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ORIGINAL PAPER

Analysis of nutritional value in feed mixtures and premixes produced by selected feed manufacturers in southeastern Kazakhstan for dairy farms*

Tulegen Kobzhassarov[1], Jan Miciński[2], Dastabbek Baimukanov[3], Anuarbek Bissembayev[3], Iwona Chwastowska-Siwiecka[2], Alicja Sobczak[2], Anuarbek Seitmuranov[3]

[1] Department of Food Security and Biotechnology
Akhmet Baitursynuly Kostanay Regional University, Kostanay, Kazakhstan
[2] Department of Sheep and Goat Breeding
University of Warmia and Mazury in Olsztyn, Poland
[3] Department of Animal Husbandry
Scientific and Production Center for Animal Husbandry and Veterinary LLP, National Academy of Sciences, Astana, Kazkhstan

Abstract

The aim of this study was to analyze the nutritional value of feed mixtures and premixes produced by selected feed manufacturers in southeastern Kazakhstan for dairy farms. The feed mixtures produced in the analyzed feed mills differed significantly ($p \leq 0.01$ and $p \leq 0.05$) in terms of their basic nutrient content. The amino acid, mineral, and vitamin composition of the feed mixtures was neither monitored nor balanced, except in the Good-Zhem feed mill, as the facilities did not produce mineral-vitamin premixes. For research purposes, the Kormovik and Vet Effect feed mills developed premixes for lactating cows, dry cows, and young cattle aged 6-12 months. The premixes contained high levels of minerals, including Ca, P, Mg, Na, Cl, Cu, Zn, Mn, Co, Se, and I, as well as vitamins A, D, and E. For high-yielding cows from the OST group and for cows in the first dry period (period I), an antioxidant was added at levels of 177 mg kg^{-1} and 95 mg kg^{-1}, respectively. Additionally, for low-yielding cows and cows in the second dry period (period II), supplementary vitamins were included: K, B_1, B_2, B_4, B_5, B_6, B_9, B_{12}, and PP. The experimental premixes used in cattle feeding on the JSC AIC Adal farm allowed the maintenance of milk yield in cows, kept there at the level of 8 000 kg of milk. The research shows that including a premix in cattle feed rations helps to balance ratios in terms of their nutritional value and content of minerals and vitamins, which ultimately enables better use of the animals' genetic potential.

Keywords: dairy cattle breeding, cows, productivity, diet, mixed feed, nutritional value, premixes

Jan Miciński, Prof. PhD DSc, Eng., Department of Sheep and Goat Breeding, Faculty of Animal Bioengineering, University of Warmia and Mazury in Olsztyn, Oczapowskiego, 5/145, 10-719 Olsztyn, Poland, e-mail: micinsk@uwm.edu.pl
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INTRODUCTION

The Republic of Kazakhstan is a country located in Central Asia. The population is estimated at 20.2 million people in 2025. The country's total area is 2.724.902 km², making it the 9th largest in the world by area and 62nd by population. The southern part of Kazakhstan includes five regions: Almaty, Zhambyl, Zhetysu, Kyzylorda, and Turkistan. The eastern part includes the Abay and East Kazakhstan regions. The total area of southeastern Kazakhstan is 993.626 km², which accounts for 36.46% of the country's territory, including: Almaty (105.263 km²), Zhambyl (144.264 km²), Zhetysu (118.500 km²), Kyzylorda (226.019 km²), Turkistan (116.280 km²), Abay (185.500 km²) and East Kazakhstan (97.800 km²) (WC 2025).

The cattle population in Kazakhstan exceeds 8 million, with half located in southeastern Kazakhstan. The beef cattle population is approximately 750.000. The meat breeds include: Aulie-Kolskaya (65.262), Charolaise (1.007), Limousin (365), Aubrack (145), Kazakh Whiteheaded (477.431), Aberdeen-Angus (81.524), Hereford (77.015) and Kalmyk (44.991). The largest concentration is in western Kazakhstan (142.901), followed by the Abay Region (110.216) and the Aktobe Region (74.294). The populations of other species is as follows: sheep (approx. 18 million); horses (2 million); camels (200.000) and donkeys (30.000) (BNSK 2025).

