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The Impact of Nutrition On the Results of Rearing and Metabolic Profile of Heifers and Breeding Bulls of Kazakh White Head Race.

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ABSTRACT

The aim of the work was an analysis of feeding of young breeding cattle of the Kazakh White Head race, from birth to the age of 450 days in one of the Kazakh farms called „Dinar's Ranch". In the last stage of the research an assessment of animal's health condition was done, basing on the biochemical blood parameters. The level of nutrition in the first period of life of the animals influenced the growth and development of young breeding cattle significantly. 1250 liters of milk, besides solid feed is recommended for calves from birth to the age of 240 days. Applied nutrition in subsequent life periods, based on hay, silage, concentrated feed and mineral additives ensured that the assumed daily body weight increases were real. The average daily dry weight absorption by the heifers was from 5.3 to 7.1kg, whereas bulls absorbed from 6.5 to 8.7kg. Daily increases of heifers at the age of 361-450 days were 833g, whereas bulls - 1055 g/day. Metabolic profile parameters of bulls (hepatic enzymes – AST and ALT, urea, protein, alkaline phosphatase – ALP, as well as Ca, Na, K, Mg and P content) were in the range of the reference standards, which testified a good health status of the animals.

Keywords: nutrition, metabolic profile, body weight, urea, protein, alkaline phosphatase

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INTRODUCTION

In Kazakhstan, most beef is derived from animals used both sides, but Caspian meat breed has also a big part. Both genetic and environmental factors affect the quality of beef. [1,2]. Very important is the influence of the breed cattle for fattening [3]. Cattle of different races or of different genotype is characterized by diverse physiological features, i.e. earliness of ripening, growth, sex, which consequently affects the quality of meat [4-6]. Main influence on beef quality among environmental factors has feeding and housing system [7], that age at slaughter, preslaughter trading (stress resulting from transport, residing in slaughter warehouse, starvation) and meat treatment after the slaughter [8]. Both in breeding and production (fattening) herds the main cost component is fodder. Grassland is a purveyor of cheap feed. Feed manufactured on them can be fed only when fresh and on pasture or preserved as silage, haylage or hay [9]. The pure-bred herds of meat calves born in the early spring can spend it with their mothers, using the pasture until the end of October. Further growth of calves takes place in the alcove already [2].

Nutritional strategy is a factor used as a tool for monitoring of bulls and heifers rearing in breeding herds, as well as in relation to improvement and control of cattle fattening, animal welfare, safety, nutritional value and nutritional and technological quality of meat [10]. Research conducted on the effects of nutrition on the course of rearing took into account not only diversity of cow breeds, but also the types and availability of used feed [11]. Research in which feeding affects the muscle and slaughter efficiency growth on one part and on the other it allows the introduction of components and chemical compounds into the feed, that could be potentially absorbed from the gastrointestinal tract and subsequently incorporated into cellular structures or by accumulating in tissues lead to an improvement in nutritional or biological quality of meat, are extremely valuable [12]. An example of such a situation can be a modification of feed composition [13, 14]. Warren *et al.* (2008) found that bovine meat originating from cattle fattened with silage from green forage has a 2-3 days longer shelf life [15], due to slow progressive changes in lipid oxidation and thus more stable color when compared to meat of cattle fed with concentrated feeds Lee *et al.* (2008) demonstrated that the addition of sulfur and vitamin E to feed increases the stability of lipids and myoglobin during meat storage [16]. Vitamin E effectively slows down oxidation of lipids and sulfur preferably affects the stability of oxymyoglobin supplementing the feed with Vitamin D3 have found that it affects the improvement of meat tenderness which is inherently hard[17], whereas in the case of animals which are the source of such a meat it is irrelevant [18]. The results of both tests show the high efficiency of such a feeding system and encourage further scientific research in this field [19].

Aim of the work:

The aim of the research was an analysis of nutrition impact of Kazakh White Head race heifers and bulls, which ensured achieving optimal growth and development indicators of young breeding cattle in the period from birth to 450 days of life and an assessment of health status basing on chosen biochemical blood parameters.

MATERIAL AND METHODS

The research was conducted on the farm “Dinara’s Ranch” near Almaty, Kazakhstan. The material consisted of a beef Kazakh White Head race cattle herd. The first stage of the study was to present the specifics of nutrition of cows and bulls born in the early spring and staying with their mothers in the pasture up to the age of 7 – 8 months old. The second stage involved the following months of life in two periods, i.e. from 240 to 360 days and from 361 to 450 days of life, specifying the 2 feeding periods – summer and winter. The types of feed were specified. Feed doses in subsequent months of heifers and bulls lives were also specified taking gender into account. Nutrition was based mainly on roughage produced on grasslands, i.e. green forage or silage from grass or corn silage, hay and concentrated feed addition. The total consumption of each feed used in nutritional doses for heifers and bulls feeding, from birth to 15 months of their lives were also presented. Indicators of growth and development of farm animals have become daily increases in body weight at certain ages.

