Goncharuk, 2016; Razanova, 2018; Poberezhets et al., 2021). Application of developed zonal premixes for feeding meat bulls, especially complex protein-vitamin microelements, increases the growth rates, meat productivity and meat quality, decreases costs for fodders and increases the return rate of beef production (Griban & Mylostiva, 2014; Mazurenko et al., 2015; Denkovich et al., 2017). A special function in complete diet of animals is performed by mineral substances, particularly microelements (Kincaid, 2000).

Today, one of the conditions for obtaining high-quality beef is the use of various mineral additives in feeding young animals. Thus, study of parameters of meat productivity and quality of meat depending on inclusion of active supplements in the diet of bulls is of certain scientific and practical interest. Therefore, the objective of the study was the influence of the Intermix Feeding protein-vitamin premix on parameters of slaughter, morphological composition of carcass of bulls of Ukrainian Black - Spotted Dairy breed.

Materials and methods

In our studies on young cattle, we followed the International and National biotic positions on experiments on animals: the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (ETS No. 123, Strasbourg, 1986), Law of Ukraine "On Protection of Animals from Cruel Treatment" No. 3447-IV as of 21.06.2006 with amendments as of 04.08.2017.

The study was performed on 20 bulls of the Ukrainian Black- Spotted Dairy breed. When selecting the animals, we took into account their origin, age, and body weight. The calves were divided into two groups, 10 animals in each. The experiment lasted for 274 days, from the bulls' age equaling 6 months to the age of 15 months. In the period from 6 months to 15 months of age, the diet of animals was supplemented by the protein-vitamin premix Intermix Fattening. The technology of raising bulls on diet with the protein-vitamin premix Intermix Fatteing provided more intense growth, and live weight of animals at the age of 15 months exceeded the control counterparts by 7.0%, and on average equaled 439.1 kg in the group (Razanova et al., 2022). During the experiment, the animals were fed with the diet balanced according to the detailed norms of the feeding, corresponding to their age, live weight and average daily increment. The diet of the animals was corrected once a month. The difference between the groups was in feeding the protein-vitamin premix Intermix Fattening. The composition of the studied supplement included mineral elements: calcium, sodium, phosphorus, magnesium, iron, zinc, manganese, copper, selenium, cobalt, and also vitamins of B, A, D, E groups. The animal premises where the bulls were held and the studies were performed were provided with all necessary equipment and feeder system. All the animals were in the same conditions and had free access to fodder and water throughout the study. To conduct the study of the effects of the additive on post-slaughter parameters of meat productivity, all necessary conditions were created, particularly, systems of growing and fattening, means of transportation of animals, pre-slaughter preparation and slaughter of bulls. Care and maintenance of the animals were the same, according to the compulsory norms of the State Standard of Ukraine 7823:2015 Animal farms. Requirements to the parameters of microclimate in the animal premises (temperature, humidity, light regime and gas content in air in the premise) were within the zoohygienic norms.

