©2022 International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA 8

International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

Influence of Age and Lactation Period on the Variability of Blood Biochemical Composition of Kazakh Whitehead Cows

M.A. Derkho[1*], B.K. Balabaev[2], A.Zh. Baltabekova[2], T.I. Sereda[1], M.V. Eliseenkova[1]

[1] *Department of Natural Sciences, South Ural State Agrarian University, Troitsk, RUSSIAN FEDERATION.*

[2] *Municipal State-owned Public Enterprise "Kostanay Agricultural College" of the Education Department of the Akimat of the Kostanay region, Kostanay, KAZAKHSTAN.*

**Corresponding author (Email: derkho2010@yandex.ru).*

Paper ID: 13A3F

Volume 13 Issue 3

Received 07 October 2021

Received in revised form 09 February 2022

Accepted 27 February 2022

Available online 05 March 2022

Keywords:

Cow blood test; Lactation period; Blood biochemical composition; Cow age; Cow blood protein, Cow blood albumins, Cow blood urea, Cow blood ALT, Cow blood AST, Cow blood total lipids, Cow blood triglycerides; Cow blood cholesterol; Catabolic; Cow milk secretion.

Abstract

The biochemical composition of blood in Kazakh Whitehead cows was studied depending on the age and lactation period. Factors affecting the total variability of blood biochemical composition were determined, from 40 cows were used, divided into groups: group 1 - heifers (28 months); group 2 - cows after the second calving (3-4 years); group 3 - cows after the 3rd calving (5-6 years); group 4 - cows after the 5th calving (8 years). Blood levels of T3, T4, total protein, albumins, urea, ALT, AST, total lipids, triglycerides and cholesterol were established. It was found that the amount of triiodothyronine increases during lactation, and thyroxine, on the contrary, decreases. In protein metabolism in cows at the beginning and at the peak of lactation, "catabolic" reactions predominate, determining the possibility of using free amino acids in glucose (gluconeogenesis) and energy synthesis, at the end of lactation - anabolic. The variability of triglyceride and cholesterol concentrations reflects the degree of their use for energy and plastic purposes, providing both the synthesis of milk components and the functional state of the liver. The assessment of the complete variability of the biochemical composition of cow blood by the principal components method allowed to reveal its clear dependence on the lactation period and, accordingly, the secretory activity of the mammary gland.

Disciplinary: Animal Sciences, Biochemical Science.

Cite This Article:

Derkho, M.A., Balabaev, B.K., Baltabekova, A.Zh., Sereda, T.I., Eliseenkova, M.V. (2022). Assessment of the Influence of Age and Lactation Period on the Variability of Blood Biochemical Composition of Kazakh Whitehead Cows. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, *13*(3), 13A3F, 1-12. http://TUENGR.COM/V13/13A3F.pdf DOI: 10.14456/ITJEMAST.2022.48

1 Introduction

Lactation is an important physiological period in the postnatal ontogenesis of cows, during which all life processes under gene control are focused on the production of milk components [1]. It is designed to ensure the offspring's survival after birth [2].

In the early lactation period, cows form a negative energy balance even in conditions of sufficient feed intake, which is a "metabolic priority", and not a sign of pathology [3]. At the same time, milk secretion increases to the peak of lactation, ensuring offspring survival [2], and milk productivity is interrelated with the availability of glucose, which is used not only for energy purposes but also in the synthesis of milk components [4]. At the peak of lactation, the mammary gland extracts up to 2.7 kg of glucose from the blood channels every day. Therefore, the hormonal background of the cow body is focused on maintaining a high intensity of not only carbohydrate and lipid metabolism, but protein metabolism, which is the main source of glucose (gluconeogenesis) in ruminants [5]. An important role in the lactation period is played by the "metabolic plasticity" of the body, which allows it to tolerate the catabolic orientation of metabolism without health consequences, especially in the late stages of lactation [2]. For its regulation and maintenance, as well as subsequent use in breeding work, it is important to know the mechanisms and patterns of physiological adaptation of cows to the effects of metabolic stressors. Currently, this problem is being actively studied in dairy farming [6-8], but these issues have not been studied in beef cattle, which actualizes the research topic.

In beef cows, unlike dairy cows, lactation coincides with the suckling period of young-stock breeding. At the same time, beef cows are not milked, and young animals consume milk independently by sucking. According to the technology of beef cattle breeding, which provides for rounded calving, labor and the beginning of lactation in cows occur in February-March, that is, they coincide with the cold season, which requires additional energy consumption to maintain heat exchange. Therefore, beef cows have sufficiently large fat reserves in the body that allow them to provide energy needs during lactation. This, on the one hand, determines the importance of lipid metabolism in their body, and, on the other hand, the ability to mobilize fat from fat depots to adapt to a negative energy balance [9].

Thyroid hormones that control thermoregulation and intracellular metabolism play an important role in the distribution of resources in the cow body during lactation [10-12]. They determine the efficiency of using the energy of feed and body tissues in the formation of the functional activity of physiological systems, depending on the biological characteristics of the animal body. Therefore, the role of hormones increases significantly during lactation, as they contribute to covering the needs for energy and nutrients. In addition, thyroxine promotes the secretion of milk from the udder by regulating the blood velocity in the mammary gland [13]. At the same time, age determines the variability of hormones in the cow blood, determining the energy costs of the body for milk production [14].