In the Republic of Kazakhstan, dairy cattle breeding is one of the main production sectors that contribute to solving the problem of food security and improving the living conditions of the population (Abugaliyev et al. 2019). In farms of the southern region, the grazing period is 10-11 months, and the preparation of roughage takes place for 1-2 months, while in farms of the eastern region, the grazing period lasts 6 months, from mid-April to mid--October. Further development of dairy cattle breeding requires the feeding of biologically complete diets to animals at different stages of growth. However, this can be challenging because actual diets are often inadequately balanced in terms of protein, sugars, minerals, and vitamins due to deficiencies of these nutrients in feeds (Chindaliyev et al. 2019). As a result, the rate and direction of metabolism are disturbed, the disease resistance, reproductive performance, and productivity of animals decrease, the quality of the resulting products deteriorates, and the productive lifespan of cows, regardless of breed, is shortened (Chindaliyev et al. 2021). Dietary protein and carbohydrate deficiencies are among the most important factors limiting cow growth and productivity. Due to intensive milk synthesis, the need for sugars increases in highly productive cows. Adequate levels and quality of these compounds are usually maintained with the use of molasses, cakes, and meals (Kalmagambetov et al. 2021). Balanced feeding plays a key role in animal production. More than 60% of animals' productive performance is determined by feeding, and feed costs account for 70% of total costs in milk production (Baimukanov et al. 2021, Baimukanov et al. 2024).

The level and completeness of feeding depend on feed quality, including diet optimization, feeding timing and methods, advanced procurement techniques, as well as feed preparation technology (Sammad et al. 2020, Semenov et al. 2020). Diets for dairy cows are balanced on the basis of at least 25 nutritional indicators (energy feed units, dry matter, digestible and crude protein, water-soluble and salt-soluble protein fractions, lysine, methionine, tryptophan, fat, sugar, fiber, crude ash, calcium, phosphorus, magnesium, sulfur, potassium, sodium, copper, zinc, manganese, cobalt, iron, iodine, carotene, vitamin D, vitamin E, etc.). Diets balanced according to 25-30 nutritional indicators with the use of premixes and protein-vitamin-mineral supplements stimulate the enzymatic activity (cellulolytic, proteolytic, amylolytic, lipolytic) of ruminal microorganisms, and increase the digestibility of structural and non-structural carbohydrates, proteins, and fats (Hennessy et al. 2020).

Animal productivity can be significantly increased by efficient use of feed and application of scientifically based feeding methods (Vostroilova et al. 2023). The most beneficial component of dairy cows' diet is bulk (forage) feed, which plays a key role in promoting the development of cellulolytic bacteria in the rumen. However, it is becoming increasingly common, especially in high-yielding cows, to include higher amounts of concentrate mixtures and various protein-mineral-vitamin supplements in the form of premixes. High milk productivity increases the animals' metabolic rate, intensifies physiological processes, and exposes cows to a range of metabolic diseases resulting from improper feeding. Therefore, feed rations must be precisely balanced in terms of nutrient content, considering the cow's productivity, stage of lactation, physiological status, body weight, age, etc. (Yumaguzin et al. 2023). This requires continuous analysis and monitoring of nutrient content in both basic forages and concentrate mixtures, as well as premixes (Vostroilova et al. 2023).

The aim of this study was to make an analysis of the bioactive compound content in feed mixtures and premixes produced in Southeastern Kazakhstan by selected feed manufactures for dairy farms.

MATERIALS AND METHODS

In the southeastern part of Kazakhstan, 13 feed plants produce animal feed. All these enterprises have their own laboratories, where tests of feed and raw materials are carried out to determine the optimal feeding rates for farm animals, poultry and fish, and to develop recipes for premixes and protein-vitamin-mineral supplements. The laboratories are equipped with the most modern, proven and certified equipment from leading world manufacturers, which ensures the completeness and correctness of the tests, objectivity and reliability of the results. Sample tests are carried out in accordance with the rules and procedures of the state technical regulation system of the Republic of Kazakhstan. The study included 5 feed producers: JSC Asia AgroFood, Azyl-Zhem, Kormovik, VetEffect and Good-Zhem, and three farms: JSC AIC Adal, Beybit (Almaty region) and Balke (East Kazakhstan region).