During alcove feeding the basic ad libitum feed was corn silage supplemented with hay in an amount of 2.5 – 6 kg (heifers) and 3 – 7.5 kg (bulls). The addition of roughage is as follows: 1.5 – 2.5 kg (heifers) and 2.5 kg bulls. Daily doses of silage were increased in 30-day intervals, not to exceed 10% of unused feed per dose.

Young cattle nutrition in the specified periods of breeding falling in the summer proceeded as follows: heifers of age 240-360 days consumed 20kg of fodder and 1kg of concentrated feed supplemented with microelements, whereas bulls during this period consumed 20kg of fodder and 3kg of concentrated feed. In the next period (361-450 days) there was an increase to 22kg in forage intake by heifers (concentrated feed remained the same, while bulls consumed 23kg of fodder and 4kg of concentrated feed during this period).

From 450 days old (± 10 days) randomly selected bulls blood was collected from the jugular vein to determine blood biochemical parameters. Blood samples were collected to heparinized tubes and allowed to coagulate. After two hours the blood was centrifuged for 10 minutes at 3000rpm (centrifuge MPW 223e) and the resulting serum was collected by pipette and stored in Eppendorf tubes at -18° C until determination. Total protein (TP) [g/dl] level was determined in blood serum. The content was determined using the colorimetric micro method (Sigma Diagnostic Kits)[20]. Further indications of blood serum were performed on a Mindray BS-120 photometer. These included the following biochemical indicators: serum alanine aminotransferase (ALT) [U/l], alkaline phosphatase (ALP) [U/l] and urea concentration (UREA) [mg/dl].

To interpret the results of blood biochemical parameters the reference levels adopted in developed standards for cattle were used. These standards were as follows: ALT – 25 – 74 U/l, AST – 58-100 U/l, ALP – 41-116 U/l, UREA – 10-45 mg/dl and protein level – 51-71g [21-23]. The content of some macro elements, i.e. calcium (Ca), natrium (Na), potassium (K), magnesium (Mg) and phosphorus (P) was also determined in the collected blood.

Achieved results were analyzed statistically using one-way analysis of variance in the orthogonal system. The mean (x) and standard deviation (Sd) were determined. The significance of differences was verified using Fisher LSD test (40). The results were analyzed statistically using Statistica ver. 9.0 [24].

RESULTS AND DISCUSSION

Three groups of factors decide of the economic results of beef cattle breeding and production of beef: correct breeding (64-65%), an adequate system of breeding and production technology (approx. 32%) and the right choice of race (3-4%). Therefore, the choice of feeding system, grazing and winter maintenance of the basic herd technology, calf rearing method, type of rooms, care of animals etc. is one of the most important elements influencing the profitability[25].

The decisive impact on the achieved rearing results have not only the race, type of utility, cattle sex, age, conditions of living but most of all nutrition. Nutrition is one of the most important factors of production, constituting a major component of production cost of animals for slaughter. The basic feature of modern cattle feeding methods is to achieve a high rate of daily weight growth, hence the tendency to intensify the nutrition. While the increased intensity of the fattening is possible in almost all circumstances of production, which involves the use of large quantities of concentrated feed in rations, in breeding herds such feeding is not recommended.

Nutrition is a major cost factor. It is therefore reasonable to seek the possibility of its reduction. Grasslands are by far the cheapest source of feed, because the production cost of one food unit on pastures is 3 times lower in comparison to the cereals production [19].Weglarz's (2010) research on the impact of fattened cattle category on beef quality indicate the impact of season of slaughter (winter or summer)[26]. In another experiment, bulls of 3 races were fattened: Limousine, Hereford, Simmental. They were fed with unified rations, composed of corn silage and meadow grass with an addition of hay (1kg/day) and concentrated feed (1% of body weight/day). In the experiment weight was determined, the chemical composition of feed, fatty acid profile of the feed as well as slaughter efficiency and chemical composition of beef. In terms of fattening and slaughter value Herefords resolved only Limousine and Simmental [27].

