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

http://TuEngr.com

PAPER ID: 11A10E

TECHNOGENIC ECOSYSTEM AS THE MAIN FACTOR AFFECTING THE IMMUNOBIOCHEMICAL STATUS OF ANIMALS

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ARTICLEINFO

Received 06 January 2020
Received in revised form 23 February 2020
Accepted 01 April 2020
Available online 16 April 2020

Keywords:
Agricultural ecosystem contamination; Biochemical characteristics of animals; Clinical and biochemical assessment of processes; Analysis of total protein and protein fractions of blood serum; Lipid metabolism; Mineral metabolism; Blood analysis; Carbohydrate metabolism; Respiratory function of the blood; Oxidoreduction; Carbohydrate decomposition phase.

ABSTRACT

The production of food products of animal origin is considered as the dominant producer of the agrarian ecosystem, characterized by their own features of the biotic cycle in agricultural systems of agro landscapes geoecochemistry, thereby influencing living organisms through trophic chains. The modern state of livestock breeding through analysis of blood, feed, and organs from animals in all types of farms confirms that one of the important drivers of low efficiency of the industry is an excess of some vital trace elements in environmentally disadvantaged areas against a background of chronic deficiency of the complex of others, which leads to low reproduction of the uterine livestock and producers.

There are significant works based on the analyzes of the study of microbiogenic parts of the trophic chain, however, the problems of the formation of processes associated with metabolic disorders in microelementoses from development to clinical manifestations are still insufficiently studied. Analysis of data on animal husbandry and veterinary medicine, indicators of the immune system, article of clinical status used to diagnose the transformation of the physiological state of animals, laboratory tests of milk, blood, urine, and feces are group methods of research in the forest-steppe zone of the Southern Urals.

Disciplinary: Animal Sciences, Biological Science, Biotechnology.

1. INTRODUCTION

Immunobiological and neuroendocrine factors of biological and chemical adaptation are interconnected and genetically determined, they carry out biochemical processes that serve as reactions to the adjusting of individual organs or the whole organism of cows to specific environmental conditions are characteristic of pathological conditions, including stages and periods of ontogenesis (Pauli and Fatkullin, 2018).

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In order to establish the characteristics of metabolic processes and to study the peculiarity of adaptation of the animal organism to contamination of ecosystems by toxic elements, an analysis of the biochemical parameters of carbohydrate, protein, mineral and lipid metabolism in animals was performed, since the biochemical feature of the systems makes it possible to recognize nature and pathogenesis. When choosing laboratory methods, the requirements of the clinical and biochemical principles of pathological processes in the body of cows were followed (Fatkullin et al., 2018).

To achieve the set goal, in Rassvet LLP there was organized a group of cow breeds according to the following criteria: Kazakh white-headed, age 6-7.5 years, live weight 490-530 kg, gestation period 3-3.5 months (I group). The group of cows corresponding to the biogeochemical situation was organized in Novokatenino LLP (group II).

2. ANALYTICAL RESULT

2.1 ANALYSIS OF CRUDE PROTEIN AND PROTEIN FRACTIONS OF BLOOD SERUM IN COWS

According to the data shown in Table 1, the indices of crude protein in animals of the first group are lower than the norm by 4.2% (P> 0.05), and contains 82.22±31 g/L. In cows of the second group, a marked decrease in the level of crude protein was observed, which confirms the inhibition of protein biosynthesis in the body, reaching 79.32±0.43 g/L, which is primarily associated with the disturbance of the protein-synthetic function of the liver.

Table 1: Content of crude protein and protein fractions of blood serum in cows ($g \cdot l^{-1}$; n = 10)

Parameter		Crude protein content	Whey protein							β-Lp
			Albumin (Alb)	Prealbumin (Palb)	Transferin (Tf)	Albumin (Cp)	Globulins			
							β_2-	α_2-macro -+γ_1-	γ_2-	
Reference quantity	$\bar{X} \pm S_x$	85.92±0.21	40.32±0.24	7.52±0.04	8.09±0.01	2.42±0.04	4.82±0.03	7.11±0.02	9.92±0.02	6.06±0.07
1	$\bar{X} \pm S_x$	82.22±0.31	32.85±0.18	9.48±0.08	10.47±0.03	1.53±0.02	4.30±0.02	6.42±0.04	8.64±0.06	8.01±0.12
	%	-4.20	-18.52	+26.05	+29.29	-36.36	-10.59	-10.72	-12.81	+32.01
2	$\bar{X} \pm S_x$	79.32±0.43	31.24±0.08	9.34±0.05	10.85±0.04	1.51±0.08	4.09±0.01	6.47±0.07	8.00±0.10	7.29±0.11
	%	-7.70	-22.51	+24.20	+33.99	-37.19	-14.94	-9.02	-19.25	+20.13