The staple feeds on the analyzed farms consisted of the following: Beybit farm – alfalfa hay, maize silage, wheat bran, and barley grain; Balke farm – meadow hay, barley grain, and sunflower cake; JSC AIC Adal farm – alfalfa hay, alfalfa haylage, maize silage, barley grain, maize grain, triticale, soybeans, and sunflower cake. Feed samples were collected on the farms to determine their chemical composition. An analysis of the milk yield of cows during lactation showed that the average productivity per cow was 3.500 kg (Balke), 3.852 kg (Beybit), and 8.000 kg (JSC AIC Adal). The body weight of cows ranged from 500 kg to 600 kg. Rations were formulated considering the nutritional value of available feeds, the actual milk productivity, and the live weight of the animals. Feed ingredients and premixes from the feed mills included in the study were incorporated into the diets to ensure adequate levels of nutrients and bioactive compounds.

These enterprises also carry out control of raw materials and feed materials, control during the production process at all stages of production, and control of finished products. In the study, the following were analyzed:

– the composition of feed mixtures produced in the analyzed feed mills, differentiated for cows with different productivity levels, young cattle, and fattening animals;
– nutrient composition of concentrate mixtures for dairy cows;
– chemical composition of premixes produced by the Kormovik and Vet Effect feed mills for lactating cows with different milk yields and for dry cows;
– nutrient content in the diets of dairy cattle on three analyzed farms using feed mixtures from selected feed manufacturers;
– nutrient content in the dairy cattle diets on the JSC AIC Adal farm using compound feeds from the Asyl-Zhem, Vet Effect, and Good-Zhem feed plants;
– chemical composition of the premix used at the JSC AIC Adal farm for lactating cows, dry cows, and young cattle.

The recipes and quality indicators of mixed feeds and premixes for different age-sex groups of cattle produced by five feed companies were analyzed. The composition and nutritional value of feeds were determined using the FOSS NIRS DS2500 analyzer (Denmark) series No. 91714226 (2011) and the FOSS InfraXact FIAstar 5000, KJELTEC (2012) (Denmark).

The significance of differences was calculated between the farms that were included in the research and which used mixtures and premixes purchased from the feed plants covered by the research in their feeding regimes.

The results were statistically processed using Statistica v. 13 (StatSoft 2018). Least squares mean (LSM) and standard of deviation (Sd) were calculated. The significance of differences was calculated using the Tukey test.

RESULTS

Table 1 presents the composition of feed mixtures produced by the analyzed feed mills, differentiated for: cows with varying milk productivity levels (OST), i.e., over 6.000 kg of milk per lactation, and (UST), i.e., below 6.000 kg per lactation-fattening cattle (FAT), and young cattle aged 6-12 months (YC 6-12). The main ingredients of the feed mixtures included barley grain, wheat grain, maize grain, and wheat bran. The feed mixtures produced by the analyzed feed mills differed significantly in the content of these components, which fell within the following ranges: barley – from 17% to 29%, wheat – from 19% to 25%, rapeseed meal – 20%, wheat bran – from 12% to 22%, maize – from 25% to 29%, sunflower cake – from 8% to 25%, oats – from 5% to 15%, full-fat soybeans – from 15% to 33%, and feed yeast (from 5% to 10%), which was mainly used as a protein source. In some feed mills, safflower meal (Asyl Zhem), sunflower meal, and soybean meal (Good-Zhem) were also used. Peas were additionally fed, but only to cows in the UST group. As sources of macronutrients, monosodium phosphate, monocalcium phosphate, defluorinated phosphate, and limestone flour (in amounts ranging from 0.5% to 5%) were incorporated into the feed mixtures.

The amino acid composition of the feed mixtures was neither monitored nor balanced, except at the Good-Zhem feed mill, where amino acid additives such as DL-methionine 98.5%, L-lysine hydrochloride, and threonine were used. Sugar supplementation in the form of molasses was applied only at the Kormovik and Asyl Zhem feed mills, and exclusively for cows in the OST group, i.e., high-yielding cows (Table 1).

