Journal of Elementology ISSN 1644-2296

Beisenov A.K., Amanzholov K.Ż., Mirzakulov S.M., Miciński B., Pogorzelska J., Miciński J. 2017. *Fattening, slaughter features and meat mineral composition of 3 beef cattle breeds*. J. Elem., 22(3): 1141-1154. DOI: 10.5601/jelem.2017.22.1.1394

ORIGINAL PAPER

FATTENING, SLAUGHTER FEATURES AND MEAT MINERAL COMPOSITION OF 3 BEEF CATTLE BREEDS*

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Abstract

The aim of the work was to assess the fattening capability and slaughter value, including the meat mineral composition, of 3 beef cattle breeds. In the first stage of the experiment, the experimental materials comprised 90 bulls divided into three groups of 30 animals each, representing three beef breeds: Kazakh Hereford (KH), Kazakh Whiteheaded (KW) and imported Hereford (IH). The second stage of the study involved 60 bulls at 450 days of age (± 10 days), 10 bulls of each breed were selected randomly and slaughtered. The tested bulls were fattened from 240 to 450 days and from 450 to 540 days of age, respectively (1st and 2nd stage). The studies showed that the birth weight of bulls was relatively low (slightly above 27 kg) in all groups. Until 240 days of age, imported Hereford bulls were characterized by the highest average daily gains (904 g day^{-1}). At 360 days of age, the average body weight of bulls fattened indoors exceeded 300 kg; Kazakh Hereford bulls had the highest body weight, and differences in the average body weight between groups were statistically significant ($p \leq 0.05$). From birth to 450 days of age, the highest daily gain of 810 g was noted in imported Hereford bulls. At 540 days of age, imported Hereford bulls fed indoors (maize silage, hay and concentrate) had the highest average body weight (487.2 kg). In bulls of all breeds, metabolic profile parameters (*AST, ALT, ALP*, protein, content of Ca, Na, K, Mg and P) remained within the reference ranges, which points to a good health status of animals. Moderate feeding contributed to achieving the highest weight at slaughter by imported Hereford bulls (377.2 kg). Imported Hereford bulls were also characterized by the carcass dressing percentage above 56%, the highest carcass lean content, the lowest carcass fat content and the largest *MLD* area. Meat from imported Hereford and Kazakh Hereford bulls had the most desirable chemical composition and sensory properties.

Keywords: beef bulls, daily gains, slaughter traits, metabolic profile parameters, macroelements.

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* The work financed under the statutory research in Department of Technology and Biological Resources.

INTRODUCTION

Beef quality is determined by genetic and environmental factors, including a cattle breed, gender, age, nutritional regime and genetic potential related to the type traits of cattle. Cattle breeds represent different maturity types characterized by different growth rates and daily gains, and can be classified as early-, medium- and late-maturing (WHEELER et al. 1994, BURROW et al. 2004). The most important environmental factor is a diet, followed by a management system, slaughter age and pre-slaughter treatment (stress resulting from transportation to the abattoir, lairage time and pre-slaughter fasting) (MICIŃSKI et al. 2005, 2012).

Cattle breeders aim to maintain good animal health, which is greatly influenced by nutrition, including the prevention of protein, mineral (macronutrient and micronutrient) and vitamin deficiencies that could affect the functioning of all body systems (MORDAK 2008, MINKIEWICZ et al. 2013). The meat of ruminants is an important source of minerals in human nutrition. It provides essential elements with high digestibility, especially Fe and Zn (GRANIT et al. 2001, CABRERA, SAADOUN 2014). Calcium, phosphorus and magnesium are essential nutrients for the mineralization of bones and teeth (RODRIGUEZ et al. 2001). Calcium also plays a key role in the development and function of the nervous system and muscles, assists in blood clotting and acts as an activator for several enzymes, e.g. lipase and ATP-ase (KŁOBUKOWSKI et al. 2014). Calcium concentrated in meat is characterized by good digestibility and physiological activity owing to its ratio to phosphorus, which is beneficial for humans. Phosphorus is involved in numerous metabolic processes and plays a major role in energy transfer, phosphorylation and other processes important for glucose, fructose and protein metabolism (MWAURA, AKINSOYINU 2010). Sodium and potassium are involved in osmotic pressure regulation and play essential roles in muscle contraction.