The content of serum albumin, which has a kind of erudition to regulate their level in the body due to the small molecular weight, and transport physiological metabolites, is reduced. Regarding regulatory requirements, the cows of the first group have them lower by 18.52 and the second by 22.51%, which, firstly, indicates a decrease in the concentration of albumin, which leads to a slowdown in the regeneration of proteins in the cellular structures of the body, and secondly, a slowdown the antitoxic functioning of albumin and the emergence of isolated metabolites in a free biologically active state (Pauli and Fatkullin, 2019).

The mentioned situation in the proteinogram is worsened by an increase by 1.26 times in the content of postalbumin in the first group of cows and by 1.24 times in the second one, which can slow down enzymatic catalysis during intensively uninterrupted or pathological proliferative processes.

The total protein fractions were 9.02 and 10.72%, which is lower in cows of both groups relatively to the required norms. α_2-macroglobulin and haptoglobulin of the α_2+γ_1-globulin fraction zone are also endowed with immunosuppressive activity. In our opinion, the low content of the

$\alpha_2+\gamma_1$-globulin fraction can be explained by the ability of α_2-macroglobulin to bind and move Ni in the form of nickel plasmin. In humans, the concentration of this protein is on average 43% of the total amount, despite the fact that the physiological function of this metalloprotein is still unknown.

The quantity of the iron protein fraction, on the contrary, exceeds the indicated reference quantities by an average of 31.65%, its content is 10.47±0.03 (P <0.001), 10.85±0.04 g/L (P <0.001), relatively to animal groups. In our opinion, this increase, not taking into account the participation of transferrins in hematopoiesis, is associated with the particularity of their structure. It is known that sialic acids are considered to be one of the main elements of the prosthetic group of transferrins, which are a typical barrier to infection before the production of specific antibodies since transferrin-unsaturated iron inhibits the growth of bacteria and viruses (Fatkullin, 2014). It is also obvious that sialic acids represent the acylated derivatives of neuraminic acid, which come as a labile component of glycoproteins. According to the results of studies, the indicators of animal serum neuraminic acid reach 41.95±2.31 (P <0.01) for the 1st and 45.31±1.95 mcmol/L (P <0.001) for the 2nd group of cows. Perhaps the envisaged decrease in neuraminic acid by 20.79% is associated with increased synthesis of its derivatives. The concentration of transferrins in blood serum can be involved as a parameter of pathological processes occurring in the body, which have a positive effect, according to some authors.

The content of ceruloplasmin, a transport protein of the α_2-globulin fraction, tends to lower levels in both groups of animals and is 1.53±0.02 (P <0.001) for the 1st and 1.51 ± 0.08 g/L (P <0.01) for the 2nd group (Table 1).

In spite of the variety of biological characteristics of ceruloplasmin, a decrease in its indices, in our opinion, is interconnected with a suppression of the antioxidant activity of copper oxidase, due to which lipid autooxidation is activated and toxic radicals of superoxidion, a product of abnormal aerobic metabolism, are accumulated in the organism of animals of the technogenic zone.

Our hypothesis about a decrease in the antioxidant functioning of animal blood plasma is justified by a high content of β-lipoproteins, amounting to 8.01±0.12 for the first and 7.29±0.11 g/L (P <0.001) for the second group of cows, exceeding the reference quantities by 20.13 and 32.01% (Table 1).

The abrupt change in the protein background in the animal organism was significantly reflected in the performance of protective blood proteins, β_2-globulins. The content of proteins was found to be reduced to 4.30±0.02 and 4.09±0.01 g/L (P <0.001), relatively to the groups of cows, which is primarily associated with the toxic effects of Cd, the content of which in subsequent studies became high in the kidneys, suppressing the reabsorption of β_2-globulins by destructive changes in the proximal renal tubules.

