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Research Article

Natural Immune Resistance of Young Pigs on the Background of the Use of Mineral Substances

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ABSTRACT

The results of the studies on the effectiveness of the use of natural sorbents for increasing the natural immune resistance of young pigs are presented here. It was discovered that in order to increase the immune resistance of young pigs for fattening and reduce the concentration of heavy metals in their organs and tissues, it is expedient to use bentonite clay of Zyryanskoeregion origin as a part of concentrated feeds, which contains oxides of essential elements (in %): calcium - 1.89, phosphorus - 0.03, magnesium - 1.25, natrium - 0.47, potassium - 0.50, iron - 0.85, manganese - 0.01, copper - 0.08, zinc -0.04. Feeding of bentonite in a dose of 3% of the weight of the feed promotes an increase in the level of cellular immunity in the blood of young pigs for fattening, while the reference ranges for peripheral bloodwere within the physiological normal limits. Phagocytic, lysozyme and bactericidal activity of blood serum in the animals of the experimental group was 7.66%, 3.73% and 9.39% higher than in the control group analogues. The introduction of bentonite of the Zyryanskoeorigin into diets of fattened pigs has a positive effect on the removal of toxic elements from the organs and tissues of young pigs. The use of 3% bentonite of Zyryanskoeoriginin the pig mixed fodders promoted the deposition of copper in the liver and spleen, as well as a decrease in the concentration of heavy metals in organs and tissues. In the animals of this group, in comparison with the control group, the copper concentration was significantly higher by 68.10 - 38.06%, the concentration of cadmium was lower by 21.61-40.04%; the lead content level is lower by 13.96-29.84%.

Keywords: young pigs, bentonite clay, sorbents, immune resistance, heavy metals.

1. INTRODUCTION.

In the modern conditions of intensification of industrial pig production and obtaining the maximum of its productivity, the process of reducing the natural immune resistance of the organism is noted, which leads to premature culling and death of pigs. In this connection, it is necessary to find and apply new animal feeds and technological methods that ensure not only a high level of productivity, but also affect the increase in the overall immune resistance of the organism [1,9]. The diversity of sedimentary, volcanic and other rocks predetermined the wide use of various types of minerals: zeolites, bentonites, phosphorites, glauconites, etc. In foreign countries, due to their unique physicochemical properties and rich composition, these minerals play an important active and increasing role in many areas of human activity: industry, building, medicine, agriculture and environmental protection. In agriculture, aluminosilicates are used as dietary supplements in animal feeds, which leads to the reduction in morbidity, increase in population of livestock and its productivity, and improvement in the product quality [2, 3].To increase the natural immune resistance of the animal organismin our country and abroad we began to apply substances of natural origin: travertine, sapropel, bentonite and zeolite clays and other additives that have a stimulating effect on the physiological and productive indicators of animals [4, 6, 9].

2. PECULIARITIES OF CHEMICAL COMPOSITION OF BENTONITE OF ZYRYANSK REGION ORIGIN.

In recent years, natural minerals have been used as fodder additive for animals: limestone, clays, phosphatides, opoka, kudurites, etc.Bentonitesare, regardless the origin, finely divided clays consisting of not less than 60-70% minerals of the montmorillonite group ($A1_20_3$x 4SiO x H_2O), which have a high binding capacity, adsorption and catalytic activity. In this case, various elements, most often aluminum and calcium, can be used as cations in the montmorillonite molecule.

The chemical composition of natural bentonite clays of various origins and even individual varieties of these clays can differ significantly from each other. This is due not only to a different characterization of origin rocks, but also to the fact that these clays in their natural form are often clogged with extraneous impurities in the form of gypsum, calcite, magnetite, biotite, silica minerals, and water-soluble salts of alkali and alkaline earth metals, etc. These impurities sometimes constitute a large percentage, greatly reducing the quality of bentonites.Zyryanskoe origin of bentonite clays is located in the Russian Federation, Kurgan region, Ketovskyarea, 4 km from the railway stationZyryanka. The landscape is an almost flat surface. The region is located on the border of the forest and forest-steppe zone, 95% of the area is plowed up for grain crops. Soil origins belong to the category of leached soils [4,5].The average chemical composition of bentonite clays of the Zyryanskoe origin in comparison with bentonites from other origins is presented in Table 1.