Magnesium participates in numerous metabolic processes in the body, it is found in the cell nucleus and is very important in cellular function (BLUM, HAMMON 2000). Magnesium is an essential element in the synthesis and breakdown of high-energy compounds, primarily adenosine triphosphate (*ATP*). Magnesium is also a co-factor and an activator of many enzyme systems, particularly those transferring phosphate groups. Magnesium is important for the proper functioning of various metabolic pathways of proteins, nucleic acids, lipids and carbohydrates. It also participates in electrolyte transport across cell membranes. Magnesium supports the regeneration of all living cells, and it needs to be in balance with calcium. This mineral element is involved in blood clot formation, bone development, immune function and defense responses. It helps to prevent phlebitis and postoperative blood clots, and to maintain a healthy cardiovascular system. Magnesium also helps to reduce stress and anxiety, protects against anaphylactic shock, has anti-inflammatory properties, reduces cholesterol levels, prevents cardiac muscle damage, and – together with potassium – regulates blood pressure (TOUYZ 2004).

Beef cattle are fattened intensively to increase lean muscle yield. Feeding intensity can be increased under different production systems, and it is determined by the availability of home grown feed resources on a farm, a feeding system, the selection of feed ingredients and preparation of balanced rations. The nutritional regime should be adjusted to the genetic potential of cattle in order to produce beef carcasses with desired composition. Studies investigating the effect of a diet on meat quality, conducted to date, have focused on muscle weight gain and evaluation of carcass dressing percentage as well as on feed components and chemical compounds that can be absorbed from the gastrointestinal tract and incorporated into cell structures to improve the nutritional and biological value of meat. An example could be the modification of the fatty acid profile of meat (intramuscular fat) through the modification of a diet's composition (STRUSIŃSKA et al. 2009). According to WARREN et al. (2008), as well as having a more stable colour owing to a slower rate of lipid oxidation, meat from animals fed grass silage has a longer shelf-life (by 2 to 3 days) in comparison with meat from cattle fed a concentrate diet. LEE et al. (2008) demonstrated that dietary sulphur and vitamin E supplementation increased lipid and myoglobin stability in stored meat. Vitamin E effectively slows down lipid oxidation, and sulphur stabilizes oxymyoglobin. PEDREIRA et al. (2003) reported that dietary vitamin D_3 supplementation improved the tenderness of beef which tends to be rather tough. However, supplemental vitamin D_3 has no influence on the quality characteristics of meat that is naturally more tender (ANDERSEN et al. 2005).

Research has shown that cattle fed roughage-based diets (preserved and fresh) and grazed on pasture are a source of high-quality beef, and that such a feeding system is most cost-effective (WARREN et al. 2008).

The hypothesis assumes that a race, nutrition and health condition of bulls have an impact on the animals' fattening and slaughter indicators (parameters).The aim of the work was to assess the fattening capability and slaughter value, including the meat mineral composition, of three beef cattle races (Kazakh Hereford, Kazakh Whiteheaded and imported Hereford).

MATERIAL AND METHODS

The experiment was conducted at the Dinar's Ranch cattle farm located in the Almaty Region in the Republic of Kazakhstan. The bulls were born in the early spring and stayed with their mothers on a pasture until weaning at 240 days of age. Research was conducted in two stages: Stage 1 (age of 240 days to 450 days of age) and stage 2 (from 450 days to 540 days of age). The body weight of bulls under the experiment is presented in Table 1.