According to the analysis of the protein spectrum of the blood of animals, it is clear that a reaction to the prolonged influence of a qualitatively new environmental factor (toxic elements) results in a change in homeostasis that activates adaptation systems through the hypothalamic-pituitary systems of the brain. Through releasing hormones, the hypothalamus embodies the contact of the endocrine system with the nervous system, reconfiguring nerve impulses into humoral ones. At the same time, the functional system is mobilized, which is responsible for the

*Corresponding author (A.K. Saken) Email: aika_saken@mail.ru Volume 11 No.10 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A10E http://TUENGR.COM/V11A/11A10E.pdf DOI: 10.14456/ITJEMAST.2020.188

adaptive function, the generation of cell structures that limit the level of functioning of cells and organs. At the same time, there is a high content of immunosuppressants, which lead to suppression of the immune function by affecting the processes associated with the splitting of immunocompetent cells, as evidenced by our studies with a decrease in the content of gamma-2-globulins in the animal body, which were 8.64±0.06 for the first group and 8.00±0.10 g/L ($P < 0.01$) for the 2nd group relatively, with the averaged normative indicators 9.92±0.056 g/l. The synthesis of gamma-2-globulins, a typical function of immunocompetent cells, shows the well-being of the cellular immune system, indicating the need to study the parameters of cellular immunity (Tairova et al., 2010).

Alanine aminotransferase (AlAT) and aspartate aminotransferase (AsAT), which exist in two molecular forms — mitochondrial and cytosolic, belong to the group of indicator enzymes that play an important role in determining the nature of specific protein metabolism pathways.

Based on our research, the change in the activity of aminotransferases in the blood serum of animals of the first and second groups is approximately similar. In cows of the first group, the level of activity of AsAT is increased by 86.03% and contains 4650.69 ± 45.26 nkat/L ($P < 0.001$), in the second group, respectively, is higher than the norm by 52.61% (3815 , 16-29.72 nkat/L, $P < 0.001$). According to the results of the study, it is clear that an abnormal concentration of trace elements in environmental objects more fruitfully generates ontogenesis of the activity of the cytoplasmic enzyme, indicating pathology of the structure and function of hepatocytes, which contribute to the release and entry into the blood of the cytosolic enzyme. So the activity of alanine aminotransferase in animals of the first group increased by 2.27 times, in the second it increased by 1.73 times, respectively, for aspartate aminotransferase these quantities are 86.03 and 52.61% more.

An increase in the de Ritis coefficient (2.49 units; $P < 0.01$ and 2.68 units; $P < 0.001$, relatively to the groups of cows) confirms the appearance of a pathological process in the animal liver, which contributes to an increase in the permeability of cell membranes. Since the biosynthesis of 75-90% of alpha and gamma globulins and all albumin takes place in the liver, in the pathology of the liver, protein and amino acid exchanges are disturbed, due to which the studied metamorphosis of transaminase activity is most likely subject not only to the neuro-humoral regulatory effect through activators and inhibitors, but also inhibition of protein biosynthesis in the affected liver. An increase in the activity of aminotransferases in the blood of cows can also be manifested in the form of an adaptive reaction of the body, one of the protective actions in the process of adaptation to arbitrary stressful effects of negative environmental factors.

2.2 ANALYSIS OF CARBOHYDRATE METABOLISM IN BLOOD OF COWS

Considering the location of animals in the conditions of ecosystem pollution by toxic elements, a dozen energy reserves are being requested to adapt to the environment, it is equally important to analyze the condition of carbohydrate metabolism, since carbohydrates, namely glucose, are the main energy resource for body cells. With this aspiration, in the course of the study, we revealed the concentrations of the main metabolites of carbohydrate metabolism: glucose, pyruvic acid, and lactic acid (Table 2).

Studies have shown that indicators of total blood sugar in animals of both groups are lower than the reference standards by 13.86-15.83%. A similar concentration of glucose in the blood of animals

(2.97±0.07 ... 3.04±0.19 mc mol/L), in our opinion, has a correlation with the total protein and the characteristics of the protein profile of blood serum (table 2) . Apparently, under these conditions, glucose begins to import due to the mechanisms arising as a result of metabolic reactions of amino acids with glyconeogenesis (Khlyupin and Fatkullin, 2016a; 2016b).

The shift in the level of blood indices of the studied animals of the main metabolites of carbohydrate metabolism is unidirectional, the parameters found during the study convince of a violation of the proper functioning of the liver, despite the uneven increase in their levels (Table 2). The content of pyruvic acid, an important metabolite of glycolysis and glyconeogenesis, is significantly higher than the reference values by 21.0% - 119.18±9.99 and 122.02±8.06 mmol/L; therefore, in the experimental groups, a significant increase in the level of the final glycolysis product in the form of lactate (1.97±0.02 and 2.23±0.07 mmol/L) and exceeds the reference standards by 62.17 and 82.04%, relatively to the groups.