Based on the fact that the blood composition of cows at different stages of lactation depends on the metabolic status of the body, interconnected with biological cyclicity in milk secretion and age [15-16], the purpose of our study was to identify and compare the biochemical parameters of blood in Kazakh White-Headed cows at different times of the lactation period, depending on their age and number of labors; to determine the factors influencing the formation of complete variability of the biochemical composition of blood.

2 Materials and Methods

2.1 Ethical Statement

Experimental studies on animals were conducted in accordance with the recommendations of the Bioethics Committee of the South Ural State Agrarian University (Chelyabinsk region, Russia).

2.2 Animals, Study Design

This study was conducted on a livestock ranch of the breeding farm of Argofirma Borovskoye LLP (Kostanay region, Republic of Kazakhstan) in 2019-2020. The farm specializes in the cultivation of pedigree purebred young of Kazakh White-Headed breed for commercial and own purposes. The animals are kept according to the technology of beef cattle breeding, which provides for rounded calving of cows (February-March), a suckling period lasting 8 months (the "bebi-bef" system). In winter and transitional periods, animals are kept indoors on deep bedding, with access to ground runs; in summer - on pastures. Feeding of animals is carried out in accordance with the VIZH norms [17], the feeding diet is formed by the feed of own production, enriched with vitamin and mineral premix.

In this study, 40 cows of the Kazakh White-Headed breed were used. The design of the study provided for the formation of four experimental groups based on the principle of balanced groups (age, number of calves, time of delivery, clinical status): group I - heifers, age 28 months, live weight 431-461 kg; group II - cows after the second calving (3-4 years), live weight 475-500 kg; group III - cows after the 3rd calving (5-6 years), live weight 550-600 kg; group IV - cows after the 5th calving (8 years), live weight 650-700 kg. On the farm, cows after the 6th month of the suckling period begin to be inseminated by free mating. Young animals at weaning reached a live weight corresponding to the I class of the breed standard.

2.3 Data Collection

The blood in cows was taken from the subcaudal vein by vacuum in the morning before feeding, using vacuum tubes for serum (Vacuette, 9 ml, 16x100 mm), vacuum tube holders (TU 32.50.13-013-54287340-2017, Perint), bilateral needle for blood sampling (RUSTECH) at the end of the first (beginning), the fourth (peak) and the seventh (end) months of lactation. The blood was used to obtain blood serum by centrifugation at 3000 rpm for 15 minutes, was poured into Eppendorf tubes and frozen at -20° C, and then delivered in a thermal container to the laboratory of the Department of Natural Sciences of the SUrSAU on the first day after collection. In total, 120 blood samples were collected during the research period.

The biochemical composition of blood is determined on the automatic biochemical analyzer Super Z (Raito Life and Analytical Sciences Co., China) using a set of reagents from the manufacturer. The analysis provided for the determination of total protein (g/l), albumins (g/l), urea (mmol/l), ALT activity (mmol/h·l), AST (mmol/h·l), total lipids (g/l), triglycerides (mmol/l), cholesterol (mmol/l). To determine the amount of total thyroxine (T_4) and triiodothyronine (T_3), an enzyme immunoassay and ready-made sets of Vector Best reagents with specific monoclonal antibodies were used (Novosibirsk). The analysis was performed in accordance with the procedure indicated by the manufacturer using the Infinite F50 enzyme immunoassay analyzer and Hydro Flex Washer Software (Tecan Austria GMBH) washer.

2.4 Statistical Analysis

Statistical data processing is performed in the Statistica 6.0 program. The normality of all blood biochemical parameters (variables) was checked using Shapiro-Wilk's test. For each group, the average value of the parameter (X) and its standard error (Sx), the trait variation in the interval "minimum - maximum" were calculated. For a general statistical sample of cows, considering age and lactation periods, the average value of each parameter, standard error, and trait variation were determined. A *p*-value below 0.05 was considered statistically significant. Identification of factors affecting the variability of the biochemical composition of blood. It was carried out by the principal components method [18]. Spearman's rank correlation ($P \leqslant 0.05$) was used to determine the similarity measure. The number of principal components was determined by the graphical method - by the Cattell factorial scree [19]. The calculations were performed in the PAST package [20].

3 Results

The role of thyroid hormones as regulators of energy homeostasis increases dramatically in the cow body during such a "critical" period of vital activity as lactation.