Table 1

Selected parameters of fattening performance in beef bulls

Specification		Groups		
		KH	KW	IH
Number of animals (head)		30	30	30
Body weight (kg)	birth	27.2 ± 7.20	27.4 ± 8.31	27.3 ± 6.53
Stage 1 of the study				
Number of animals (head)		30	30	30
Body weight (kg)	240 days	238.5 ± 3.31	235.6± 6.02	244.2± 4.00
	360 days	314.7^{a} ± 5.62	303.2^{b} ± 5.93	310 ± 7.30
	450 days	383.8 ± 9.50	380.4^{a} ± 10.40	392^{b} ± 12.70
Average daily gain (g)	240-360 days	635^{A} ± 8.32	563^{B} ± 3.12	550^{B} ± 6.70
	360-450 days	768^{A} ± 8.12	858^{Ba} ± 5.24	911^{Bb} ± 5.47
	birth-450 days	792^{a} ± 11.47	784^{a} ± 7.33	810^{b} ± 9.11
Dry matter intake kg^{-1} body weight gain	240-450 days	7.4 ± 0.16	7.2 ± 0.17	6.9 ± 0.19
Stage 2 of the study				
Number of animals (head)		20	20	20
Body weight (kg)	540 days	469^{a} ± 10.70	477^{a} ± 12.90	487.2^{b} ± 13.40
Average daily gain (g)	450-540 days	947^{A} ± 11.66	1073^{B} ± 6.90	1058^{B} ± 9.11
	birth-540 days	818^{a} ± 4.23	833^{a} ± 3.14	852^{b} ± 8.22
Dry matter intake kg^{-1} body weight gain	450-540 days	8.1 ± 0.18	8.3 ± 0.15	7.9 ± 0.14

KH-Kazakh Hereford, KW – Kazakh Whitehead, IH – Hereford imported;
Differences between bulls of different breeds within lines: *A*,*B*,*C* – significant at $p \leq 0.01$, *a*,*b*,*c* – significant at $p \leq 0.05$.

At the age from 240 to 450 days, fattened bulls were given a diet based on roughage, i.e. green fodder, grass silage, maize silage and hay supplemented with concentrate. The bulls were fed half-intensively, assuming that daily gains were from 800 to 900 g. Throughout the alcove feeding nutrition, doses presented in Table 2 were used. The share of mixes in rations was established based on the energy density of a feeding dose recommended in the evaluation and nutrition system INRA (1993), and using models for bulls of beef races. The average feeding value of 1kg of dry weight of collected doses amounted to 0.96 UFV (meat fodder units) and 159 g of total protein.

The first and second stages covered the period from 240 to 540 days of age, when bulls were fattened according to the regime presented in Table 2. In the 2nd stage, the diets were supplemented with 2.5 to 3.0 kg of concentrate per day. The daily silage ration was increased at 30-day intervals allowing for 10% leftover from a daily allotment.

Table 2

Feeding regime of bulls

Age (days)	Body weight (kg)	Feed consumption (kg/day/animal)				
		hay	silage	concentrate	salt	feed phosphate
240-270	220	3.0	10	2.5	0.04	0.04
271-300	245	4.0	10	2.5	0.04	0.04
301-330	270	5.0	11	2.5	0.04	0.04
331-360	305	5.5	12	2.5	0.05	0.04
361-390	335	6.0	12	2.5	0.05	0.05
391-420	365	6.5	13	2.5	0.05	0.05
421-450	387	6.5	13	2.5	0.05	0.05
451-480	414	6.5	13	3.0	0.05	0.05
481-510	445	6.5	13	3.0	0.05	0.05
511-540	478	6.5	13	3.0	0.05	0.05

Throughout fattening, daily gains were determined from birth to 240 days of age, from 240 to 360 days of age, from 360 to 450 days of age, from 450 to 540 days of age, and from birth to 540 days of age. The body weight of bulls was determined at birth and at 240, 360, 450 and 540 days of age. Dry matter intake per kg of body weight gain was estimated in each stage of the study and in each experimental group.

In the 1st stage of the experiment, the experimental materials comprised 90 bulls divided into three groups of 30 animals each, representing three beef breeds: Kazakh Hereford (KH), Kazakh Whiteheaded (KW) and imported Hereford (IH). The IInd stage of the study involved 60 bulls because at 450 days of age (±10 days), 10 bulls of each breed were selected randomly and slaughtered.