Table 2: Indices of carbohydrate metabolism in the blood of cows (n = 10)

Parameter		1	2	Reference quantity
Glucose, mcmol/L	$\bar{X} \pm S_x$	3.04±0.19	2.97±0.07	3.54-4.00
	%	-13.86	-15.83	
Pyruvic acid, mcmol/L	$\bar{X} \pm S_x$	119.18±9.99	122.02±8.06	91.20-100.0
	%	+19.16	+22.01	
Lactic acid, mcmol/L	$\bar{X} \pm S_x$	1.97±0.02	2.23±0.07	1.06-1.22
	%	+62.17	+82.04	
Lactate/Pyruvate, units	$\bar{X} \pm S_x$	16.61±0.12	18.20±0.09	11.62-12.20
	%	+36.16	+49.19	
Fructose bisphosphate aldolase, nka/L	$\bar{X} \pm S_x$	91.33±11.24	76.63±14.4	179.87±3.23
	%	-49.21	-57.38	
Alkaline phosphatase, nkat/L	$\bar{X} \pm S_x$	178.25±19.14	120.13±21.15	483.00-2534.0
	%	-63.10	-75.13	

The lack of oxygen in the cells is due to the transformation of the metabolism of carbohydrates from aerobic to anaerobic, under the conditions of accumulation of lactic acid, D-glucose is modified to anaerobic glycolysis.

All of the above, despite the protein and carbohydrate balance in the diet, have signs of a hypoxic profile of sugar metabolism, and participate unidirectionally in the generation of heavy metal hypoxia. Apparently, their high content, in particular, Pb and Cd, becomes the cause of morphological and functional changes in mitochondria and impedes breathing, phosphorylation, and transport processes, which probably reflects the pathological effects of these metals (Kokshanov and Fatkullin, 2019).

Oxidoreduction between phosphoglyceric pyruvic acid and aldehyde is considered the main transitional reaction of glycolysis, which is accompanied by the release of energy.

According to our research, a change in the activity of fructobisphosphate aldolase proves a decrease in the intensity of the glycolytic phase of the breakdown of carbohydrates. A comparative analysis of the activity of the enzyme in animals with comparative values demonstrates its decrease. Thus, the activity of fructose bisphosphate aldolase in animals is 1.49 and 1.57 times lower than

normal and reaches 91.33±11.24 nkat/L (P <0.01) and 76.63±14.4 nkat/L (P <0.001), which indicates functional disorders of the liver.

We think that all of the above descriptions of the transition of carbohydrate metabolism in experimental animals are consistent with the fact that in a given period in the maternal body, deep morphological and physiological shifts are observed associated with the improvement of metabolic processes in animals. These metabolic reactions are aimed at mobilizing intraorgan sources of energy supply to the mother's body and form embryos on a number of indicators of hypoxia and anaerobic oxidation of carbohydrates, as well as plastic functioning for the formation of tissue structures and organs of embryos and confirm metabolic disturbances in the body of pregnant cows living in an unfavorable ecological zone.

In our opinion, a decrease in the concentration of carbohydrates in the blood of animals as the main energy provider reveals the occurrence of underdeveloped and stillborn calves, up to miscarriage and abortion. Obviously, blood glucose is supplied due to glycogen in the depot of the body and sugars of food nutrients, which supply the required volume of the respiratory chain, Krebs cycle, oxidative phosphorylation and glucose phosphate for glycolysis. By suppressing ATP-adrenaline-dependent sources of glycogenolysis, the aggravation of energy sources begins, which ultimately leads to a violation of carbohydrate metabolism. Under the influence of regulatory participation in the metabolic processes of the parasympathetic nervous system, the use of galactose and other feed sugars is deteriorating, and glucose is supplied due to glyconeogenesis reactions. The parasympathetic pathway of metabolic regulation notifies the appearance of hypoglycemic presence and is not corrected by energy deficiency of macroergic compounds (Fatkullin et al., 2016).

Therefore, as a result of the activation of the shunt path to metabolism and energy exchange, the amino acid capital of the body gradually decreases over a long period, respectively, making it difficult for the embryos to become and finally develop, as well as the calf gains in weight after calving.

Studies of lipid metabolism represent a characteristic enthusiasm because hypoglycemia and anaerobic oxidation of carbohydrates contribute to the growth of lipolysis (Fatkullin et al., 2016).

2.3 ANALYSIS OF LIPID METABOLISM IN THE BLOOD OF COWS

The research data (Table 3) indicate that experimental cows show a tendency to increase the level of total lipids, the index of which is 6.16±0.79 for cows of the first group and 6.25±0.33 g/L for the 2nd group, where the data of the 2nd group are reliable with a reference norm of 6.30% (P <0.05).