At the end of the fattening experimental period, when the bulls reached the age of 15 months, we selected 10 animals, 5 from each group, and the animals were slaughtered. To slaughter the bulls, we used electric shock. According to the results of the slaughter of the animals, we studied the pre-slaughter live weight, weight of paired and chilled carcass, weight of raw fat, slaughter weight, yield of carcass and slaughter yield. The weight of fresh carcasses was determined by weighing 45 minutes after the slaughter on industrial scales of accuracy class III. Fatness of the carcasses was determined according to the corresponding standard (State Standard of Ukraine 4673:2006 Cattle for slaughter. Technical conditions), and yield of carcasses and other products of slaughter – by weighing. Morphological composition of carcasses was determined by the meat separation method after 24 h in a refrigerator at the temperature of 0–4 ºC followed by calculation of meatiness coefficient (Shkurin et al., 2002). In the carcasses, we determined the weight of flesh, bones, tendons and cartilages. To evaluate the meatiness of animals mathematically, we calculated meatiness coefficient as the ratio of weight of the muscular tissue to weight of bones, cartilages and tendons and muscle-bone ratio, determined by dividing the weight of flesh by bone weight. Flesh of the carcasses after removing bones, cartilages and other rough parts was classified to three grades: highest – pure muscular tissue with no visible residuals of the connective tissue formations, grade I – presence of no more than 6% of the connective tissues formations, grade II – no more than 20% of the connective tissue formations, presence of tendons, membranes and small veins is allowed. To conduct chemical analysis of meat, we took the average sample of the longissimus. The longissimus was cut at the levels of the 9–11th ribs, the fat and the connective tissues were removed. The longissimus samples for the chemical analysis were taken in the amount of 250 g from each carcass. During the chemical analysis of the longissimus, we studied the following parameters: contents of moisture, dry matter, protein, fat, ash. Moisture content, protein (nitrogen x 6.25), overall fat and ash in muscles were determined according to the methods recommended by the International Organization for Standardization. Biochemical content of carcass flesh was determined using the following techniques: hygroscopic moisture – method of drying the samples to constant weight in the temperature of 100–105 ºC; fat concentration – extraction of dry amount using ether; ash content – burning weighed amount in a muffle furnace in the temperature of 400–450 ºC; protein content – by determining overall nitrogen. Based on the obtained data, we determined the calorie value of meat. The calorie values of meat were determined based on the data of chemical analysis according to the formula: $C = [D – (F + A)] \times 41 + F \times 93$, where C – calorie value of meat (kcal/kg), C – dry matter (%), F – fat (%), A – ash (%), 41 – calorie value of 10 g of protein (kcal, 1% of kg); 93 – calories in 10 g of fat (kcal, 1% of kg).

The results of the study were statistically analyzed using ANOVA. Differences between the groups were considered statistically significant at $P < 0.05$ (taking into account Bonferroni correction). The data in the tables are presented as $x \pm SD$ (mean value ± standard deviation).

Results

According to the State Standard of Ukraine 4673:2006, all the bulls – prior to the slaughter – were more fattened, and highly muscular carcasses from them were identified to the first category. Animals of the experimental group, after 24 h fasting, had 29.4 kg ($P < 0.05$), or 7.1%, higher parameters of pre-slaughter live weight (Table 1). From them, we obtained better carcasses, and therefore more edible parts in absolute ratio of carcass were obtained after meat separation. The best slaughter qualities were characteristic for animals of the experimental group, which had been receiving the studied food supplement in their diet. From bulls that consumed the Intermix supplement, we obtained 22.6 kg, or 9.8% ($P < 0.05$), more of beef in the slaughter weight. Therefore, in this group, we obtained 2.6% higher slaughter yield of animals, but the significance of increase was not confirmed. The weight of paired carcass was higher in the experimental group by 21.5 kg, or by 9.5% ($P < 0.05$), which respectively increased the carcass yield by 2.4%, compared with the control. From the

experimental bulls, we obtained 1.17 kg, or 18.6% ($P < 0.01$), more internal raw fat.

Table 1
Slaughter parameters of bulls that had been consuming the Intermix Fattening proteinvitamin complex from the age of 6 months to the age of 15 months (x ± SD, n = 5)

Parameter	Group	
	control (MD)	experimental (PVMS)
Pre-slaughter live weight, kg	411.4 ± 7.4	440.8 ± 9.6*
Slaughter weight, kg	230.4 ± 5.8	253.0 ± 6.2*
Slaughter yield, %	55.9 ± 0.5	57.4 ± 0.3
Weight of paired carcass, kg	224.1 ± 5.6	245.6 ± 6.0*
Carcass yield, %	54.4 ± 0.5	55.7 ± 0.3
Weight of internal raw fat, kg	6.26 ± 0.23	7.43 ± 0.23**
Yield of internal raw fat, %	1.520 ± 0.037	1.686 ± 0.025**

Note: * – $P < 0.05$; ** – $P < 0.01$; *** – $P < 0.001$ differences between the control and experimental groups; MD – the main diet, PVMS – protein-vitamin-mineral supplement.