Blood was sampled from the jugular vein to determine the serum biochemical parameters. Blood was collected into test tubes containing heparin. Blood samples were allowed to clot. After two hours, they were centrifuged for 10 min at 3000 rpm (MPW 223e centrifuge). Serum was collected with an automatic pipette and was stored in Eppendorf tubes at a temperature of -18^{o}C until analysis. The serum total protein (g l^{-1}) was determined by a micromethod for colorimetric determination (Lowry et al. 1951). Further analyses were performed with the use of a *MINDRAY BS-120* chemistry analyzer. The kits used for the measurements of the activity of serum biochemical parameters such as alanine transaminase (*ALT*), aspartate transaminase (*AST*) and alkaline phosphatase (*ALP*) were purchased from Randox (Great Britain). The results were interpreted using the reference ranges for serum biochemical parameters in cattle: *ALT* – 25-74 U l^{-1}, *AST* – 58-100 U l^{-1}, *ALP* – 41-116 U l^{-1} (Winnicka 2008). The blood levels of selected macroelements (mmol l^{-1}): calcium (Ca), sodium (Na), potassium (K), magnesium (Mg) and phosphorus (P), were also determined:

Bulls aged 450 days (±10 days) were transported to slaughterhouses, where, after 24h starvation and weighing, they were experimentally slaughtered using the technology approved in the meat industry of Kazachstan. The cutting of the right half-carcasses was carried out according to methodology GOST 31797 (2012). Immediately after slaughter, the body weight and pH were specified (GOST R 51478-99). Carcasses were divided into halves by cutting through the middle of vertebrae. Carcass characteristics and meat quality were evaluated after slaughter. Bulls were weighed before slaughter, and carcasses and visceral fat were weighed after slaughter to determine dressing percentage. Chilled (24 h) carcasses were dissected to determine their morphological composition, separating muscle tissue, adipose tissue, cartilages and tendons, and pulp made from 1 kg of bones. The cross-sectional area (cm^2) of *musculus longissimus dorsi* (MLD) was measured behind the 13^{th} rib.

The data were processed statistically by one-way analysis of variance (ANOVA) for orthogonal designs. Means ($\bar{x}$) and standard deviations (SD) were calculated. The significance of differences was estimated by the Fisher's Least Significant Difference (LSD) test. All calculations were performed using Statistica ver. 9.0 software (StatSoft, 2011).

RESULTS

The birth weight of bulls was similar in all groups, with no significant differences between mean values. Calves consumed mother's milk and feeds specified in Table 3. The consumption of green forage was from 3 to 16 kg (at the age of 90 to 240 days). Throughout the whole rearing period since birth to 240 days old concentrated feed was available, and its consumption increased to the level of 2.0 kg/calf/day by the 8^{th} month. Table 2 shows the scheme for fattening bulls. The resulting daily gains are reported in Table 1. At 240 days of age, KH bulls had an average body weight of 238.5 kg, and IH bulls weighed 244.2 kg on average. From birth to 240 days of age, average daily gain reached 880 g in KH, 868 g in KW and 904 g in IH bulls. This means that the average gains of the examined bulls reached 883 g. The diets resulted in an average body weight exceeding 300 kg at 360 days of age. At the next stage of fattening, from 360 to 450 days of age, compensatory gain was observed, and IH bulls were characterized by the highest average daily gain (911 g) over this period. From birth to 450 days of age, daily gains reached 792 g in KH, 784 g in KW and 810 g in IH.

Table 1 presents the fattening performance of 60 bulls up to 540 days of age. At the end of fattening, IH bulls were characterized by the highest ave-

Table 3

Feeding regime of young bulls

Age (days)	Feed consumption (kg/day/animal)				
	hay	silage	concentrate	salt	feed phosphate
5-30	*ad libitum*	-	*ad libitum*	-	-
31-60	0.1	-	0.4	0.008	0.010
61-90	0.3	-	0.4	0.012	0.015
91-120	0.6	3	0.5	0.016	0.020
121-150	-	6	0.5	0.018	0.025
151-180	-	12	1.0	0.020	0.030
181-210	-	14	1.0	0.025	0.035
211-240	-	16	2.0	0.030	0.040
Total (kg)	60	1440	186	3.90	5.25

rage body weight (487.2 kg), followed by KW bulls (477 kg) and KH bulls (469 kg), $p \leq 0.05$. From 450 to 540 days of age, the diets were based on maize silage offered *ad libitum* at 13 kg, supplemented with hay (6.5 kg) and concentrate (3 kg/animal/day). The average daily gains in the analyzed age categories, which serve as indicators of the growth and development of animals, were as follows: from 450 to 540 days of age – 1073 g (group KW), 1058 g (group IH) and 947 g (group KH), $p \leq 0.01$ and $p \leq 0.05$; from birth to 540 days of age, the highest and lowest average daily gains were noted in IH bulls (852 g) and KH bulls (818 g), respectively ($p \leq 0.05$).