According to table 3, it can be seen that during the study, the content of β-lipoproteins was determined in the animals of the experimental group, taking into account the transportation of exo- and endogenous lipids with blood and lymph in the form of water-soluble lipid-protein biocomplexes.

Serum antioxidant resistance is decreased, which led to an improvement in the synthesis of low-density lipoproteins (Pauli and Fatkullin, 2018). Studies have shown that the level of β-lipoproteins increases in cows located in the region contaminated with toxic elements, where deviations of the indicators from the required norms are by 20.14 and 32.02%, in addition, a significant synthesis of β-lipoproteins, with a norm of 6.06±0.07 g/L, P <0.001, was observed in the cows of the first group 8.01±0.12 g/L and 7.29±0.11 g/L in the second group.

Table 3: Indices of lipid metabolism in the blood of cows (n = 10)

Parameter	Unit of measurement		1	2	Reference quantity
Total lipids	g/L	$\bar{X} \pm S_x$	6.16±0.79	6.25±0.33	5.87±0.48
		%	+4.78	+6.31	
β- lipoproteins	g/L	$\bar{X} \pm S_x$	8.01±0.12	7.29±0.11	6.05±0.07
		%	+32.02	+20.14	
Cholesterol	millimole/L	$\bar{X} \pm S_x$	6.50±0.01	7.13±0.06	4.39±0.34
		%	+47.9	+62.18	
Malonic dialdehyde	micromole/L	$\bar{X} \pm S_x$	3.25±0.15	3.44±0.21	2.43±0.01

According to the data in Table 3, it can be seen that the indices of β-lipoproteins, as well as cholesterol, respectively, are genuinely overestimated from the required norms, amounting to 6.50 ± 0.01 (P <0.01) and 7.13 ± 0.06 mmol/L (P <0.001), respectively, to the groups of cows.

The detection of such an increase in cholesterol during the analysis, as one of the most important levers of glyconeogenesis, along with hypoglycemia, must be associated with excessive intake of Mn in animals and with a change in the synthesis and activity of microsomal CoA reductase, which regulates biosynthesis mevalonic acid cholesterol by the negative feedback mechanism (Yakovleva and Fatkullin, 2018). In addition, the indicator of this compound in the blood of cows can be identified by the need for biosynthesis of steroid hormones of the adrenal glands, which are important for the normal course of gluconeogenesis in the body of cows when exposed to stress stimulants (Vasilieva et al., 2018).

As a result of lowering glucose indicators, especially its anaerobic oxidation, improving lipolysis in animals, the initial products of lipid peroxidation are intensified. An increase of 1.32 and 1.40 times is stated relatively with reference requirements, the parameters of the content of the initial product of lipid peroxidation - malondialdehyde (MDA). Ceruloplasmin, the most important antioxidant in blood serum, which suppresses and prevents lipid oxidation, is of great importance in the utilization of toxic radicals of superoxidion (Arapova et al., 2018). Obvious protection from mutilation by the superoxidion radical with the help of copper-containing superoxide dismutase (SOD) - an intracellular cell and tissue enzyme that catalyzes the dismutation of free radicals to oxygen and peroxide. Inhibition of the level of ceruloplasmin in the experimental groups to 1.52±0.07 and 1.54±0.02 g / l (P <0.001) and an increase in the level of lipid indices indicate the presence of disorder in the link of lipid peroxidation, amounting to 3.25±0.15 and 3.44±0.21 mcmol/L (P <0.01), respectively, to the studied groups of cows (Lazarenko et al., 2009).

2.4 ANALYSIS OF MINERAL METABOLISM IN THE BLOOD OF COWS

Table 4 results indicate that when studying metabolic processes it is unacceptable to miss the mineral metabolism quantities, because most of the mineral elements in the necessary proportions participate in membrane permeability, the energy supply of the organism, activation of enzymes, while the imbalance of mineral elements results in fluctuations in the metabolic processes.

During the study, the Ca content in the blood serum of animals was kept within the upper limit of the species norm, amounting to 2.78±0.24 g/L in the first and 2.74±0.36 g/L in the second group of experimental cows, which does not disagree with the required regulatory parameters (P> 0.5).