Adding the Intermix Fattening supplement to the diet of bulls affected the pattern of growth and development of muscles and bones, intensity of fat deposition, leading to changes in morphological composition and ratio of their certain parts (Table 2). The weight of a chilled carcass from the experimental group equaled 237.6 kg, which was 15.9 kg, or 7.2% greater ($P < 0.05$) than in the control. The group of bulls that had been receiving the premix also showed greater meatiness. According to the main parameter of flesh weight, which characterizes the value of carcass, animals of the experimental group exceeded the control counterparts by 18.5 kg, or by 10.8% ($P < 0.05$). In the experimental group, we observed higher yield of flesh compared with the weight of carcass ($P < 0.001$), insignificant increase in weight of bones and decrease in bone yield – by 2.1%, compared with the same parameters of the control group. Somewhat lower weight values of tendons and cartilages was seen in carcasses of bulls of the experimental group – lower by 1.51 kg, or by 17.4% ($P < 0.05$), and yield compared with the weight of chilled carcass decreased by 0.90% ($P < 0.01$). In the animals, meat-bone ratio varied, equaling 4.27 in the control, and 4.56 in the experimental group, i.e. higher by 6.8% ($P < 0.05$). The ratio of edible to non-edible parts in the experimental group was higher compared with the control, and therefore weight of bones, cartilages and tendons in bulls of the experimental group was lower by 3.1 kg, or 1.3%. Therefore, the meatiness index in the young that consumed the food supplement with the diet was higher by 11.1% ($P < 0.01$). Flesh yield per 100 kg of pre-slaughter weight equaled 41.89 kg in the control group, and 42.93 kg in the experimental group, i.e. higher by 1.04 kg.

Table 2
Morphological composition of carcasses of bulls aged 15 months in the conditions of intake the Intermix Fattening protein-vitamin additive (x ± SD, n = 5)

Parameters	Group	
	control (MD)	experimental (PVMS)
Weight of chilled carcass, kg	221.7 ± 5.4	237.6 ± 4.3*
Weight of flesh, kg	171.4 ± 4.8	189.9 ± 3.8*
Flesh yield, %	76.92 ± 0.35	79.54 ± 0.23***
Weight of bones, kg	40.58 ± 0.30	41.46 ± 0.39
Bone yield, %	18.34 ± 0.36	17.46 ± 0.30
Weight of tendons and cartilages, kg	8.63 ± 0.39	7.12 ± 0.52*
Yield of tendons and cartilages, %	3.89 ± 0.17	2.99 ± 0.18**
Muscular-bone ratio	4.27 ± 0.10	4.56 ± 0.09*
Meatiness coefficient	3.50 ± 0.08	3.89 ± 0.05*
Yield of meatiness per 100 kg of live weight, kg	41.89 ± 0.55	42.93 ± 1.0

Note: see Table 1.

Detailed characteristic of morphological composition of carcasses of the experimental bulls was obtained for their flesh compositions according to the quality grades. The analysis of the data revealed that flesh of carcasses of bulls of the experimental group had higher content of valuable grades of beef, compared with the analogues of the control group (Table 3). Content of highest-grade flesh in carcasses of bulls after consumption of the Intermix Fattening premix was greater by 7.7 kg, or 27.3% ($P < 0.001$), and first-grade flesh – by 10.5 kg, or 11.5% ($P < 0.05$). As with flesh of the second grade, the weight parameters of bulls of the experimental group somewhat exceeded that of their counterparts of the control group (by 4.38 kg), but were lower by 2.9% ($P < 0.05$) according to percentage values of the experimental bulls.