Table 2 presents the qualitative composition of concentrate mixtures for dairy cattle. The table shows statistically significant differences ($p \leq 0.05$) in the composition of feed mixtures produced by the analyzed feed mills. This is particularly evident in the case of dairy cows, where the Energy Feed Unit content for high-yielding cows (OST) was 0.99 MJ in the Kormovik company, while it was the highest in Asia A. Food, reaching 1.19 MJ for OST cows. Similar trends were observed for Metabolizable Energy (MJ). Statistically significant differences ($p \leq 0.05$) were also found in the mass fractions of protein, fiber, fat, and ash, as well as in calcium and phosphorus content. A notable disadvantage of the analyzed feed mills is the absence of ingredients typically found in premixes, as these companies, except for Good-Zhem, do not produce mineral-vitamin premixes.

Therefore, premix production was initiated at the Kormovik and Vet

Table 1

The composition of feed mixtures produced in the analyzed feed mills, differentiated for cows with different productivity levels, young cattle, and fattening animals (% by weight^{-1})

Components	Asia A. Food		Asyl-Zhem			Kormowik		Good Zhem		Vet. effect
	OST	UST	OST	UST	FAT	OST	UST	OST	FAT	YC 6-12
Barley	20	17	20	29	25	27	19	28	28	25
Wheat		19		25			20	25	16	20
Rapeseed meal	20									
Wheat bran	12	22	15		22	18	19	22	25	18
Maize	27	25		29						10
Sunflower cake		10	13	8	10	25	12			15
Oats						15	15			5
Full-fat soybeans 33%	15									
Peas		5		7			12			
Salt	1	1	1	1	1	1	1	1	1	1
Corn cobs			20		28					
Fodder yeasts	5		10			5				
Rice flour			5		5					
DL-methionine 98.5%									2	
L-lysine hydrochloride									1	
Threonine									1	
Limestone flour			5			1		1	1	
Monosodium phosphate		1		1	1					
Monocalcium phosphate				0,5						
Defluorinated phosphate							2			1
Molasses			1			7				
Safflower meal			10		8			10	7	
Sunflower meal						1		12	13	
Soybean meal									5	5
MIAVIT premix cattle								1	1	
Total	100									

OST – over six thousand kg milk yield, UST – up to six thousand kg milk yield, YC6-12 MO – young cattle 6-12 months old, FAT – fattening

Effect feed mills, and the resulting premixes were applied on the JSC AIC Adal farm. Table 3 presents the chemical composition of premixes produced by the Kormovik and Vet Effect feed mills for lactating cows with different milk yields and for dry cows. The data in the table show that the premixes contained high levels of minerals, including calcium, phosphorus, magnesium, sodium, chloride, copper, zinc, manganese, cobalt, selenium, and iodine, as well as vitamins A, D, and E. For high-yielding cows (OST) and cows in the first dry period (period I), antioxidants were also added at levels

Table 2

Nutrient composition of concentrate mixtures for dairy cows

Composition	Asia A. Food		Asyl-Zhem			Kormovik		Good-Zhem		Vet. effect
	OST	UST	OST	UST	FAT	OST	UST	OST	FAT	YC6-12
Energy feed unit (MJ)	1.19^a	1.06	1.11	1.18^a	1.11	0.99^b	1.00^b	1.03^b	1.08	1.05^b
Metab. energy (MJ)	11.83^a	11.06	11.04	11.80^a	11.13	9.99^b	10.24^b	10.36^b	10.64	10.48^b
Dry matter (g)	875	878	829	886	871	871	858	830	832	825
Mass fract. prot. (g)	221^a	149^b	178	140^b	160	210^a	161	141^b	163	131^b
Mass fract. of fiber (g)	66.41	62.29	53.52^a	49.32^a	113.23^b	69.23	73.69	95.96^b	103.31^b	86.77
Mass fract. of fat (g)	41.37^a	35.87	38.77	37.81	40.49	36.84	30.84^b			
Mass fract. of ash (g)		22.02^a	47.52^b	24.43^a	49.05^b					
Lysine (g)									9.01	4.3
Methion. + cysteine (g)									7.15	5.30
Tryptophan (g)									7.32	
Calcium (g)	2.93^a	2.13^a	13.64^b	2.27^a	4.14	6.28^c	6.66^c	8.41^d	6.03^c	9.16
Phosphorus (g)	6.48^a	8.84^b	6.91^a	8.19^b	7.26	8.39^b	10.23^c	6.72	6.96	7.48