*Corresponding author (A.K. Saken) Email: aika_saken@mail.ru Volume 11 No.10 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A10E http://TUENGR.COM/V11A/11A10E.pdf DOI: 10.14456/ITJEMAST.2020.188

Table 4: Indices of mineral metabolism in the blood of cows (n = 10)

Parameter, µmol / L		1	2	Reference quantity
Ca (mmol/L)	$\bar{X} \pm S_x$	2.78±0.24	2.74±0.36	2.50-2.75
	% to normal	+1.45	---	
P ((mmol/L))	$\bar{X} \pm S_x$	2.26±0.13	2.20±0.19	1.68-1.23
	% to normal	+7.14	+4.28	
Mg ((mmol/L))	$\bar{X} \pm S_x$	1.43±0.02	1.39±0.01	0.83-1.15
	% to normal	+23.48	+20.0	
Fe	$\bar{X} \pm S_x$	33.29±2.18	29.09±2.95	16.1-19.7
	% to normal	+68.93	+47.61	
Cu	$\bar{X} \pm S_x$	20.21±0.18	18.86±0.13	14.1-15.0
	% to normal	+28.72	+20.14	
Zn	$\bar{X} \pm S_x$	13.04±0.08	14.19±0.03	19.9-26.0
	% to normal	-34.43	-29.65	
Mn	$\bar{X} \pm S_x$	5.47±0.20	5.94±0.17	2.73-4.55
	% to normal	+20.44	+30.77	
Co	$\bar{X} \pm S_x$	0.35±0.002	0.40±0.002	0.51-0.85
	% to normal	-31.37	-21.56	
Ni	$\bar{X} \pm S_x$	10.35±0.21	12.01±0.13	1.72-8.62
	% to MRL	+20.18	+27.84	
Pb	$\bar{X} \pm S_x$	1.90±0.02	1.79±0.01	1.20-1.42
	% to MRL	+34.5	+26.76	
Cd	$\bar{X} \pm S_x$	0.57±0.001	0.58±0.003	0.44-0.50
	% to MRL	+12.0	+16.0	

Table 4 also shows the level of P content in the blood serum of the studied groups of cows, where for the first group the indices are 2.26 ± 0.13 and 1.20±0.19 mmol/L in the second cows, reliably exceeding the comparison quantity by 5.71%.

The need for the above elements for the growth and development of the fetus is explained by similar direct transformations in their levels. Like other Ca and P minerals, they enter the forming fetus from the female's body, in response to which in the maternal organism the compensatory mechanisms of mobilization of these elements from the skeleton are activated to maintain them at a certain level in the blood (Pavlova et al., 2008).

The content of Mg exchanging with Ca creates a fundamental component of the intracellular environment, causing the elasticity of muscle fibers, has a significant effect on the central nervous system, limits blood coagulation, etc. Mg^{2+} forms a complex with proteins and nucleic acids in cells, and in mitochondria it stimulates oxidative phosphorylation.

According to the results of our study, the Mg indices are 1.43±00.02 in the 1st group of cows and 1.39±0.01 mmol/L (P <0.001) in the 2nd group, therefore exceeding the physiological norm by 1.20 times.

According to the results of the study, shown in table 4, it is clear that microelements of the blood of cows are predisposed to significant shifts, the function of which has not been studied enough in the body in excess of the MPC (heavy metals).

The indices of the content of Cu, Fe, and Mn in the blood of experimental animals were overestimated, while a greater intensity was observed in the parameters of Fe concentration with indices of 33.29±2.18 mcmol/L (P <0.01) for the first and 29.09± 2.95 mcmol/L (P <0.01) for the

second group of cows, consequently exceeding the parameters of the reference norms by 47.61 and 68.93%. There is a correlation between the indicative levels of Fe and cow blood transferrins, which indicates an increased availability of Fe from RES, an increase in the tendency to saturate transferrins with iron and an increase in hematopoiesis, which is consistent with our results for determining the hemoglobin content in groups 128.01±0.22 and 130.43±0.17 g/L, P <0.001 (table 5).

As it is known, Cu promotes the incorporation of Fe into the porphyrin ring during heme formation. Cu is an osteogenic trace element that forms many enzymes; 90-95% of blood plasma copper is located in ceruloplasmin, with a small content of which, according to our analysis, an increase in Cu in the blood of cows is observed. According to our research, the concentration of copper in the blood of experimental animals exceeds the reference values by 1.20 and 1.28 times (P <0.01), respectively, to the groups.

A high level of Mn in the blood of experimental animals (5.47 ± 0.20 and 5.94 ± 0.17 mcmol/L; P> 0.001, in the 1st and 2nd groups) is probably associated with its oversaturation in the feed (table 4), as well as with its biological significance in the adaptation of the body. Mn owns a characteristic lipotropic effect that promotes the activation of the cycle of di- and tricarboxylic acids, and also improves the process of lipid expenditure in the body, being an activator of kinases, decarboxylases and hydrolases.