Table 3
Graded composition of carcasses of bulls aged 15 months, raised consuming the Intermix Fattening protein-vitamin premix (x ± SD, n = 5)

Parameter	Group	
	control (MD)	experimental (PVMS)
Weight of flesh in carcass, kg	171.4 ± 5.0	189.9 ± 3.8*
Weight of flesh of highest grade, kg	28.18 ± 0.45	35.88 ± 0.34***
Yield of flesh of highest grade, %	16.46 ± 0.28	19.02 ± 0.34***
Weight of first-grade flesh, kg	91.2 ± 3.0	101.7 ± 2.5*
Yield of first-grade flesh, %	53.22 ± 0.34	53.86 ± 0.27
Weight of second-grade flesh, kg	63.66 ± 2.15	68.04 ± 1.68
Yield of second-grade flesh, %	37.12 ± 0.36	36.03 ± 0.25*

Note: see Table 1.

The analysis of the composition of the longissimus of bulls in the conducted experiment indicated that animals that had been consuming the studied Intermix supplement had higher concentrations of dry matter – by 0.78% ($P < 0.05$) and protein – by 0.85% ($P < 0.05$) compared with such parameters of the control group (Table 4). In the experimental group, content of fat was somewhat lower (by 0.13%) and ash content was higher by 0.05%, but we obtained no significant confirmation of those changes in the groups. The analysis of samples of the longissimus of the experimental bulls revealed that the ratio of moisture to dry matter was favourable, equaling 3.03–3.17. The longissimus in the experimental group bulls had higher energy value – by 23 kcal, or 2.1%.

Table 4
Chemical composition and calorie value of the longissimus of bulls aged 15 months, raised consuming the Intermix Fattening protein-vitamin premix (x ± SD, n = 5)

Parameter	Group	
	control (MD)	experimental (PVMS)
Dry matter, %	24.00 ± 0.14	24.78 ± 0.23*
Protein, %	20.58 ± 0.16	21.43 ± 0.20*
Fat, %	2.462 ± 0.053	2.330 ± 0.031
Ash, %	0.964 ± 0.021	1.018 ± 0.018
Calorie value, kcal	1072 ± 6	1095 ± 10

Note: see Table 1.

Discussion

Providing the country's population with food products, including meat, is the most important task of the agroindustrial complex of Ukraine. Currently, more attention is paid to solving problems related to increasing beef production. Over the recent years, due to decrease in the population of dairy cattle, the number of young meat animals for fattening decreased as well. There are reports that more intensive growth of dairy cattle can result in no less heavy carcass and high-quality meat than that from meat cattle (Bown et al., 2016). Therefore, study of meat qualities of bulls of modern dairy breeds in the conditions of the region with certain nutrition conditions, advanced cattle breeding, is relevant. Effective development of livestock breeding is possible only in the conditions of rational use of existing fodders in each farm. However, most plant-based fodders do not satisfy the need of animals for the most essential microelements necessary for the highest parameters of meat productivity, which are important factors of providing complete diet (McCarthy et al., 2020). The source of nutrients for animals in easily-digested form is food additives that can compensate deficiency of elements in diet. According to Fediuchka et al. (2010), an essential component in the rational diet of young cattle is mineral nutrition. Their study also confirmed the efficacy of using vitamin-mineral and protein-vitamin-mineral additives in the diet of calves. We should note that consumption of various sources of microelements led to different effects on the slaughter parameters, qualitative composition of bulls' carcasses. Tsup et al. (2015) recommend using a phytopremic based

on *Echinacea purpurea* in feeding calves to increase their growth intensity by 16% against the background of decrease in fodder expenses by 5.1%, improvement in parameters of non-specific resistance. The conducted studies of effects of the protein-vitamin premix Intermix Calf on young bulls in the milk-feeding raising period revealed positive effect on growth and development of the animals. Starting from the age of 11 days, the diet of bulls was gradually supplemented with the protein-vitamin premix Intermix Calf, which was fed until the age of 6 months. Growth intensity of bulls throughout the period of the experiment was better in animals the diet of which included the supplement, specifically, 3.4% higher live weight, 4.5% higher mean daily increment, 8.4% higher absolute increment, against the background of 6.2% decrease in fodder expenses per 1 kg of increment (Razanova et al., 2022).