Table 1 Chemical analysis of bentonite of various origins

Component	Origin				
	Zyryanskoe, Russia	Biklyanskoe,*Tatarstan, Russia	Nurlanskoe,*Tatarstan, Russia	Cherkasskoe,* Ukraine	Kolesskoe,* Kazakhstan
$Si0_2$	54,81	46,80	45,20	50,40	54,84
$Ti0_2$	0,93	1,10	0,83	1,02	0,81
$A1_20_3$	16,12	20,90	18,80	19,12	15,12
Pe_20_3	6,28	6,76	8,04	7,29	6,74
FeO	0,14	-	-	-	0,20
CaO	2,20	2,55	2,51	0,60	1,32
MgO	1,56	2,25	3,08	2,05	3,68
K_2O	0,69	1,90	2,04	0,45	1,35
Na_2O	0,38	0,70	0,98	0,50	0,75
$S0_3$	0,07	-	1,83	-	0,15
$C0_2$	2,36	-	-	-	-
ППП. H_2O**	14,09	13,99	16,84	18,80	14,92

* According to I.N. Mikolajchik, A.P. Bulatova, 2008 [6].

** – loss of moisture on ignition.

The presented data indicate that the chemical composition of the bentonite of Zyryanskoe origin does not differ significantly from the composition of bentonite clays of known exploitable origins of similar genesis.Studies have found that Zyryanskoebentonite contains (in %): calcium - 1.89, phosphorus - 0.03, magnesium - 1.25, natrium - 0.47, potassium - 0.5, iron - 0.85, manganese - 0.014, copper - 0.08, zinc - 0.04 and ash - 85.2.The bentonite of Zyryanskoe origin has a color from light brown to dark brown, odorless, the pH indicator of its aqueous suspension is 8-9 (Table 2).

Table 2 Organoleptic and physicochemical parameters of bentonite of Zyryanskoe origin

Index	Characterization and norms
Appearance:	
-in natural reservoir	dark brown
-in powder	light brown
Odor	absent
Natural humidity, in %	28
Sieve analysis of the suspension:	
Residue on a sieve with a grid № 0.65, in%, no more than	0.10
№ 0.1, in %,no more than	10.0
pH indicator of aqueous suspension, no less than	8-9
Swelling, %	17.8-32.9
Mass fraction of sand, in %, no more than	5
Friability, in points, no less than	4
Dispersibility, in %,no more than	3-4
Specific gravity, ing/m^3	1.93-2.62
Colloidality, in %	38
Number of pliability, in cm	32
Coefficient of porosity, in %	0.52-0.8
Total porosity, in %	34.2-44.5
Coefficient of soil compaction under loads, kg/cm^2	0.5-4

In the Zauralskiy origin, where elements like magnesium and calsium significantly prevail, makes it possible to classify the bentonites of the Zyryanskoe origin as an alkaline-earth type (Table 3). The results of studies of 70% of samples indicate that the ratio of exchangeable cations is represented by Mg2 +> Ca2 +> Na +> K +, and 30% - Ca2 +> Mg2 +> Na +> K +. The predominance of magnesium in the exchange complex is a distinctive feature of betonite of the Zauralskiy origin compared to the others. The total amount of cations ranges from 45.28 to 94.96 mg.eq. The alkalinity coefficient varies from 0.07 to 0.24, which emphasizes the alkaline-earth composition. In accordance with this, in the direction from magnesium to potassium, the content of alumina decreases insignificantly (by 1-2%).
Within the industrial layer of bentonite deposits in the upper part of the incision, the content of calcium and magnesium oxides (CaO + MgO) is slightly higher than in the middle and lower layers. It was found that calcium and magnesium are structurally related in amounts of 0.8-2.0%. The content of sodium oxide, potassium oxide and loss of moisture on ignition is approximately constant.