The recorded relatively insignificant content of Zn and Co in agricultural feed is due to the antagonism of its interaction with such elements as Cu, P and Mg — the inhibition of absorption of each other in the intestine; with Zn in competition for a connection with transferrin in the blood, it affects their level in the blood of cows. Thus, according to the study indices, the level of Zn in the blood is as low as 13.04±0.08 and 14.19±0.03 mcmol/L P <0.01 for both groups of cows, respectively. Most likely, the discrimination of Mn with respect to Zn does not occur during absorption, but in the case of an intermediate metabolism in the blood → liver → bile → intestine system.

Under conditions of technogenic tension in the blood of animals, the Co level decreases compared to the norm by 31.37 and 21.56%, which is caused by the effect on the Co concentration of the high Fe levels determined by us in the feed, which are in the body of cows, manifested by competition for substance which is the ions carrier in the intestinal wall (Hlyupin and Fatkullin, 2016).

According to the study (Table 4), the concentration of Ni in the blood of experimental cows contains 10.35 and 12.01 mcmol/L with regulatory requirements up to 8.62 mcmol/L, in the same way it is significantly overestimated from the permissible value of Pb and was 1.90±0.02 and 1.79 ±0.01 mcmol/L, P <0.001; respectively. The level of Cd in the blood shows 0.57±0.001 for cows of the 1st and 0.58±0.003 mcmol/L for cows of the 2nd group, which exceeds the permissible concentrations by 12.0 and 16.0%.

Thus, the results of a quantitative deermination of the group of chemical elements show the presence of a one-way correlation among Co, Fe, Cu, Mn, Ni, Zn, Pb, Cd in the blood of the studied cows and the concentration of these elements in water, soil and feed of farms (Fatkullin and Gizatulin, 2017).

2.5 ANALYSIS OF THE RESPIRATORY FUNCTION OF BLOOD OF COWS

In the body of the studied animals, which causes a systemic load with a complex of heavy metals, the process of stress of hematopoietic functioning takes place (Yakovleva and Fatkullin 2019). As shown in Table 5, besides a decrease in metabolism and energy metabolism, in addition, with a pronounced hypoxic nature of carbohydrate metabolism, a fixed tendency to hematopoiesis is adaptive in nature, therefore, there is a certain tendency to increase the levels of red blood cells, hemoglobin and hemoglobin in one red blood cell (table 5) (Yakovleva and Fatkullin, 2019).

The studied cows in ecologically unfavorable farms appeared to have increased content of the color blood indicator by 12.7% (P <0.001), which leads to an increase in the level of red blood cells. The hematocrit quantity in cows of a similar nature makes changes to lower the oncotic pressure of the blood of animals, improving vascular permeability, and inhibiting the protein synthesizing functions of the liver, reaches 50.01± 0.10 (P <0.01) for the 1st and 48.83±0.16% for the 2nd group of cows (P <0.001), which indicates high concentrations of Pb, which probably led to a disorder of the heme biosynthesis pathways (Fatkullin and Gizatulin, 2017).

Table 5: Indicators of respiratory function of the blood of cows.

Parameter	Unit of measurement	Reference quantity	1		2	
			$\bar{X} \pm S_x$	± deviations, %	$\bar{X} \pm S_x$	± deviations, %
Catalase number	mg H_2O_2	5.93-6.34	8.97±0.07	+41.17	7.95±0.02	+25.24
Red blood cells	x10^{12}/L	5.0-7.5	6.81±0.05	---	6.91±0.06	---
ESR	ml/h	0.5-1.5	1.68±0.09	+12.0	1.78±0.4	+19.33
Hemoglobin in a single red blood cell	pg	16.5-18.5	18.83±0.02	+1.73	18.87±0.05	+2.0
Color indicator of blood	unit	0.7-1.1	1.13±0.003	+2.73	1.12±0.001	+2.73
Hematocrit	%	35-45	50.01±0.10	+11.16	48.83±0.16	+8.51
Hemoglobin	g/L	95.0-125.0	128.01±0.22	+2.4	130.43±0.17	+6.0

As a result of an abnormal disorder of the respiratory chain and oxidative phosphorylation, catalase activity increases during inhibition of macroergic compounds synthesis in cells, which reduces the activity of ceruloplasmin, the main blood antioxidant.