Studying only the growth parameters cannot sufficiently characterize peculiarities of the development of animals and gives no full understandding of meat productivity and meat quality. More accurate and objective data may be obtained only after slaughter. Slaughter parameters give more complete characteristic of quality and amount of meat compared with parameters of live weight and mean daily increments when animals were alive (Aydin et al., 2013). To characterize meat products from bulls, we evaluated quantitative and qualitative indicators of carcasses. Quantitative indicators of meat products from cattle were pre-slaughter weight, slaughter weight, weight of paired carcass, weight of internal fat, yield of carcass, yield of fat and slaughter yield. The main indicators of meat qualities of animals were weight of the carcass and its morphological composition. Senichenko (2018) experimentally confirmed that feeding calves of the Ukrainian Black- Spotted Dairy breed with the Zhyvyna vitamin-mineral supplement with mineral complex is economically profitable. Consumption of the additive resulted in 1.7% higher carcass yield. In order to study meat productivity and quality of meat of bulls fed with the diet containing the protein-vitamin premix Intermix, we carried out control slaughter of animals after the experiment (15 months). The results of the conducted studies add to the existing scientific data about the effects of complex mineral supplements on slaughter parameters and morphological composition of carcass, which are described in the studies by a number of domestic and foreign scientists (Budde et al., 2019). Prilipko & Zakharchuk (2015) performed a number of experiments on determining the efficacy of E-Selenium and Devivit in diets of bulls of Simmental cattle. They found out that selenium-containing food additives – against the background of balanced diet – increased not only mean daily increments in live weight, but also slaughter weight – by 3.2–4.5%. The results of slaughter of bulls revealed the best slaughter qualities in animals that had been consuming the Intermix Fattening supplement in their diet. After the correction of the diet with the premix, a greater amount of beef was obtained in slaughter weight and higher slaughter yield at the same time. Carcasses in that group of animals were heavier. The results of the study indicate a more expressed positive effect of the Intermix protein-vitamin premix on slaughter weight of bulls.

The carcass weight and yield of slaughter products are known to characterize the qualitative side of the production insufficiently. Increase in overall weight of carcass often does not reflect changes occurring in it under the influence of any factor (Girard et al., 2012; Muller et al., 2015; Edenburn et al., 2016). Thus, to obtain more significant difference between the changes occurring in carcasses of experimental bulls, their morphological composition – which gives fuller characteristic of meat qualities of animals – was analyzed. Chilled carcasses of the experimental group were superior by weight of flesh and had lower contents of bones, cartilages and tendons. The results of our study correlate with the studies by Prilipko & Zakharchuk (2015). They indicate that the application of selenium-containing supplements increased the content of flesh in carcass. Quality of carcass is characterized by ratios of muscular and fat tissues, bones, cartilages and tendons. The lower the amount of bones and cartilage in carcasses and the higher the amount of muscular and fat tissues, the higher is the grade of meat. A carcass with 4.0–4.5:1 flesh to bones ratio is more valuable. The muscular-bone ratio in carcasses of bulls that consumed the Intermix protein-vitamin premix equaled 4.56, which was significantly higher than the similar parameter in the control group. We should note that we found increase in the meatiness coefficient in the experimental group of bulls. Comparative study of flesh yield per 100 kg of pre-slaughter weight of bulls indicated positive effects of the food additive not only on growth intensity of animals, but also qualitative parameters of slaughter products. In the experimental group, this parameter was significantly higher than in the control.