Dry matter intake per kg of body weight gain was 6.9 (IH) – 7.4 kg (KH) at the first stage of the study, and the highest dry matter intake at the second stage was noted in group KW (8.3 kg) while the lowest one (7.9 kg) occurred in group IH.

In the present experiment, blood was sampled from the jugular vein of five bulls selected randomly from each group at 450 days of age to determine the serum biochemical parameters (Table 4).The metabolic profiles of animals were evaluated based on the following indicators: activity levels of liver enzymes (*ALT* and *AST*) and alkaline phosphatase (*ALP*). Alanine transaminase (*ALT*) (EC 2.6.1.2) and aspartate transaminase (*AST*) (EC 2.6.1.1) are enzymes that catalyze the transfer of α-amino groups between amino acids and α-ketoacids.

Table 5 presents the parameters of slaughter value in beef bulls selected randomly from each group and slaughtered at 450 days of age. An average live body weight at slaughter ranged from 366.6 kg in KW bulls to 377.2 kg IH bulls, which points to moderate feeding levels throughout the fattening period. Attention should be paid to high carcass fatness, reflected by a high visceral fat content. KH bulls had the highest visceral fat content (14.2 kg), followed by KW bulls (11.72 kg) and IH bulls (10.53 kg). Carcass dressing

Table 4

Serum biochemical parameters in beef bulls

Specification	Groups			Reference ranges	
	KH	KW	IH	value	author
Number (head)	10	10	10		
AST (U l^{-1})	$78.4^{Aa} \pm 1.10$	$76.3^{b} \pm 2.00$	$71.9^{Bc} \pm 5.70$	58-100	WINNICKA (2008)
ALT (U l^{-1})	$24.8^{A} \pm 2.30$	$24.9^{A} \pm 4.4$	$28.6^{B} \pm 3.60$	25-74	
ALP (U l^{-1})	$147.5^{Aa} \pm 4.50$	$205.2^{B} \pm 4.32$	$135.2^{Ab} \pm 3.01$	41-116	
Ca (mmol l^{-1})	2.2 ± 0.10	2.3 ± 0.20	2.1 ± 0.30	2.3-3.0	
Na (mmol l^{-1})	$198^{A} \pm 17.1$	$103.7^{B} \pm 19.10$	$179.5^{C} \pm 19.70$	130-150	
K (mmol l^{-1})	$4.5^{Aa} \pm 0.20$	$1.1^{B} \pm 0.30$	$5.2^{Ab} \pm 0.40$	4.4-5.7	
P (mmol l^{-1})	$2.6^{a} \pm 0.12$	$1.8^{b} \pm 0.21$	$1.8^{b} \pm 0.27$	1.6-2.3	
Mg (mmol l^{-1})	$0.9^{a} \pm 0.1$	$1.2^{b} \pm 0.23$	$0.9^{a} \pm 0.10$	0.7-1.2	

KH-Kazakh Hereford, KW – Kazakh Whitehead, IH – Hereford imported, AST – aspartate transaminase, ALT – alanine transaminase, ALP – alkaline phosphatase;
Differences between bulls of different breeds within lines: *A*,*B*,*C* – significant at $p \leq 0.01$, *a*,*b*,*c* – significant at $p \leq 0.05$.