OST – over six thousand kg milk yield, UST – up to six thousand kg milk yield, YC6-12 MO – young cattle 6-12 months old, FAT – fattening, significance of differences marked in rows: *A*,*B*,*C* – at $p \leq 0.01$, *a*,*b*,*c* – at $p \leq 0.05$

of 177 mg kg^{-1} and 95 mg kg^{-1}, respectively. In addition, for low-yielding cows and cows in the second dry period (period II), supplementary vitamins were included: K, B_1, B_2, B_4, B_5, B_6, B_9, B_{12}, and PP.

In the feed rations for high-yielding dairy cows (OST group), lower-yielding cows (UST group), and young cattle aged 6-12 months (YC6-12 group), statistically significant differences at the levels of $p \leq 0.01$ and $p \leq 0.05$ were observed in the following components: replicable, bypass, and digestible protein; lysine; methionine + cysteine; tryptophan; crude fat and fiber; starch; calcium; phosphorus; magnesium; potassium; sulfur; iron; copper; zinc; manganese; cobalt; iodine; carotene; and vitamins D and E. The highest values of these components were found in the rations prepared for the highest-yielding cows (OST group). In the feed rations for young cattle (YC6-12 group) raised at JSC AIC Adal, the inclusion of concentrates and premixes ensured a nutrient balance that was slightly lower than that for cows producing under 6.000 kg of milk (UST group) – Table 4.

Nutrient deficiencies in the diets of high-yielding cows (group OST) ranged from 23% to 40% when only concentrate mixtures were used, and decreased to 7.7%-15% when mixtures with premix were included. In the diets of young animals, these values were 56%-66% and 20%-25%, respectively. A significant deficiency in sugar was still observed, as there were practically no complementary supplements available. Balancing the diet in terms of bioactive compounds, i.e., lysine, methionine + cysteine, tryptophan, copper, zinc, manganese, selenium, cobalt, iodine, carotene, vitamin D,

Table 3

Chemical composition of premixes produced by the Kormovik and Vet Effect feed mills for lactating cows with different milk yields and for dry cows

Specification	Units	Kormovik				Vet Eff.	
		Milk yield		Dry cows		Dairy cows	Dry cows
		OST	UST	Period I	Period II		
1	2	3	4	5	6	7	8
Calcium	(g kg^{-1})	180	110	13	45	180	25
Phosphorus	(g kg^{-1})	90	60	23	61	60	50
Magnesium	(g kg^{-1})	95	40	80	160	40	80
Sodium	(g kg^{-1})	158	89	100	120	90	100
Chloride	(g kg^{-1})	235	132	140	179	-	-
Copper	(mg kg^{-1})	1416	699	1506	1501	700	1500
Zinc	(mg kg^{-1})	9469	9015	7332	9012	9000	7300
Manganese	(mg kg^{-1})	4749	3011	7530	7509	3000	7500
Cobalt	(mg kg^{-1})	47	25	130	50	20	150
Selenium	(mg kg^{-1})	47	25	25	50	40	40
Iodine	(mg kg^{-1})	128	100	100	200	100	100
Vitamin A	(IU kg^{-1})	708 000	1 006 000	800 000	1 020 800	1 000 000	800 000
Vitamin D	(IU kg^{-1})	188 800	100 200	100 800	204 160	100 000	100 000
Vitamin E	(mg kg^{-1})	4720	1030	3000	5104	2000	3000
Vitamin K	(mg kg^{-1})	-	3	-	12	3	-
Vitamin B1	(mg kg^{-1})	-	23	-	75	24	-
Vitamin B2	(mg kg^{-1})	-	15	-	60	18	-
Vitamin B4	(mg kg^{-1})	-	-	23	-	-	-
Vitamin B5	(mg kg^{-1})	-	60	-	240	72	-
Vitamin B6	(mg kg^{-1})	-	12	-	40	12	-
Vitamin B9	(mg kg^{-1})	-	5	-	15	5	-
Vitamin B12	(mg kg^{-1})	-	90	-	250	-	-
Vitamin PP	(mg kg^{-1})	-	100	-	300	108	-
Antioxidant	(mg kg^{-1})	177	-	95	-	-	-
Feeding rate	g animal per day^{-1}	170	200	150	150	180	150

OST – over six thousand kg milk yield, UST – up to six thousand kg milk yield, period I – dry cows to 30 days, period II – dry cows from 31 to 52 days

and vitamin E, showed that their content, according to monitored indicators, was optimized and within the normal range.