Table3 Exchangeablecation complex, in %

Origin	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Всего	Alkalinity factor
Zyryanskoe	27,89	30,18	5,46	0,87	64,40	0,11
Biklyanskoe*	41,3	31,4	1,6	0,1	74,4	0,02
Nurlanskoe*	25,9	8,2	3,0	3,3	40,4	0,20
Cherkasskoe*	39,2	19,4	3,5	4,2	66,9	0,14
Kolesskoe*	-	22,21	26,6	3,3	52,0	1,4

* According to I.N. Mikolajchik, A.P. Bulatova, 2008 [6].

The chemical composition of individual clay particles of bentonite shows that all the chemical elements are in the form of oxides. This is an important factor in the possible use of this mineral complex in the feeding of farm animals and poultry, since all the basic micro- and macroelements circulate in the body in conjunction with oxygen. In addition, Zyryanskoebentonite is rich in aluminum and iron oxides.

3. USE OF NATURAL SORBENTS IN PIGINDER.

In order to study the effect of bentonite on the immune resistance of young pigs of large white breed, according to the principle of analogs, taking into account age, live weight and origin - 4 groups of animals, 10 animals in each groups, of the age of 4 months, were formed. The conditions of living, conditions of feeding and drinking, the microclimate parameters in all groups were all the same. The animals of the control group received the basic diet. In addition to the basic rations, the pigs of experimental groups were given Zyryanskoebentonitein amnount of 1, 3 and 5% of the from the mass of the feed. Bentonite was given in a mixture with concentrated food during morning feeding. The accounting of the given feeds was made every day,the accounting of feed consumption was made every ten days, for two adjacent days.Control over the full value of feeding and the state of health of young pigs was carried out by studying the morphological and biochemical reference ranges of blood, as well as indicators of natural immune resistance. For this purpose, blood was taken from the auricularisvein in the morning 2 hours prior to feeding in three animals from each group. Studies of blood and serum were performed according to generally accepted methods.The content of elements like Cu, Zn, Cd, and Pb was determined on an atomic absorption spectrophotometer "Saturn-11 P-1" in an air-acetylene flame.

4. MORPHOLOGICAL, BIOCHEMICAL AND IMMUNOLOGICAL REFERENCE RANGES OF BLOOD.

Studies have established that the reference ranges of peripheral blood of young pigs on fattening were within the limits of physiological norms (Table 4).

Table 4 Morphological and biochemical references ($\overline{X} \pm S_{\overline{x}}$)

Test	Group			
	Control group	1stexperimental group	2nd experimental group	3rdexperimental group
Erythrocytes, 10^{12}/l	6,50 ± 0,26	6,73 ± 0,28	6,97 ± 0,41	6,80 ± 0,44
Hemoglobin, g/l	105,33 ± 1,45	107,67 ± 3,38	113,67 ± 2,60*	108,00 ± 3,21
Blood color index	1,06 ± 0,04	1,05 ± 0,07	1,07 ± 0,06	1,04 ± 0,04
Leukocytes, 10^9/l	9,35 ± 0,38	9,37 ± 0,27	9,40 ± 0,38	9,48 ± 0,29
Alkaline reserve, mg%	459,30 ± 0,89	470,60 ± 1,14	499,70 ± 1,11*	491,00 ± 1,15
Calsium, mmol/l	2,70 ± 0,32	3,47 ± 0,41	3,87 ± 0,24*	3,50 ± 0,49
Phosphorus inorganic, mmol/l	4,56 ± 0,20	4,69 ± 0,23	4,92 ± 0,17	4,86 ± 0,15

The content of red blood cells in the blood of young pigs was at the level of 6.50-6.97 * 10^{12} / l with a tendency to increase in the experimental groups. The hemoglobin level in the animals of the 2nd experimental group was 7.92% ($P < 0.05$) higher than in the control group.The blood color index makes it possible to see the saturation of erythrocytes with hemoglobin [6]. The results of the studies do not reveal significant differences between the control and the experimental groups.The use of bentonite in rations of young pigs had no effect on the content of leukocytes in the blood, which varied within 9.35-9.48 * 109 / L.In the animals of the control group, the alkaline reserve of blood serum was less than in the 1st experimental group by 11.30 mg%, the 2nd experimental group by 40.40 mg% ($P < 0.05$) and by 31.70 mg% than in the 3rd experimental group.