Table 5

Parameters of slaughter value in beef bulls slaughtered at 450 days of age

Specification		Groups		
		KH	KW	IH
Number of animals (head)		10	10	10
Weight (kg)	live	370 ± 10.40	$366.6^{a} \pm 10.36$	$377.2^{b} \pm 10.40$
	carcass	206.1 ± 8.32	$199.1^{a} \pm 7.32$	$211.2^{b} \pm 8.50$
	visceral fat	$14.2^{a} \pm 0.54$	11.72 ± 0.43	$10.53^{b} \pm 0.48$
Carcass dressing percentage (%)		$55.7^{a} \pm 0.71$	$54.31^{b} \pm 0.71$	$55.99^{a} \pm 0.65$
Morphological composition of carcass (%)	muscle tissue	$71.0^{a} \pm 1.30$	$64.7^{b} \pm 1.3$	$73.2^{a} \pm 1.50$
	adipose tissue	$15.7^{a} \pm 0.62$	$15.7^{a} \pm 0.66$	$12.4^{b} \pm 0.52$
	cartilages and tendons	$3.22^{a} \pm 0.20$	$2.84^{b} \pm 0.21$	$2.98^{b} \pm 0.27$
	pulp made from 1 kg of bones	4.52 ± 0.22	4.26 ± 0.21	4.18 ± 0.18
MLD area (cm^2)		$72.8^{a} \pm 1.42$	$68.5^{b} \pm 1.42$	$75.21^{a} \pm 1.57$

KH-Kazakh Hereford, KW – Kazakh Whitehead, IH – Hereford imported, *MLD* – *musculus longissimus dorsi*;
Differences between bulls of different breeds within lines: *a*,*b*,*c* – significant at $p \leq 0.05$.

percentage, the most important indicator of slaughter value, was the highest in IH bulls (56.12%), and lower dressing percentage values were noted in KH bulls (55.7%) and KW bulls (54.31%). Carcass quality is determined by carcass tissue composition, in particular the content of lean meat and valuable cuts. Table 5 contains data on the percentage content of muscle tissue, adipose tissue, cartilages and tendons in the analyzed groups of beef bulls. IH bulls had the highest carcass lean content (73.2%) and the lowest carcass fat content (12.4%). In contrast, carcasses of KW bulls contained only 64.7% of muscle tissue and 15.7% of adipose tissue. The area of *musculus longissimus dorsi – MLD* is a reliable indicator of carcass lean content. In our study, IH bulls had the highest *MLD* area (75.21 cm^2), followed by KH bulls (72.8 cm^2) and KW bulls (68.5 cm^2).

Apart from the morphological composition of carcass, beef quality also depends on the carcass's physicochemical properties. In the present study, the physicochemical parameters of *MLD* samples (Table 6) pointed to minor

Table 6

Chemical composition and sensory properties of meat

Specification	Groups		
	KH	KW	IH
Number of animals (head)	10	10	10
Dry matter (%)	24.3 ± 0.48	23.8 ± 0.46	24.8 ± 0.45
Protein (%)	20.8 ± 0.33	21.0 ± 0.39	20.4 ± 0.30
Fat (%)	2.12^A ± 0.02	1.50^B ± 0.06	2.13^A ± 0.04
Ash (%)	1.04 ± 0.01	1.10 ± 0.02	1.04 ± 0.02
Colour parameters:			
*L**	20.84 ± 0.27	20.11 ± 0.31	20.16 ± 0,34
*a**	19.63 ± 0.42	18.52 ± 0.40	19.42 ± 0,38
*b**	22.91 ± 0.33	21.77 ± 0.36	22.72 ± 0.32
*c**	30.73 ± 0.29	29.10 ± 0.34	30.12 ± 0.32
pH	5.7^a ± 0.04	6.0^b ± 0.05	5.5^c ±0.05
Shear force (N)	68.9^a ± 0.49	70.3^b ± 0.53	69.9 ± 0.050
Toughness (N)	47^a ± 0.45	48.5 ± 0.47	44.7^b ± 0.47
Tenderness (points)	6.5 ± 0.07	6.2 ± 0.08	6.4 ± 0.07
Juiciness (points)	6.7 ± 0.08	6.8 ± 0.08	6.7 ± 0.07
Cooking loss (%)	32.3 ± 0.39	31.6 ± 0.38	32.0 ± 0.39
Glycogen (mg 100 g^{-1})	205^a ± 9.46	194^b ± 10.12	217^c ± 11.44
Lactic acid (mg 100 g^{-1})	446^a ± 14.98	403^b ± 17.18	467^c ± 18.18