Thus, feed and premix formulations based on the actual chemical composition of the feed, the actual productivity of the animals, the existing diet

Table 4

Nutrient content in the dose used at the JSC AIC Adal farm, including purchased concentrate mixes and mineral premix produced by Kormovik and Vet Effect (% of the norm)

Components	Stat. Meas.	JSC AIC Adal		
		Kormovik		Vet. Effect
		OST	UST	YC6-12
Energy feed unit (MJ^{-1})	LSM	100	99	99
	Sd	8.22	7.31	6.29
Metabolizable energy (MJ^{-1})	LSM	101	100	100
	Sd	11.26	10.31	9.34
Dry matter (kg^{-1})	LSM	106	91	96
	Sd	8.14	7.19	7.88
Crude protein (g^{-1})	LSM	114	94	84
	Sd	10.42	9.18	9.38
Rumen degradable (g^{-1})	LSM	121^{Aa}	106^{b}	71^{B}
	Sd	10,16	9.45	10.12
Bypass protein (g^{-1})	LSM	92^{A}	71^{A}	34^{B}
	Sd	10.28	9.11	10.25
Digestible protein (g^{-1})	LSM	125^{A}	93^{A}	48^{B}
	Sd	11.20	12.32	9.57
Lysine (g^{-1})	LSM	99^{a}	69^{b}	-
	Sd	7.22	7.13	-
Methionine+cysteine (g^{-1})	LSM	173^{A}	111^{B}	-
	Sd	12.39	9.15	
Tryptophan [g^{-1}]	LSM	102^{a}	59^{a}	-
	Sd	10.11	9.37	
Crude fat [g^{-1}]	LSM	165^{A}	129^{B}	47^{C}
	Sd	9.39	7.12	9.31
Crude fiber (g^{-1})	LSM	117^{Aa}	75^{Bb}	92^{Bc}
	Sd	9.21	8.11	8.96
Starch (g^{-1})	LSM	170^{Aa}	156^{B}	95^{Ab}
	Sd	10.51	9.75	10.33
Sugar (g^{-1})	LSM	53	33	29
	Sd	11.21	9.44	11.16
Calcium (g^{-1})	LSM	221^{A}	137^{B}	184^{C}
	Sd	9.01	8.34	5.08
Phosphorus (g^{-1})	LSM	121^{A}	118^{Ba}	101^{Bb}
	Sd	9.50	8.47	9.33

cont. Table 4

Components	Stat. Meas.	JSC AIC Adal		
		Kormovik		Vet. Effect
		OST	UST	YC6-12
Magnesium (g^{-1})	LSM	237^{A}	226^{A}	143^{B}
	Sd	13.23	11.38	10.55
Potassium (g^{-1})	LSM	168^{A}	139^{A}	82^{B}
	Sd	13.44	11.55	13.33
Sulfur (g^{-1})	LSM	285^{A}	149^{B}	50^{C}
	Sd	13.23	11.38	10.55
Iron (g^{-1})	LSM	384^{A}	271^{Ba}	233^{Bb}
	Sd	13.23	11.38	10.55
Copper (mg^{-1})	LSM	181^{A}	149^{B}	175^{C}
	Sd	10.22	9.34	8.27
Zinc (g^{-1})	LSM	248^{A}	143^{B}	120^{C}
	Sd	12.26	10.34	11.53
Manganese (g^{-1})	LSM	202^{A}	116^{A}	136^{B}
	Sd	11.01	10.44	9.27
Selenium (g^{-1})	LSM	4	2	3
	Sd	0.98	0.95	0.94
Cobalt (mg^{-1})	LSM	100	99	99
	Sd	8.22	7.31	6.29
Iodine (mg^{-1})	LSM	101	100	100
	Sd	11.26	10.31	9.34
Sodium (g^{-1})	LSM	106	91	96
	Sd	8.14	7.19	7.88
Carotene (mg^{-1})	LSM	114	94	84
	Sd	10.42	9.18	9.38
Vitamin D (IU^{-1})	LSM	121^{Aa}	106^{b}	71^{B}
	Sd	10,16	9.45	10.12
Vitamin E (mg^{-1})	LSM	92^{A}	71^{A}	34^{B}
	Sd	10.28	9.11	10.25