Table 1: Thyroid profile (thyroxine, triiodothyronine) of Kazakh White-Headed cows (n=10)

Group of cows	T_4, nmol/L			T_3, nmol/L		
	Lactation period					
	beginning	peak	end	beginning	peak	end
	X±Sx (X_{min}-X_{max})	X±Sx (X_{min}-X_{max})	X±Sx (X_{min}-X_{max})	X±Sx (X_{min}-X_{max})	X±Sx (X_{min}-X_{max})	X±Sx (X_{min}-X_{max})
Group I (1 lactation)	52.01±2.19 (40.10-60.00)	68.44±2.84 (54.50-79.00)	57.50±1.28 (53.00-64.00)	4.30±0.15 (3.76-4.88)	3.69±0.12 (3.03-4.07)	3.37±0.15 (2.88-4.03)
Group II (2 lactation)	48.71±0.96 (43.90-52.40)	56.82±1.88* (45.80-65.00)	51.86±1.08* (46.00-55.00)	4.70±0.05 (4.47-4.90)	4.13±0.18 (3.36-4.99)	3.73±0.15 (3.12-4.33)
Group III (3 lactation)	43.34±0.88* (39.10-46.80)	53.66±1.93* (46.50-63.50)	50.21±1.33* (43.00-54.80)	6.60±0.12* (5.99-7.15)	4.45±0.15* (3.73-5.00)	4.05±0.21* (3.00-4.81)
Group IV (5 lactation)	41.00±2.20* (30.00-53.45)	47.44±1.52* (40.10-52.50)	49.78±1.01* (45.00-53.00)	7.31±0.36* (6.14-8.91)	5.04±0.15* (4.50-5.76)	4.64±0.17* (3.76-5.30)
$X_{average}$	52.06±1.27 (30.00-79.00)			4.67±0.15 (2.88-8.91)		

Note: *p*<0.05 in relation to group 1

The average content of T_4 in cow blood in the general statistical sample was 52.06±1.27 (30.00-79.00) nmol/l, and T_3 - 4.67±0.15 (2.88-8.91) nmol/l (Table 1). At the same time, their concentration depended, first, on age: the level of T_4 decreased, reflecting changes in the secretory activity of the thyroid gland, and T_3, on the contrary, increased; second, on lactation period. Lactation dynamics T_4 had the form of an increasing parabola with a maximum at the peak of lactation, and T_3 - a decreasing straight line (Table 1). The regularities of the thyroid hormone pool formation in the blood of cows of different ages were of the same type, which can be regarded as a genetically fixed adaptive strategy of the body, allowing it to regulate energy homeostasis in lactation.

Protein metabolism in the animal body is a key factor, providing it not only with substrates (especially glycogenic) but also with catalytic molecules. The average concentration of total protein and albumins in the experimental groups of cows, regardless of the lactation period, was 72.96±0.97 (69.76-76.76) and 27.81±0.51 (20.40 - 38.11) g/l. These indicators can be used as a reference for the population of Kazakh White-Headed cows. The amount of total protein, as the sum of all blood proteins, depended on the age of cows and lactation period (Table 2). The minimal concentration of the parameter was detected in the first-calf heifers (66.01±1.46 - 71.69±0.88 g/l), the maximum - in the III (72.64±1.01 - 80.80±1.18 g/l) and IV (72.96±0.97 - 80.12±1.18 g/l) groups. During lactation, its level was minimal at the beginning, regardless of the age of the cows, reflecting not so much the body's provision with protein substrates, but their rapid inclusion in metabolic processes.

Table 2: Indicators of protein metabolism (n=10).

Group	Lactation period	Total protein, (g/l) X±Sx (X_{min}-X_{max})	Albumins, g/l X±Sx (X_{min}-X_{max})	Urea, mmol/l X±Sx (X_{min}-X_{max})	AST, mmol/h·l X±Sx (X_{min}-X_{max})	ALT, mmol/h·l X±Sx (X_{min}-X_{max})
Group 1 (1 lactation)	beginning	66.01±1.46 (60.32-70.99)	27.24±0.70 (23.82-30.09)	3.45±0.09 (2.96-3.74)	1.67±0.08 (1.25-1.92)	1,22±0,03 (0,75-1,60)
	peak	68.87±0.85 (65.62-72.97)	23.03±0.54 (20.40-24.64)	4.00±0.10 (3.60-4.50)	1.77±0.11 (1.25-2.22)	1,29±0,07 (1,08-1,60)
	end	71.69±0.88 (69.01-74.87)	24.23±0.99 (20.40-28.54)	3.81±0.12 (3.28-4.38)	1.73±0.08 (1.30-2.00)	1,26±0,07 (0,97-1,55)
Group 2 (2 lactation)	beginning	69.21±1.56 (62.06-75.89)	29.84±0.43* (28.16-31.09)	3.71±0.17 (3.06-4.50)	1.80±0.07 (1.42-2.01)	1,28±0,11 (0,86-1,75)
	peak	79.41±2.37* (70.32-87.81)	25.78±1.20* (22.39-31.88)	4.30±0.13 (3.70-4.74)	2.49±0.10* (1.95-2.85)	1,51±0,06* (1,20-1,75)
	end	79.46±2.07* (72.06-86.03)	26.64±1.09 (22.51-32.16)	4.05±0.18 (3.35-4.54)	2.33±0.10* (1.99-2.70)	1,40±0,05 (1,12-1,60)
Group 3 (3 lactation)	beginning	72.64±1.01* (68.36-77.46)	34.37±1.25* (29.25-38.11)	4.06±0.12* (3.73-4.56)	1.98±0.04* (1.81-2.15)	1,35±0,04* (1,17-1,51)
	peak	80.64±1.46* (74.16-87.46)	26.91±0.57* (22.33-29.54)	4.38±0.13 (3.93-5.00)	2.39±0.11* (1.92-2.81)	1,25±0,09* (1,25-2,00)
	end	80.80±1.18* (75.97-86.47)	27.20±0.55* (25.18-30.12)	4.11±0.15 (3.72-4.83)	2.34±0.09* (1.90-2.60)	1,37±0,05 (1,22-1,65)
Group 4 (5 lactation)	beginning	72.96±0.97* (69.76-76.76)	34.43±0.49* (31.91-36.28)	4.46±0.11* (4.07-5.03)	1.97±0.04* (1.71-2.10)	1,34±0,05* (1,15-1,48)
	peak	80.02±1.30* (73.97-86.06)	26.14±0.41* (24.59-28.07)	4.65±0.09 (4.26-5.00)	2.12±0.06* (1.90-2.40)	1,51±0,08* (1,17-1,90)
	end	80.12±1.18* (74.83-85.69)	27.89±0.75* (25.00-31.00)	4.29±0.11* (4.07-4.87)	2.08±0.08* (1.70-2.40)	1,42±0,05 (0,95-1,79)
$X_{average}$		75.15±0.91 (60.32-87.81)	27.81±0.51 (20.40-38.11)	4.10±0.07 (2.96-5.03)	2.05±0.05 (1.25-2.85)	1.37±0.04 (0.75-2.00)