The calcium content in the blood serum of the animals of the 2md esperimental group was significantly higher than in the control group by 43.33% at $P < 0.05$. The concentration of inorganic phosphorus was also higher in the blood of the animals in the experimental groups. The difference with the control group and the animals of 1st experimental group was 2.85%, 2nd experimental group -7.89 and 3rd experimental group -6.58%.

The information shows that the introduction of bentonite into the pig's diet promoted an increase in the total protein content in the blood serum of animals in the experimental groups. Its highest content value was found in the serum of animals of the 2nd experimental group - 83.67 g/ l, which is 8 g/l or 10.56% ($P < 0.05$) more than in the control group.The albumin value in the blood serum of the animals of the control group was less than that of the gilts of the experimental groups (Table 5).

Table 5 The content of total protein and its fractions in blood serum ($\overline{X} \pm S_{\overline{x}}$)

Test	Group			
	Control group	1stexperimental group	2ndexperimental group	3rdexperimental group
Total protein, g/l	75,67 ± 1,86	80,33 ± 2,60	83,67 ± 2,03*	82,00 ± 2,08
Albumins, %	40,01 ± 0,39	40,44 ± 0,69	41,77 ± 0,30*	41,66 ± 0,22*
Globulins, %	59,99 ± 0,39	59,56 ± 0,69	58,23 ± 0,30*	58,34 ± 0,22*
α-globulins, %	19,41 ± 1,08	20,21 ± 0,85	21,65 ± 0,69	21,39 ± 0,57
β-globulins, %	17,86 ± 0,50	18,57 ± 0,37	17,52 ± 0,17	17,73 ± 0,30
γ-globulins, %	22,72 ± 0,95	20,78 ± 0,34	19,06 ± 0,74*	19,22 ± 5,16*
Albumin-globulin ratio	0,67 ± 0,01	0,68 ± 0,02	0,72 ± 0,01*	0,71 ± 0,01

The highest indicator of the total protein was in animals of the 2nd experimental group - 41.77%, which is 1.76% (P <0.05) higher than in the control group; 1.33% than in 1st experimental group and 0.11% than in the 3rd experimental group. In the control analogues, the mass fraction of albumins was less than that of the 1st experimental group by 0.41%, 2nd experimental group by 1.76% (P <0.05), and the 3rd experimental group by 1.65% (P < 0.05). The level of globulins in animals of 2nd and 3rd experimental groups was less than in the control group by 1.76 and 1.65% respectively. A significant difference was established by the value of the albumin-globulin ratio between the control group and the 2nd experimental group (P <0.05), with the advantage of the pigs that were fed with bentonite.

Indicators of cellular and humoral immunity of blood serum of young pigs are presented in Table 6. Phagocytic activity in animals of the 1st experimental group is 1.66%, 2nd experimental group - by 7.66 (P <0.05) and 3rd experimental group - by 8.00% (P <0.05) more than in the control group.In pigs of 2nd and 3rd experimental groups the phagocytic index of 0.34 and 0.26 is significantly (P <0.05) bigger than in the control group. In the blood of pigs of 2nd experimental group, who received 3% of bentonite from the weight of the feed, the phagocytic number is 0.72% (P <0.05) higher than in the control group.