3. DISCUSSION

The results of the study were compared with reference indices of metabolism in the body of cows. According to the results of the study to determine the concentration of protein

fractions and crude protein in the blood serum of the cattle of the experimental group, a slight decrease in the crude protein content was found, causing significant changes in the proteinogram, the reason for which is the effect of adverse environmental factors on the animal's body, where the protein composition of the blood serum of the cattle inhabiting the technogenic zone undergoes significant transformations in comparison with the reference quantity of proteins. Conclusions regarding changes in the background of protein fractions were carried out according to the results of statistical processing of the obtained data.

Therefore, the obtained results (Table 1) of biochemical studies of the blood serum of experimental animals on a number of indicators of protein metabolism in the body and their comparison with reference quantities can suggest that the strong complex effect of environmental pollution of anthropogenic nature provoke the manifestation of pseudo-adaptation of cows,

temporarily compensating for hidden pathological processes.

The results of the study on the content of lactic and pyruvic acids, in particular, on the increasing lactate/pyruvate coefficient in cows of the first group by 36.16% ($P < 0.01$) and 49.19% ($P < 0.001$) in the second group, allow us to conclude that the organism of the studied animals suffers an energy deficiency under the influence of unfavorable ecosystem factors.

The catabolism of chylomicrons (Chm) and pre-β-lipoproteins (VLDL) in the role of the final product is obtained by β-lipoproteins, which accumulation in the blood of cows under the conditions of lipid metabolism pathology occurs due to a long half-cycle of 3.3 days of their biological life. Probably, the prevailing rate of catabolism over the rate of chylomicron biosynthesis in the intestine and pre-β-lipoproteins in the liver depresses, initially, it rests on changes in lipid metabolism in general, and, in second place, their own levels of indicators, as well as levels of high-density lipoproteins (HDL) of albumin zone.

In our opinion, lipidemia, and hyper-β-lipoproteinemia arose as a result of the intermediate lipid metabolism disorder, as evidenced by the changes established during the study.

The ESR quantity in the blood is 1.68±0.09 mm/g for the 1st and 1.78±0.04 mm/g for the 2nd group of animals, which is caused by inhibition of the albumin fraction, as well as an increase in cholesterol parameters, which led to the transformation of the protein spectrum, inhibition of the charge of red blood cells, as a result of which the rate of their sedimentation increased.

The catalase activity in the blood of experimental cows is 8.97±0.07 and 7.95±0.02 mg H_2O_2 in animals of both groups; this hydroperoxide destroyer forms molecular oxygen, acting as an additional respiratory enzyme.

4. CONCLUSION

The productivity of experimental cows is affected by metabolic disorders in cows that occur against the background of an excess Cu, Fe, Mn, Pb, Ni and Cd in the diets of cows, as well as a lack of Co and Zn in biopathogenic areas. Low indices of the level of β- and γ -two-globulins, albumin in the blood, recession, and supply of necessary plastic materials to intensely forming embryos, suppression of their development rate and the physiological underdevelopment of calves is the result of inhibition of the humoral factor of natural resistance of cows already in the first half of pregnancy due to the prolonged impact on the body of cows of unfavorable factors of agroecosystem.

In our opinion, the step-by-step transformation of the neurohumoral and immune regulatory mechanisms of the adaptive process, which comes close to a significant expenditure of energy, results from a specific change in the activity of basic enzymes in the form of transaminases responsible for the correct cycle of glyconeogenesis due to the patronage of amino acid metabolism products. All this contributes to the weakening of alkaline phosphatase activity, which occurs against the background of a delay in the biosynthesis of proteins that function as immunobiological resistance in animals, which therefore impairs energy metabolism.

Based on the data in Table 2, it can be concluded that a high level of increased activity of blood catalase and a decrease in glucose level confirms the increased involvement of lipids in the metabolism as fundamental sources of energy at the stage of adaptation of cows to abnormal intake of

*Corresponding author (A.K. Saken) Email: aika_saken@mail.ru Volume 11 No.10 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A10E http://TUENGR.COM/V11A/11A10E.pdf DOI: 10.14456/ITJEMAST.2020.188

chemical elements in the body.

Analyzing the respiratory function indices of experimental animals, it can be assumed that negative anthropogenic factors that establish the forced metabolism contributed to the high selectivity of the compensatory mechanisms of the organism of experimental animals to increase the likelihood of oxygen supply to both the mother's body and the forming embryo.

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Note: The original version of this article has been reviewed, accepted, and presented at the International Scientific and Practical Conference "From Inertia to Development: Scientific and Innovative Support for Agriculture" (IDSISA2020) at the Ural State Agrarian University, Ural, Russia, during 19-20 February 2020.