Note: $p<0.05$ in relation to group 1

Then it steadily increased, reaching a maximum at the end of lactation, exceeding the "beginning of lactation" value by 8.60-14.81% (Table 2). The priority part of the total blood protein is albumins, which have a number of unique properties, among which the most important colloidal osmotic, transport and reserve functions [21]. The average level of the parameter in the statistical sample of cows was 27.81±0.51 (20.40 - 38.11) g/l. Its concentration increased by 9.84-26.39% with age (Table 2). At the same time, the minimum parameter was detected at the peak of lactation, reflecting the demand for protein in metabolic processes and liver biosynthetic capabilities.

An indirect indicator of the degree of protein nitrogen-fixing in the animal body is urea since it reflects the rate of degradation of feed proteins in the rumen and catabolism of its own proteins [22]. In the studied cow sample, the concentration of urea was 4.10±0.07 (2.96 - 5.03) mmol/l. Its level, first, increased with age by 1.12-1.29 times (Table 2). Second, it changed during lactation: the parameter minimum corresponded to the beginning, the maximum to the peak of lactation, reflecting the protein metabolism direction.

Protein metabolism is associated with the activity of aminotransferases, which determine the use of free amino acids in glucose and energy synthesis. Thus, the activity of AST and ALT increased in cow blood with age, which was the result of an increase in the live weight of animals and the volume of biochemical reactions. At the same time, the AST concentration increased by 1.18-1.20 times, and ALT by 1.10-1.17 times (Table 2). During lactation, maximum activity was detected at its peak, both in ALT and AST. Consequently, the activity of transamination enzymes influenced the direction of the use of free amino acids in the animal body. In addition, its variability was combined with the age and lactation variability of total protein and albumins, reflecting the preservation of the body's metabolic status within the physiological norm.

Table 3: Indicators of the cow blood lipid panel (n=10).

Group	Lactation period	Total lipids, g/l	Triglycerides, mmol/l	Cholesterol, mmol/l
		$X \pm Sx$ (X_{min}-X_{max})	$X \pm Sx$ (X_{min}-X_{max})	$X \pm Sx$ (X_{min}-X_{max})
Group 1 (1 lactation)	beginning	3.50±0.24 (2.62-4.83)	0.52±0.04 (0.34-0.67)	2.44±0.09 (2.02-2.75)
	peak	3.10±0.14 (2.62-3.85)	0.36±0.03 (0.22-0.46)	2.92±0.08 (2.73-3.34)
	end	2.93±0.14 (2.18-3.45)	0.34±0.02 (0.22-0.42)	2.98±0.08 (2.75-3.44)
Group 2 (2 lactation)	beginning	3.10±0.28 (1.83-4.11)	0.57±0.02 (0.48-0.67)	2.81±0.06* (2.50-3.02)
	peak	2.82±0.22 (1.93-3.85)	0.44±0.04 (0.22-0.56)	3.32±0.17* (2.73-4.02)
	end	2.63±0.14 (2.00-3.11)	0.40±0.03 (0.24-0.52)	3.40±0.14 (2.80-3.90)
Group 3 (3 lactation)	beginning	2.34±0.33* (1.10-3.33)	0.60±0.04 (0.45-0.73)	3.14±0.08* (2.75-3.50)
	peak	2.18±0.22* (1.31-3.00)	0.48±0.03* (0.35-0.63)	3.54±0.12* (3.08-4.12)
	end	2.10±0.19* (1.41-3.00)	0.44±0.03* (0.35-0.56)	3.59±0.11* (3.16-4.18)
Group 4 (5 lactation)	beginning	1.95±0.26* (1.23-3.38)	0.63±0.02 (0.52-0.73)	3.24±0.10* (2.84-3.53)
	peak	1.75±0.14* (1.20-2.38)	0.50±0.03* (0.38-0.63)	3.54±0.06* (3.24-3.84)
	end	1.73±0.15* (1.15-2.38)	0.46±0.03* (0.28-0.58)	3.62±0.08* (3.30-4.00)
$X_{average}$		2.51±0.08 (1.10-4.83)	0.48±0.01 (0.22-0.73)	3.20±0.04 (2.02-4.18)