OST – over six thousand kg milk yield, UST – up to six thousand kg milk yield, YC6-12 MO – young cattle 6-12 months old. Significance of differences marked in rows: *A*,*B*,*C* – at $p \leq 0.01$, *a*,*b*,*c* – at $p \leq 0.05$

structure, and the specific deficiencies in nutrients and bioactive compounds, allow for the optimization of dairy cattle rations in terms of key nutritional and bioactive indicators.

DISCUSSION

The Association of Agricultural Producers of Kazakhstan reports that currently almost every large breeding enterprise in Kazakhstan uses Holstein-Friesian cows with high milk production (7-9 thousand kg of milk). Therefore, the nutritional needs of cows are increasing and feeds with a high concentration of nutrients are necessary, including micro- and macronutrients and vitamins. The demand for animal feed mixtures is about 3.5 million tons per year. Feed companies currently satisfy them by about 60%, which is why a significant part of high-quality feeds or components for their production is purchased from abroad (Erickson, Kalscheur 2020, Golovin et al. 2023).

The Ministry of Agriculture of Kazakhstan reports that in the long term, it is planned to build several feed plants that would meet all current quality standards and the needs of the domestic market. One such plant is the Zhumabayev region, which produces 140 tons of feed per day. There is still a shortage of feed mixtures on the market, mainly in the field of soy protein. In recent years, the country's annual soy production has not exceeded 150 000 metric tons, while the total demand of the feed industry is estimated at 600 000 tons (Van Saun 2024). A significant disadvantage of the mixed feeds analyzed in this study is the fact that they do not contain premixes, which significantly reduces their effectiveness in animal production. It is worth noting that in the years 1996-2008, Kazakhstan did not produce premixes, mineral-protein supplements or vitamin mineral premixes. Feed mills are now beginning to produce premixes as well. Currently, their production amounts to about 70 000 tons per year and is not yet completely sufficient (Vorotnikov 2025).

A major advantage in the discussed plants was the introduction of monosodium phosphate, monocalcium phosphate, defluorinated phosphate and limestone flour (from 0.5% to 5%) were introduced as sources of macronutrients in mixed feeds. The amino acid composition of mixed feeds was not monitored or balanced, except in the Good-Zhem feed mill, where amino acid supplements such as lysine, methionine, and tryptophan were used. Sugar supplementation was not provided in any of the feed mills except the Kormovik LLP plant (high-yielding cows only).

NRC (NRC 2021) states that the requirements of a 650 kg HF cow per day are: 13.8 kg dry matter, 32.7 MC – metabolizable energy, 13% crude protein, 64 g Ca and 32 g P. Further requirements are related to milk production. A cow producing 25 kg milk per day needs: 20.3 kg dry matter, 1.37 Energy NE Mcal kg^{-1}, 1.862 g metabolizable protein, 9.5% RDP – rumen degradable protein, 4.6% RUP – rumen undegradable protein, 25-33% min NDF – neutral detergent fiber I 36-44% max – NFC – non-fiber carbohydrate. A cow producing 54.4 kg of milk per day requires: 30 kg of dry matter, 1.61 NE, 3.476 g of MP, 9.8% RDP, 6.9% RUP, 25-33% min NDF and 36-44%

max NFC. In turn, the nutritional requirements of dry cows on the 240th day of pregnancy are as follows: 14.4 kg of dry matter, 0.97 NE Mcal kg^{-1}, 871 g of metabolizable protein, 33% NDF and 42% NFC (Safa et al. 2013, Chester-Jones et al. 2017, Ferreira et al. 2017, Goff 2017, McGuffey et al. 2017). In our research, we were unable to determine that the cows' nutritional requirements were at the levels specified by the cited authors.