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Table 1: Nutrition scheme of calves to the age of 240 days – numbers are approximate, regardless of gender

Calves age (days)	Body weight [kg]	Feed consumption [pcs/day]						
		Milk [l]	Hay [kg]	Silage [kg]	Green forage [kg]	Concentrated feed [kg]	Salt [g]	Feed Phosphate [g]
5-30	50	5.3	*ad libitum*	-	-	*ad libitum*	-	-
31-60	80	5.3	0.1	-	-	0.4	8	10
61-90	100	6.5	0.3	1.0	-	0.4	12	15
91-120	130	6.5	0.6	-	3.3	0.5	16	20
121-150	150	5.5	-	-	6.0	0.5	18	25
151-180	170	5.5	-	-	12.0	1.0	20	30
181-210	200	3.5	-	-	14.0	1.0	25	35
211-240	220	3.5	2.0	7.0	-	2.3	30	40
Summarically [kg]		1250	120	240	1060	250	3,90	5,25

A determinant of the nutrition intensity are fodder resources of the farm and feeding systems applied by the manufacturer. However, the basis of good results in the breeding herd is an appropriate rearing of calves. Veal period is a time of the most intense changes taking place in the body[28].

Table 1 shows the scheme of feeding of calves in next months of their lives – from birth to 240 days. The basis for calves feeding was milk, but the dose was supplemented with concentrated feed and hay (or green forage in the summer time). The administered doses guaranteed daily increments required to obtain body weight of calves indicated in Table 1. These results are comparable with those obtained in other studies[29]. The level of nutrition in the first period of life of animals significantly affects the growth of muscle tissue. Proper nutrition in subsequent periods of life ensures achievement of daily weight gains [1,2,8].

Table 2: Nutrition scheme of young breeding cattle at the age of 240-450 days (spring births)

Age	Gender	Body weight	Feed consumption [pcs/day]				
			Hay [kg]	Silage [kg]	Concentrated feed [kg]	Salt [g]	Feed phosphate [g]
240-270	heifers	193	2.5	7	1.5	0.03	0.03
	bulls	220	3	10	2.5	0.04	0.04
271-300	heifers	223	2.8	9	1.5	0.03	0.03
	bulls	245	4	10	2.5	0.04	0.04
301-330	heifers	250	3.5	10	1.5	0.03	0.03
	bulls	270	5	11	2.5	0.04	0.04
331-360	heifers	275	4	12	2.0	0.04	0.03
	bulls	305	5.5	13	2.5	0.05	0.04
361-390	heifers	297	5	11	2.5	0.04	0.03
	bulls	335	6	13	2.5	0.05	0.05
391-420	heifers	323	5.5	10	2.5	0.04	0.03
	bulls	365	6.5	11	2.5	0.05	0.05
421-450	heifers	350	6	10	2.5	0.04	0.03
	bulls	400	7.5	11	3.0	0.05	0.05

The data in Table 2 inform about the average daily quantity and types of feed absorbed by the heifers and bulls in the subsequent months of their lives. In the period of alcove feeding the food rations included: hay, corn silage and concentrated feed supplemented with mineral additives. The amount of taken feed and achieved body weight affected the dry weight indicator in dose per 1kg of animal growth, from birth to age of 450 days (Table 2). One of the factors affecting the size of consumption of various types of feed was the sex of animals. Generally, the nutritional needs of young bulls outweigh the needs of heifers. Therefore, in the period

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from 240 to 360 days of age hay consumption in a heifer dose ranged from 2.5kg to 4kg, while bulls consumed it in amount of 3 to 5.5kg. The increase in silage consumption by heifers was as follows: from 7kg at the age of 240-270 days to 12kg at the age of 331-360 days. Bulls of the same age ate respectively 10kg and 13kg. The dose was supplemented with the concentrated feed in the amount from 1.5 kg to 2 kg for heifers and 2.5kg for bulls. The feed consumption by animals of both sexes increased significantly after 360 days of life. In the last month of analysis (421-450 days) heifers ate 6kg of hay, 10 kg of silage and 2.5kg of concentrated feed, while the dose for bulls contained 7.5kg of hay, 11kg of silage and 3kg of concentrated feed.