Note: p<0.05 in relation to group 1

An important metabolism in the body of cows is lipid one, as it provides the mammary gland with substrates for milk fat synthesis. The concentration of total lipids, as the sum of all blood lipid fractions, in the total statistical sample of cows was 2.51±0.08 (1.10-4.83) g/l (Table 3). First, it depended on age, decreasing in group IV, compared to group I, by 1.69-1.79 times; second, on lactation period: indicator maximum was detected at the beginning, the minimum - at the end of lactation. The main component of total blood lipids are triglycerides that accumulate in adipocytes and represent the reserve and exchange fund of the body. The average value of triglycerides in the statistical matrix of cows was 0.48±0.01 (0.22 - 0.73) mmol/l (Table 3). The parameter level increased by 21.15-38.89% as the animals matured (especially strongly at the peak of lactation) but decreased by 26.66-34.61% during lactation (most significantly in first-calf heifers). A strictly controlled indicator of the blood lipid panel is cholesterol. The average value of the parameter in the blood of animals in the total statistical sample of cows was 3.20±0.04 (2.02-4.18) mmol/L (Table 3). Its concentration, first, increased with age by 21.47-34.61%. and was maximal in animals of group IV; second, it increased during lactation, most significantly in groups I and II (by 20.99-22.13%).

Consequently, the direction of changes in protein and lipid metabolism in Kazakh White-Headed cows, both in the age aspect and during lactation, was of the same type. This suggests that in similar climatic and technological conditions, homeostatic mechanisms determined by the genotype of animals are of priority.

To identify the factors that prioritize the variability of biochemical parameters in the blood of Kazakh White-Headed cows, we tried to characterize the complete variability of blood composition by the principal components method. Cattel's graphical criterion [19] showed that "on the peak" there were only two main components (GC1, GC2), which together explained 82.61% of the total variance of indicators (priority factors for the formation of the biochemical composition of cow blood). The rest fell into the factorial scree (Table 4).

Table 4: The results of the analysis of the main biochemical composition components of the Kazakh White-Head cows' blood

Indicator	Main component 1		Main component 2	
	Load	P	Load	P
T3	**-0.835**	<0.05	**-0.693**	0.075
T4	**0.808**	<0.05	**0.548**	0.085
Total protein	**-0.916**	<0.05	0.544	0.149
Albumins	**0.835**	<0.05	0.261	0.354
Urea	**-0.844**	<0.05	0.480	0.247
ALT	**-0.928**	<0.05	**-0.636**	0.071
AST	**-0.789**	<0.05	**-0.625**	0.069
Total lipids	**0.768**	<0.05	0.159	0.537
Triglycerides	**0.814**	<0.05	0.211	0.462
Cholesterol	**-0.819**	<0.05	-0.091	0.700
Explained variance, %	71.14		11.47	
P	<0.05		0.599	

Note: Statistically significant and similar effects are highlighted in bold (P≤0.05)

From Table 4, it can be seen that only the main component 1 was statistically significant, explaining 71.14% of the total variability in the biochemical composition of cow blood. Strong and statistically significant loads on it were given by all blood indicators. According to this component, samples were divided considering lactation dynamics, focusing towards the beginning of lactation. Consequently, the complete variability of the blood biochemical composition is specifically related to the secretory activity of the mammary gland. Such a conclusion could not be made regarding the cow's age.

4 Discussion

In cows, the onset of lactation is associated with the formation of a "negative energy balance" in the body, since the amount of energy and protein needed to maintain vital activity and milk production is not equivalent to their intake and fixing from feed [15]. Therefore, the substrates of one's own body are used to cover energy demand. These processes are regulated with the participation of thyroid hormones directly involved in maintaining energy homeostasis [12]. Although the milk productivity of beef cows is significantly lower than that of dairy cows, their milk contains more proteins and fats [23-24], which also requires significant plastic and energy demands from the animal body.

Thus, the concentration of triiodothyronine, a biologically active form of thyroid hormone [11] in animal blood increased by 1.36-1.70 times with age ($p<0.05$). Age differences are most significant at the beginning of lactation, that is, in conditions of "negative energy balance of the body" [15]. This suggests that the hormone effects [12, 21] determined the catabolic orientation of metabolic processes, allowing the cow body to cover its energy consumption by optimizing energy expenditure [22]. It was found that at the beginning of lactation, the rate of peripheral deiodination in the liver increases, which is associated with the modulation of the leptin system, which, as a "local" protective mechanism, prevents the formation of adipose tissue in the organ [25]. Therefore, against the background of an increase in the concentration of T_3 in cow blood, the level of T_4 decreases. Based on the fact that T_4 decreases as much as possible at the lactation peak (by 1.31 times), it can be assumed that this mechanism is in demand not only at its early stages. In general, it can be emphasized that the rate of peripheral deiodination processes, determined by the expression of liver gene mRNA [26] and deiodinase activity [27], plays a significant role in the formation of the thyroid status of cows.