During intense raising and fattening of young animals for meat, the goal should be obtaining not only large animals, but also their carcasses with optimal morphological composition of the tissues, in which the concentration of low-value parts would be minimal. The most valuable components of carcasses are muscular and fat tissues. Therefore, the more muscular and fat tissues and the less bone and connective tissues, the greater is the nutrition value of the meat. In his studies, Farionik (2015) used chelate compounds (methionates) to improve the morphological composition of carcasses, at the same time increasing muscle tissues yield by 3.79%, including meat of highest grade – by 10.35%, grade I – by 15.10%. Those results are coherent with the study of use of the protein-vitamin premix Intermix Fattening in feeding bulls from the age of 6 months to the age of 15 months. More intense development of the muscular tissue in animals that had been consuming the premix resulted not only in better parameters during the slaughter and carcasses with better morphological composition, but also better flesh composition according to quality grades. Composition of beef flesh by quality grades determines its further use in meat-processing enterprises. Flesh of carcasses of bulls that had been consuming the Intermix Fattening had higher content of meat of highest and first grades and lower content of second-grade meat.

Level and completeness of animals' diet have the greatest effects on quality of meat. Meat quality is determined according to morphological and histological structures, chemical composition, and physical properties. Study of chemical composition is the main analysis in evaluation of meat. Chemical composition depends on a number of factors, including diet. Results of studies by many scientists revealed positive effects of food supplements on the formation of qualitative parameters of meat of young cattle (Gorlov et al., 2016; Kitagawa et al., 2018). Meat of carcasses of calves contained higher concentrations of fat, protein and energy, and protein indicator of meat quality was higher than the control. In complex evaluation of meat, taking into account its qualitative parameters, an important aspect is analysis of chemical composition of the longissimus, since its average probe includes not only muscles, but also inter-muscular fat. The maturity degree of meat is determined according to fat content and is accompanied by decrease in moisture and protein levels, as confirmed by the results of the study of effects of the protein-vitamin premix Intermix Fattening on bulls. Higher concentration of fat in flesh of carcasses of bulls of the experimental group led to decrease in moisture content, and the lower fat content in flesh of carcasses of their counterparts in the control led to increase in the moisture level. Meat quality is also evaluated by the ratio of protein to fat in it. In the experimental bulls the ratio was 8.3–9.2:1. This parameter was somewhat higher in the samples from the experimental group (9.2:1). Moisture to fat ratio in flesh of carcasses characterizes the meat maturity. From 15 month-old bulls that had been receiving the protein-vitamin premix in their diet, we obtained this indicator equaling 32.3%, as compared with 30.9% in the control. This indicates that the studied supplement promotes better synthesis of fat in the organism of bulls. Different concentrations of protein and fat in flesh of bulls affected their energy value. Higher energy value of 1 kg of meat was characteristic for flesh of carcasses of bulls that had been consuming the protein-vitamin premix Intermix Fattening.

Conclusions

The Intermix Fattening protein-vitamin premix fed to bulls in the conditions of mineral deficiency of microelements in diet fodders promoted activation of metabolic processes, leading to increases in post-slaughter parameters of meat productivity, improvement of morphological composition and quality of carcasses. Having consumed the premix in their diet, young animals aged 15 months had the following parameters exceeding such of the control: slaughter weight – by 9.8% ($P < 0.05$), weight of paired carcass – by 9.5% ($P < 0.01$). Meatiness was greater in the group of bulls that had been consuming the supplement: meatiness index was higher by 11.1% ($P < 0.05$), we obtained a 27.3% ($P < 0.001$) larger amount of highest-grade flesh and 11.5% ($P < 0.01$) more first-

grade flesh. In the muscular tissue of the longissimus of bulls the diet of which included the Intermix additive, the concentration of dry matter was higher by 0.78% ($P < 0.05$), and protein was higher by 0.85% ($P < 0.05$).

The study was performed with the financial aid of the Ministry of Education and Science of Ukraine (0122U000853).

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