Table 3: Feed consumption by the young breeding cattle in the alcove feeding [kg]

Feed	Age [days]			
	240-360		361-450	
	Heifers	bulls	Heifers	bulls
Straw/hay	384	525	495	600
Corn silage	1140	1320	930	1050
Concentrated feed	195	300	225	240
Salt	3.9	5.1	3.6	4.5
Feed phosphate	3.6	4.8	2.7	4.5
Dry weight use in dose	5.3	6.5	7.1	8.7

Global consumption of feed for heifers and bulls in the specified periods of alcove feeding was given in Table 3. It shows the diversity resulting from the size of the rations set for animals of different sexes. Daily consumption of dry matter per dose (Table 3) confirms an increased feed absorption of bulls compared to heifers. Continuous improvements of animal breeds, as well as innovative practice of their rearing, as well as modifications to the composition of the feed largely contribute to changes in nutrient concentrations[30,31].Łozicki*et al.* (2010) conducted a study on Hereford race bulls fattening from 250kg of weight to about 550kg, feeding them with corn silage, hay and concentrated feed, supplemented with a vitamin-mineral mixture [31]. An average daily dry matter intake by bulls amounted from 7.92 to 8.15kg. Increases exceeded 1300g/day.

Table 4: Summer type feeding system of the young breeding cattle

Age	Sex	Green forage [kg]	Concentrated feed	Salt [kg]	Feed phosphate [g]
240-360	heifers	20	1	0.03	0.03
	bulls	20	3	0.04	0.03
361-450	heifers	22	1	0.05	0.04
	bulls	23	4	0.05	0.05

Table 5: Body weight and daily gains of the young breeding cattle

Feature	Age [days]	Numbers	
		heifers	bulls
Body weight [kg]	birth	27± 1.4	30.0 ± 1.6
	240	193± 5.1	221 ± 6.3
	360	275± 7.2	305 ± 9.3
	450	350± 10.3	400 ± 12.9
Daily gains [g]	birth –240	692± 4.3	796 ± 5.4
	240–360	683± 5.8	0.700 ± 4.7
	360 – 450	833± 4.4	1055 ± 7.2
	birth – 450	718± 3.2	0.822± 5.9

The situation is different in feeding of heifers and bulls during the summer – with the use of green forage (Table 4). Regardless of gender, the intake of silage was 20-23kg, but heifers were additionally fed only

with 1kg of concentrated feed, while the bulls received it in an amount of 3kg at the of 360 days and 4kg above that age. In Wajda *et al.* (2006) studies in the fattening of bulls from 260kg the ad libitum hay feeding was used as well as cereal grits in an amount of 3,5kg – to body weight of approximately 350kg, 4kg – from the weight of 430kg (+ mineral additives), achieving increases in the control fattening (lasting 270 days) exceeding 0,9kg [32].

The fattening system and level of nutrition of cattle has a major impact on the growth rate of animals[33]. The course of growth and development of animals is best characterized by body weight and achieved daily gains (Table 5). The average weight of heifers at birth was 27 ± 1,4kg and bulls 30 ± 1,6kg. These are sizes differing significantly from the body weight of calves of specialized meat breeds. Hereford at birth – 33-36kg, Angus – 26-30kg, Limousine – 35-40kg [34].The feeding system used in the experience influenced the achieved body weight and daily mass gains in specified periods of life. At the age of 360 days bulls reached the weight exceeding 300kg with increases from the age of 240 days amounting to 700g/day. Heifers in the same age weighed 275kg, which was a consequence of the daily gains at 683g. Another life period is significant, because daily gain of heifers exceeding 830g, allows for 350kg body weight achievement at the age of 450 days. Daily growth of bulls after 360 days of age exceeded 1050g. The resulted in body weight of bulls at the age of 450 days. These results are comparable with those of hybrids fed in a semi-intensive system[7,35].

To evaluate the metabolic profile of the tested animals following indicators were selected: the level of liver enzymes (ALT and AST), urea (UREA), alkaline phosphatase (ALP). Alanine aminotransferase (ALT) (EC 2.6.1.2) and aspartate aminotransferase (AST) (EC 2.6.1.1) are enzymes carrying the amino groups of the amino acids to α-keto acids. Their increased levels can indicate muscle damage or malfunction of the liver[36-38]. Winnicka (2008) gives the reference range for ALT amounting to 25-74 U/l and AST - 58-100 U/l [21].

Own study has shown that both the level of ALT as well as AST (Tab. 6) in the serum of bulls is in a range of reference values for the cattle presented by Winnicka (2008) [21]. It can therefore be assumed that the tested animals were characterized by normal activity of these enzymes. Their activity increased significantly could indicate potential metabolic problems.

Alkaline phosphatase (ALP) (EC 3131) Is an enzyme responsible for the release of the phosphorous from esters. It occurs in almost all tissues of the body. In mature animals ALP is produced in the liver, whereas in the maturing - mainly in the bones. Its high level of activity is associated with the rapid increase of bones[36,37]. When examining the content of alkaline phosphatase in the serum of bulls (Tab. 6) it was shown to be within a reference standard [21].Urea (UREA) is a water-soluble compound, formed in the liver during the ornithine cycle, as a derivative of an aminoacid changes. Its level indicates the state of protein transitions in the body. Increased concentration is characteristic to dehydration, disease conditions, or excessive protein intake in the diet, while the reduced level occurs in the event of a liver malfunction [38].