KH-Kazakh Hereford, KW – Kazakh Whitehead, IH – Hereford imported, *L**– brightness colour, *a** – participation of red colour, *b** - participation of yellow colour, *c** – saturation colour; Differences between bulls of different breeds within lines: *A*,*B*,*C* – significant at $p \le 0.01$, *a*,*b*,*c* – significant at $p \le 0.05$.

differences in meat quality between the analyzed breeds. No statistically significant differences were found in the content of dry matter, protein and ash in meat or meat color. The fat content varied significantly between groups. In beef, the fat content of *MLD* should be higher than 2%, and such values were noted in meat from KH and IH bulls.

Meat texture was determined based on maximum shear force values. Meat toughness was also evaluated. In all groups, meat samples were characterized by similar values of maximum shear force (approx. 70 N). In a sensory analysis of beef, tenderness and juiciness were estimated on a 9-point scale. Meat from KH and IH bulls was more tender than meat from KW bulls. Smaller differences were found in juiciness scores. The glycogen content of muscles, measured 24 h post mortem, ranged from 194 to 217 mg 100 g^{-1}. Lactic acid content exceeded 400 mg 100 g^{-1} of meat, and it was the lowest in meat from KW bulls.

DISCUSSION

An efficient calf rearing system is crucial as it determines the subsequent fattening performance of young cattle (Zwierzchowski et al. 2016), and because the most rapid physiological changes take place in growing calves (Strusińska et al. 2009). The results obtained for the birth weight and rearing in subsequent steps are comparable with those reported by other authors (Pilarczyk, Wójcik 2008, Wójcik et al. 2013, Zwierzchowski et al. 2016). Amanzholov et al. (2012) and Badiejeva (2012) claim that an adequate, well-balanced feeding in early life stages has a significant influence on muscle growth in beef cattle and contributes to achieving the target daily gain.

The growth rate of cattle is significantly affected by a fattening system and feeding level (O'Sullivan et al. 2004). The growth and development of animals are reflected in their body weights and average daily gains. In the present study, the average birth weight of bulls of the analyzed breeds exceeded 27 kg. This value is considerably lower than the body weights of beef calves reported in the literature. According to Przysucha et al. (2015), the average birth weight of Hereford calves is 33-35 kg. Continuous beef cattle improvement, innovative solutions to increasing production efficiency and dietary modifications contribute to changes in body weight and average daily gain (Scollan et al. 2006). In our study, the body weights and daily gains of bulls were affected by the nutritional regime. Similar results were reported by Nogalski et al. (2014), who evaluated crossbred cattle fattened under semi-intensive conditions. Łozicki et al. (2010) demonstrated that young Hereford bulls fattened from 250 kg to approximately 550 kg BW, fed maize silage, hay and a concentrate supplemented with a vitamin-mineral premix, achieved average daily gain of 1300 g day^{-1}, whereas their average daily dry matter intake ranged from 7.92 to 8.15 kg. In a study by Wajda et al. (2006), where young bulls fattened from 260 kg BW were fed hay *ad libitum* and ground grain at 3.5 kg to a body weight of approximately 350 kg and at 4 kg from a body weight of 430 kg (+ mineral supplements), average daily gain calculated for a 270-day fattening period exceeded 900 g.

Alkaline phosphatase (*ALP*) (EC 3.1.3.1.) is an enzyme responsible for removing phosphate groups from many types of phosphate esters. It is present in nearly all tissues. In mature animals, *ALP* is synthesized in the liver but also in the bones in pre-pubertal animals (Fernandez, Kidney 2007). In young beef cattle, high *ALP* activity is associated with rapid bone growth (Baumgartner 2005, Winnicka 2008). Elevated levels of *ALT* and *AST* may point to muscle tissue damage and liver dysfunction (Jackson, Cockroft 2002).