Thyroid hormones, being the most important metabolic hormones, affect the state, first of all, of protein metabolism, which provides glucose to the cow body through gluconeogenesis [5]. Moreover, age increase in the level of total protein in cow blood (1.10-1.12 times) due to the increase in body weight and corresponding metabolic pool of proteins and lactation variability - relevance of protein substrates in the synthesis of milk components, glucose and own proteins on the background of the decrease in the secretory activity of the mammary gland from the beginning to the end of lactation. That is the basis of the correlation of total blood protein with age and duration of lactation is the metabolic reaction of cows to energy consumption change [28].

Therefore, with a positive energy balance at the peak of lactation, the mobilized tissue reserves are replenished, as evidenced by a decrease in the amount of albumin in the blood of cows by 1.13-1.24 times due to its active extraction from the blood channels by cells of organs and tissues [22]. In this case, the protein is involved through aminotransferases in the gluconeogenesis processes and the cycle of tricarboxylic acids (energy synthesis), determining the corresponding growth of urea in a given period of lactation. Thus, in protein metabolism at the beginning and at the peak of lactation, the volume of catabolic reactions prevails over anabolic ones. This direction of metabolism is most pronounced in cows of groups III and IV, which is interconnected by the adaptive potential of hepatocytes and, accordingly, the metabolic functions of the liver [29].

By the end of lactation in the body of dairy cows, despite the decrease in productivity, the intensity of protein metabolism increases, determining the corresponding changes in the blood, which is a consequence of the presence of progressive pregnancy [28, 30]. In beef cows, unlike dairy cows, the service period is longer, it allows them to restore the plastic resources of the body [31]. At the same time, at the end of the suckling period, milk secretion is already minimal, since the young cattle mainly use vegetable feeds, and there is no pregnancy yet. This determines the possibility of protein metabolism orientation along the anabolic pathway.

Lipid metabolism also plays an important role in the body of beef cows, since milk has a high-fat content, especially at the beginning and at the peak of lactation [24]. At the same time, blood lipids are actively used in the synthesis of milk components. Although the total amount of lipids in the blood of cows decreased with age and during lactation, its main components (triglycerides, cholesterol) did not always have similar dynamics, due to their specific biological properties. Thus, the level of triglycerides and cholesterol in cow blood increased with age, as a result of changes in the live weight of animals and, accordingly, the number of cells. During lactation, the concentration of triglycerides decreased, reflecting the degree of their use as energy substrates [9, 32], the ability of the body to cover its energy consumption due to glucogeogenesis [5], as well as the correspondence of the lipogenic activity of the liver to the antioxidant status of its cells [2, 33]. The cholesterol level in the cow blood during lactation, on the contrary, increased, reflecting adaptive changes in its metabolism [34]. At the same time, it was used, especially at the beginning of lactation, in the synthesis of lipoproteins in the liver, providing transport of triglycerides [35], as well as in the synthesis of milk lipids [24] and steroid molecules.

Thus, the biochemical composition of the cow blood depends on the age and duration of lactation. To identify the factors determining blood variability, we used the principal components method, with which we established that lactation is the only statistically significant factor determining the thyroid status of the body, the activity and direction of protein and lipid metabolism.

5 Conclusion

The study presents data reflecting changes in the concentration of thyroid hormones, protein and lipid parameters in the blood of Kazakh White-Headed cows depending on the lactation period and age. Data analysis showed that the level of triiodothyronine during lactation increases and is most significant in cows lactating for the third and fifth time; thyroxine, on the contrary, decreases in a similar pattern, reflecting the intensity of glandular and non-glandular secretory processes. In protein metabolism in cows at the beginning and at the peak of lactation, "catabolic" reactions predominate, determining the possibility of using free amino acids in glucose (gluconeogenesis) and energy. At the end of lactation, protein metabolism acquires an anabolic orientation. The ratio of the blood lipid panel main components (triglycerides and cholesterol) indicates their active use for energy and plastic purposes, providing both the synthesis of milk components and the functional state of the liver. The assessment of the complete variability of the biochemical composition of cow blood by the principal components method allowed to reveal its clear dependence on the lactation period and, accordingly, the secretory activity of the mammary gland.

This study attempts to determine the reference boundaries for the main indicators of protein and lipid metabolism in Kazakh whitehead cows of different ages and at different stages of lactation, which can be used in monitoring studies involving an assessment of their health. The revealed ranges of biochemical parameters can be considered normative.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

7 References

[1] Angeli, E., et al. (2019). Protein and gene expression of relevant enzymes and nuclear receptor of hepatic lipid metabolism in grazing dairy cattle during the transition period. *Res Vet Sci.* 123, 223-231.