The data reported in Table 6 shows the level of urea in serum of bulls was correct and ranged within reference standards provided Winnicka (2008) [21]. Larger supply of proteins in the feed results in more intensive biodegradation carried out in prestomachs by bacteria. The amount of ammonia increases, which in turn is converted to urea [39, 40].

The level of total protein in serum of bulls and its fluctuations especially can be an indicator of proper nutrition or appearance of inflammations. This is an important element in the diagnosis of the state of hydration [41, 42, 40].In table 6 the level of TPin the serum of bulls amounts to75.63g/l. In the study Ježek*et al*. (2006), carried on the bulls above the ageof84 days, the level of total protein was lover and amounted to 56,71 g/l[41]. In other authors the level of total protein amounted to: Knowles *et al.*(2000) - 62 g/l, Nowak *et al.*(2005) - 50,5 g/l, Mohri*et al.*(2007) - 63 g/l [39, 40, 43].

In Łozicki(2010) research from Hereford breeding bulls of 450 kg body weight was collected and selected biochemical indicators were determined in serum - glucose, total protein, albumin and urea gaining values: 51.5 mg/dl, 6.53 g/dl, 2.66 g/dl and 4 mg/dl [31].

Calcium, together with Phosphate and Magnesium ensure normal mineralization of bones and teeth [44,45]. Calcium is also responsible for regulation of nervous and muscular system, it is involved in blood clotting. It acts as an activator of certain enzymes such as lipase, ATP-ase[46]. Phosphorus also plays an important role in numerous metabolic processes, playing a key role in receiving and transporting energy,

phosphorylation processes and important in metabolism of glucose, fructose and proteins [47]. Natrium and Potassium are essential for regulation of the osmotic pressure and normal muscle work. Magnesium is involved in many metabolic processes, it is present in the nucleus, which function it supports. The most important function of magnesium in the body is involvement in the synthesis and breakdown of high energy compounds, mainly adenosine triphosphate (ATP).

Magnesium is a coenzyme or activator of many enzymes, especially those related to the transfer of phosphate groups. It is involved in many metabolic pathways associated with the metabolism of proteins, nucleic acids, lipids and carbohydrates, and in the processes of electrolytes transport across cell membranes. It is a factor in living cells regeneration and calcium balance control. In addition, it has a positive effect on blood clotting, regulates the development of the skeletal system, increases the defensive reactions of the body, acts preventively to inflammation of the veins in post-operative situations, strengthens the cardiovascular system. It works as an anti-stress factor, anti-anafilakt factor and anti-inflammatory. Lowers cholesterol level, protects against myocardial damage [48]. Magnesium and potassium play a regulatory role in the control of blood pressure, reducing the risk of cardiovascular disease.

CONCLUSION

To sum up, we can say that the level of nutrition in the first period of life of the animals influenced the growth and development of young breeding cattle significantly. 1250 liters of milk, besides solid feed is recommended for calves from birth to the age of 240 days. Applied nutrition in subsequent life periods, based on hay, silage, concentrated feed and mineral additives ensured that the assumed daily body weight increases were real. The average daily dry weight absorption by the heifers was from 5.3 to 7.1kg, whereas bulls absorbed from 6.5 to 8.7kg. Daily increases of heifers at the age of 361-450 days were 833g, whereas bulls - 1055 g/day. Metabolic profile parameters of bulls (hepatic enzymes – AST and ALT, urea, protein, alkaline phosphatase – ALP, as well as Ca, Na, K, Mg and P content) were in the range of the reference standards, which testified a good health status of animals.

Table 6: Biochemical blood parameters of bulls

Biochemical parameters	Bulls in the age of 450 days
Quantity [pcs]	15
AST [U/l]	75.54 ± 2.93
ALT [U/l]	25.80 ± 3.43
Ca [mg/dl]	2.20 ± 0.20
UREA [mg/dl]	5.87 ± 3.43
ALP [U/l]	102.63 ± 13.93
Na [mg/l]	160.40 ± 16.10
K [mg/l]	3.60 ± 1.20
Mg [mg/l]	1.00 ± 0.43
P [mg/l]	2.07 ± 0.17
Protein [g/dl]	75.63 ± 1.83

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