The Ministry of Agriculture and various scientific organizations in Kazakhstan are taking steps to find alternative protein sources by selecting varieties of cereals, legumes and oilseeds for the needs of the feed industry. In addition, the self-sufficiency rate in microbiologically synthesized feed ingredients, including amino acids, probiotics and fermentation, is only 8-10%, and it should be noted that it is significantly increasing every year (Bas Agrarlyo Saity 2023, Bas Agrarlyo Saity 2024). In this study, it has been determined that the demand for crude protein and rumen degradable protein has been fully met. The bypass protein requirements were only met in the diets of low-yielding cows. The diets of high-yielding cows provided only 65.78%-87.06% of the bypass protein requirement. In the diets of young cattle, only 34% the of bypass protein requirement was met in during growth (Erickson, Kalscheur 2020). In the diets of young cattle raised at JSC-AIC-ADAL, the inclusion of mixed feeds and premixes ensured a higher level of nutrient balance.

Borean (2025) states that the Ca:P ratio in the blood of healthy cows should be 2.3:1, whereas in cows with milk fever it was 1:9. Normal blood calcium concentration is 9 to 10 mg 100 ml^{-1} (Nelson et al. 2016). Hibbs et al. (1950) suggested that vitamin D is related to milk fever because the incidence was higher in the winter months, when cows were kept indoors and less exposed to sunlight than in the summer, when cows had access to pasture. Vitamin D is partially degraded in the rumen, conjugated with bile salts in the duodenum and absorbed in the ileum of the small intestine (Littledike, Horst 1982, Sommerfeldt 2017). Vitamin E (α-tocopherol) supports neutrophils, basophils and macrophages, particularly during mammary gland inflammation and placental tissue shedding at calving (Hogan et al. 1993). Like many other nutrients, vitamin E decreases in the blood during the transition period (Goff, Stabel 1990). Many of the effects of vitamin E occur in conjunction with selenium (Osipenko et al. 2018).

According to Jesse et al. (Jesse et al. 1981), magnesium oxide is the most commonly used source of magnesium, and the particle size of MgO affects the rate of dissolution in the rumen. Schonewille et al. (2008) report that its solubility in rumen fluid ranges from 25 to 75% over a pH range of 5.5 to 6.5, and decreases rapidly as pH increases above 6.5. Absorption (% intake) averages about 26%, but ranges from 9.9 to 73.9%. Potassium reduces Mg absorption, so that in diets high in K, the concentration of Mg in the diet must be increased. Magnesium deficiency also increases calving paralysis (Schonewille 2013).

Since the diets for cows from group OST and UST contained sufficient amounts of phosphorus and copper (their deficiencies were within acceptable limits), they were not included in the premix. Cobalt content was nearly doubled, the content of zinc, manganese, and iodine was reduced 3 to 3.5 times, and vitamin D levels were reduced 1.2 times. A similar pattern was observed in the diets of dry

CONCLUSIONS

Due to the increasing number of Holstein-Friesian cows, it has become necessary to establish animal nutrition departments within Kazakhstani feed mills, whose task will be to develop balanced rations in terms of nutritional value, minerals, and vitamins. These departments would serve both large farms (agricultural enterprises) and individual (family) farms. Such a service should be provided free of charge to farms that purchase these companies' products in the form of feed mixtures, premixes, and concentrates. Ration formulation should be based on chemical analyses of feed mixtures and premixes, which should be conducted free of charge by feed mills or scientific institutions. The research shows that including premix in cattle feed rations allows them to be balanced in terms of nutritional value, minerals and vitamins, which ultimately allows for better use of the animals' genetic potential.

Author contributions

DBA, ABI – conceptualization, DBA, ABI – methodology, TKO, IC-S - formal analysis, data curation, TKO, DBA, ABI – writing – original draft preparation, JMI, ASE, ASO – writing – review and editing, JMI, IC-S, – supervision, JMI, TKO – funding acquisition. All authors have read and agreed to the published version of the manuscript.

Data availability statement

Data will be made available from the authors upon reasonable request.

Informed consent statement

This article does not involve experiments performed directly on animals. So, this experience does not need an ethics statement.

Instituitional review board statement

Not applicable.

Conflicts of interest

The authors declare no conflicts of interest.

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