[2] Gross, J.J., Bruckmaier, R.M. (2019). Invited review: Metabolic challenges and adaptation during different functional stages of the mammary gland in dairy cows: Perspectives for sustainable milk production. *J Dairy Sci.* 102(4), 2828-2843.

[3] Weber, C., et al. (2013). Hepatic gene expression involved in glucose and lipid metabolism in transition cows: effects of fat mobilization during early lactation in relation to milk performance and metabolic changes. *J Dairy Sci.* 96(9), 5670-5681.

[4] Habel, J., Sundrum, A. (2020). Mismatch of Glucose Allocation between Different Life Functions in the Transition Period of Dairy Cows. *Animals (Basel).* 10(6), 1028. DOI: 10.3390/ani10061028.

[5] Aschenbach, J.R., et al. (2010). Gluconeogenesis in dairy cows: The secret of making sweet milk from sour dough. *IUBMB Life.* 62, 869-877.

[6] Ha, N-T., et al. (2017) Genetische Analyse der metabolischen Adaptation von Milchkühen in der Frühlaktation. *Zuchtungskunde.* 89, 49-60.

[7] Frey, H.J., et al. (2018). Performance, body fat reserves and plasma metabolites in Brown Swiss dairy cows: Indoor feeding versus pasture-based feeding. J. Anim. Physiol. *Anim. Nutr. (Berl.)* 102, 746-757.

[8] Zbinden, R.S., et al. (2017). Metabolic load in dairy cows kept in herbage based feeding systems and suitability of potential markers for compromised well-being. J. Anim. Physiol. *Anim. Nutr. (Berl.).* 101, 767-778. DOI: 10.1111/jpn.12498

[9] Xiong, L., et al. (2020). The Study of the Response of Fat Metabolism to Long-Term Energy Stress Based on Serum, Fatty Acid and Transcriptome Profiles in Yaks. *Animals (Basel).* 10(7), 1150. DOI: 10.3390/ani10071150

[10] Li, A., et al. (2020). Impact of DDT residues in feed on thyroid gland and liver secretory activity of Aberdeen-Angus cattle depending on cattle age and sex. *Journal of Animal and Feed Sciences*. 29, 306-315.

[11] Rybyanova, J.S., Derkho, M.A. (2020). Thyroid regulation and its features in the body of animals in the conditions of natural-technogenic province. *Agro-industrial complex of Russia*. 27(5), 846-852.

[12] Derkho, M.A., Balabaev, B.K. (2020). Features of lipid metabolism and its thyroid regulation in the body of Kazakh white-headed cows during the suckling period. *Scientific Bulletin of the State Educational Institution of the LPR "Lugansk National Agrarian University"*. 1(8), 9-19.

[13] Davis, S.R., Collier, R.J., McNamara, J.P., Head, H.H., Croom, W.J., Wilcox, C.J. (1988). Effects of thyroxine and growth hormone treatment of dairy cows on mammary uptake of glucose, oxygen and other milk fat precursors. *J. Anim. Sci.* 66, 80-89.

[14] Blum, J.W., et al. (1983). Thyroid hormones, blood plasma metabolites, and haematological parameters in relationship to milk yield in dairy cows. *Anim. Prod.* 36, 93-104.

[15] Reist, M., et al. (2002). Estimation of energy balance at the individual and herd level using blood and milk traits in high-yielding dairy cows. *J Dairy Sci.* 85(12), 3314-3327. DOI: 10.3168/jds.

[16] Couperus, A.M., et al. (2021). Influence of Different Lactation Stages on Circadian Rhythmicity of Metabolic Biomarkers in Dairy Cows: A Pilot Study. *Animals (Basel)*. 11(4), 1043. DOI: 10.3390/ani11041043.

[17] Order of the Ministry of Agriculture of the Russian Federation dated October 21, 2020 No. 622 On approval of Veterinary rules for keeping cattle for the purpose of its reproduction, cultivation and sale. https://docs.cntd.ru/document/566135217

[18] Joliffe, I.T. (2002). Principal component analysis. N.Y. Springer-Verlag. 488. DOI:10.1007/b98835.

[19] Jackson, D. A. (1993). Stopping rules in principal component analysis: a comparison of heuristical and statistical approaches. *Ecology*. 74(8), 2204-2214.

[20] Hammer, O., Harpe, D.A.T., Ryan, P.D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica*. 4(1), 9.

[21] Balabaev, B.K., Derkho, M.A. (2016). Age-related features of thyroid status and protein metabolism in the body of animals of the Kazakh white-headed breed of the. *Agroindustrial complex of Russia*. 23(3), 640-645.

[22] Soul, W., Mupangwa, J., Muchenje, V., Mpendulo, T.C. (2019). Biochemical indices and heamtological parameters of goats fed lablab purpureus and vigna unguiculata as supplements to a chloris gayana basal diet. *Vet Anim Sci.* 8, 100073. DOI: 10.1016/j.vas.2019.100073.

[23] Hinz, K., et al.. (2012). Comparison of the principal proteins in bovine, caprine, buffalo, equine and camel milk. *J Dairy Res.* 79(2), 185-191.