In the experimental bulls, the serum levels of *ALT* and *AST* remained within the reference ranges for cattle (Winnicka 2008, Baumgartner 2005), which points to their normal activity. Significantly elevated levels of those enzymes could suggest the existence of metabolic problems. In study, the serum levels of *ALP* varied widely from 135.2 to 205.2 U l^{-1}, exceeding the reference range for adult cattle (Winnicka, 2008), which could have resulted from the young age of bulls, not yet reaching somatic maturity. In the literature concerning the slaughter value of cattle, publications by Baumgartner (2005) and Winnicka (2008) were used for comparison. Indicators included in these papers are given values which correspond to the physiological norms and suggest a good health status of animals.

In KH bulls, the serum phosphorus levels (2.6 mmol l^{-1}) were slightly above the reference range of 1.6 - 2.3 mmol l^{-1} (Baumgartner 2005). Normal potassium levels (4.5 - 5.2 mmol l^{-1}) were noted in the blood serum of KH and IH bulls. KW bulls were characterized by very low serum potassium concentrations (1.1 mmol l^{-1}) and the lowest (below the reference range) serum sodium concentrations (103.7 mmol l^{-1}). In the remaining groups, the serum sodium levels considerably exceeded the reference values of 130-150 mmol l^{-1} (Baumgartner 2005), as they reached 179.5 - 198 mmol l^{-1}. The serum sodium and potassium levels determined in KW bulls deviated markedly from the reference ranges, which could increase the risk for kidney disease and gastrointestinal disorders

In addition to the above blood biochemical parameters (*AST, ALT, ALP*), the levels of macroelements and microelements are also essential for animal health (Kendall, Bone 2006). An analysis of the concentrations of minerals (Ca, Na, K, P and Mg) in the blood of bulls of the analyzed breeds revealed that calcium and magnesium levels were within the reference ranges for cattle (Baumgartner 2005) in all groups. Similar results were reported by Šťercová et al. (2005) for intensively fattened bulls.

Warren et al. (2008), Łozicki et al. (2010) claim that fat and protein deposition, i.e. the body and carcass composition of cattle, are also influenced by factors other than the feeding regime, including breed, type traits, gender, body weight and daily gain. In a study by Pogorzelska and Ostoja (2001), Hereford bulls fattened from 210 to 730 days of age achieved slaughter weight of 532 kg and carcass dressing percentage of 58.2%. In another experiment (Miciński et al. 2005), where Hereford bulls were fattened from 210 to

420 days age and were fed two types of succulent roughage (maize silage or grass silage), an average slaughter weight was 476 kg and the carcass dressing percentage reached 55.3%. All of the parameters of slaughter value in beef bulls slaughtered at 450 days of age differ from those reported by Pogorzelska et al. (2013) for pure beef cattle breeds, but in the cited studies bulls were raised under intensive production systems.

Ostoja et al. (2004), who investigated the colour of meat from Hereford and Limousin bulls fed silage, demonstrated that colour lightness was affected by a cattle breed, namely the meat of Hereford bulls was lighter in colour. Miciński et al. (2005) demonstrated that meat from Hereford bulls was characterized by greater fragility of a specific test of TPA, gumminess and chewiness than Limousine bulls. In their research on better meat, fragility affected bulls fed maize silage.

CONCLUSIONS

The study showed that the birth weight of bulls was relatively low (slightly above 27 kg) in all groups. Until 240 days of age, imported Hereford bulls were characterized by the highest average daily gains (904 g day^{-1}). At 360 days of age, the average body weight of bulls fattened indoors exceeded 300 kg; Kazakh Hereford bulls had the highest body weight, and differences in the average body weight between groups were statistically significant ($p \leq 0.05$). From birth to 450 days of age, the highest daily gain of 810 g was noted in imported Hereford bulls. At 540 days of age, imported Hereford bulls fed indoors (maize silage, hay and concentrate) had the highest average body weight (487.2 kg). In bulls of all breeds, the metabolic profile parameters (*AST, ALT, ALP*, protein, content of Ca, Na, K, Mg and P) remained within the reference ranges, which points to a good health status of animals. Moderate feeding contributed to achieving the highest weight at slaughter by imported Hereford bulls (377.2 kg). Imported Hereford bulls were also characterized by the carcass dressing percentage above 56%, the highest carcass lean content, the lowest carcass fat content and the largest MLD area. Meat from imported Hereford and Kazakh Hereford bulls had the most desirable chemical composition and sensory properties.

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