[24] Fomina, N.V., Derkho, M.A. (2016). The influence of the genotype of Hereford breed mother cows on the lipid composition of milk. *Achievements of science and technology of agriculture*. 30(9), 91-94.

[25] Gyorffy, A., et al. (2009). Glycogenic induction of thyroid hormone conversion and leptin system activation in the liver of postpartum dairy cows. *Acta Vet Hung.* 57(1), 139-146. DOI: 10.1556/AVet.57.2009.1.14.

[26] Van Dorland, H.A., et al. (2009). Variation in hepatic regulation of metabolism during the dry period and in early lactation in dairy cows. *J Dairy Sci.* 92(5), 1924-1940. DOI: 10.3168/jds.2008-1454.

[27] Gereben, B., McAninch, E.A., Ribeiro, M.O., Bianco, A.C. (2015). Scope and limitations of iodothyronine deiodinases in hypothyroidism. *Nature Reviews Endocrinology*. 11, 642-652. DOI: 10.1038/nrendo.2015.155

[28] Cozzi, G., et al. (2011). Short communication: reference values for blood parameters in Holstein dairy cows: effects of parity, stage of lactation, and season of production. *J Dairy Sci.* 94(8), 3895-3901.

[29] Kuczyńska, B., et al. (2021). Metabolic profile according to the parity and stage of lactation of high-performance Holstein-Friesian cows. *Anim Biosci.* 34(4), 575-583. DOI: 10.5713/ajas.20.0018.

[30] Bjerre-Harpøth, V., et al. (2012). Metabolic and production profiles of dairy cows in response to decreased nutrient density to increase physiological imbalance at different stages of lactation. *J Dairy Sci.* 95, 2362-2380. DOI: 10.3168/jds.2011-4419.

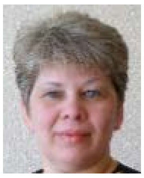
[31] Doornenbal, H., Tong, A.K., Murray, N.L. (1988). Reference values of blood parameters in beef cattle of different ages and stages of lactation. *Can J Vet Res.* 52, 99-105.

[32] Thomas, D.D., et al. (2019). Effects of medium chain triglycerides supplementation on insulin sensitivity and beta cell function: A feasibility study. *PLoS One.* 14(12), 0226200. DOI: 10.1371/journal.pone.0226200.

[33] Bouyahya, A., et al. (2021). Preclinical and Clinical Antioxidant Effects of Natural Compounds against Oxidative Stress-Induced Epigenetic Instability in Tumor Cells. Antioxidants. 10, 1553.

[34] Kessler, E.C., Gross, J.J., Bruckmaier, R.M., Albrecht, C. (2014). Cholesterol metabolism, transport, and hepatic regulation in dairy cows during transition and early lactation. *J Dairy Sci.* 97(9), 5481-5490. DOI: 10.3168/jds.2014-7926

[35] Gross, J.J., Kessle, R E.C., Albrecht, C., Bruckmaier, R.M. (2015). Response of the cholesterol metabolism to a negative energy balance in dairy cows depends on the lactational stage. *PLoS One.* 10(6), 0121956.



Professor Dr.Derkho Marina Arkadyevna is a Professor and Head of the Department of Natural Science, FSBEIHE South Ural State Agrarian University. She holds a Doctor of Biological Sciences from the Moscow State Academy of Veterinary Medicine and Biotechnology. K.I. Scriabin. Her research interests are Ecological Biochemistry, Age Physiology, Neuro-Humoral Regulation, Adaptation Processes, Biotechnology of Food Production.

Dr.Balabaev Bulat Kablanovich is a Candidate of Biological Sciences, a Teacher of Special Disciplines of the Municipal State-owned "Kostanay Agricultural College" of the Education Department of the Akimat of Kostanay region. He got a Ph.D. from the Kazan State Academy of Veterinary Medicine named after I. N.E. Bauman. His research interests are Hormonal Regulation of Metabolic Processes, Age Physiology.

Dr.Baltabekova Aigul Zhumagalievna is a Teacher of Special Disciplines at the Municipal State-owned "Kostanay Agricultural College" of the Education Department of the Akimat of Kostanay region. She got a Ph.D. from the Kazan State Academy of Veterinary Medicine named after I. N.E. Bauman. Her research interests are Hormonal Regulation of Metabolic Processes, Age Physiology.

Dr.Sereda Tatyana Igorevna is a Candidate of Biological Sciences, an Associate Professor of the Department of Natural Sciences, South Ural State Agrarian University. She got a Ph.D. from the Ural Academy of Veterinary Medicine. Her research interests are Ecological Biochemistry, Age Physiology, Food Production Biotechnology.

Dr.Eliseenkova Marina Valentinovna is a Candidate of Biological Sciences, an Associate Professor of the Department of Natural Sciences, South Ural State Agrarian University. She got a Ph.D. thesis from the Ural State Academy of Veterinary Medicine. Her research interests are Environmental Management, Biochemical Ecology, Environmental Protection, Monitoring of the State of Environmental Objects.