Table 6 Indicators of cellular and humoral immunity ($\overline{X} \pm S_{\overline{x}}$)

Indicator	Group			
	Control group	1stexperimental group	2ndexperimental group	3rdexperimental group
Phagocytic activity, %	56,67 ± 1,76	58,33 ± 2,03	64,33 ± 1,86*	64,67 ± 1,45*
Phagocytic index	6,43 ± 0,09	6,64 ± 0,11	6,77 ± 0,07*	6,69 ± 0,24
Phogocytic number	3,64 ± 0,07	3,88 ± 0,19	4,36 ± 0,17*	4,32 ± 0,14*
Phagocytic capacity, thousand micr. bodies	34,09 ± 2,02	36,39 ± 2,74	41,11 ± 3,31	41,02 ± 2,29
Lysozyme activity, %	37,98 ± 0,54	40,26 ± 0,61*	41,71 ± 0,56**	40,67 ± 0,54**
Bactericidal activity, %	52,73 ± 2,62	56,97 ± 0,61	62,12 ± 1,09*	60,00 ± 1,39

The phagocytic capacity of the blood in the pigs of the control and experimental groups did not differ significantly, although there was a clear tendency of increasing of this index in the experimental groups.

Lysozyme activity of blood serum in pigs of experimental groups was significantly higher in 1st experimental group by 2.28% (P <0.05), in 2nd experimental group - by 3.73 (P <0.01) and in 3rd experimental group - by 2, 69% (P <0.01) than in the control group.

The bactericidal activity of blood serum in the animals of the 1st experimental group was 4.24%, in the 2nd experimental group - by 9.39 (P <0.05) and in the 3rdexperimental group - by 7.27% more, as compared to the control group .

In the provision of nonspecific immunity of the organism, a large role is played by cells of the leukocyte profile. The functions of the leukocyte species are different. Therefore, when studying the mechanisms of natural immune resistance, it is necessary to determine the dynamics of the content of leukocyte forms in the blood [7,8].Experimental data show that the level of white blood cells in pigs of control and experimental groups has significant differences (Table 7).

Table7 Leukocytecount, % ($\overline{X} \pm S_{\overline{x}}$)

Test	Group			
	Control group	1stexperimental group	2ndexperimental group	3rd experimental group
Neutrophils:				
immature	0,57 ± 0,32	0,50 ± 0,26	0,27 ± 0,18	0,43 ± 0,15
stab	3,93 ± 0,18	3,40 ± 0,25	2,57 ± 0,20**	2,87 ± 0,09**
segmented	46,43 ± 0,20	46,60 ± 0,36	47,30 ± 0,23*	46,63 ± 0,30
Eosinophilis	3,10 ± 0,15	2,77 ± 0,20	2,83 ± 0,12	2,83 ± 0,32
Basophilis	0,77 ± 0,09	0,87 ± 0,15	0,67 ± 0,09	0,63 ± 0,15
Monocytes	3,00 ± 0,12	3,17 ± 0,67	3,17 ± 0,12	3,43 ± 0,19
Lymphocytes	42,20 ± 0,21	42,70 ± 0,12	43,20 ± 0,21*	43,17 ± 0,37

The main function of neutrophils is to protect the body from microbes and their toxins. Neutrophils accumulate in places of tissue damage and where themicrobs penetrate the organism. The participation of neutrophils in the realization of the immune response is not limited only to phagocytosis, but they can also release substances that possess both bactericidal and antitoxic properties into the blood.In the experimental groups there are fewer immature and stab neutrophils. An increase in the proportion of these forms of white blood cells may indicate negative tendencies in the state of animal health. The part of stab neutrophils in young pigs of the 2nd experimental groups was 1.36% (P <0.01) less than in the control group. The number of immature neutrophils in the blood of the pigs of the experimental groups was also less than in the control group. The number of immature neutrophils in the 2nd experimental group was almost half that in the control group (0.27% and 0.57% respectively).The content of segmented neutrophils in animals of the 2nd experimental group was 0.87% (P <0.05) higher than in the control group; and by 0.70 and 0.67% higher compared to the 3rd experimental group.Eosinophils play an important role in the destruction and disinfection of toxins of protein origin and foreign proteins. The main function of eosinophils is to trigger allergic reactions, mainly of immediate type. In our experience, the content of eosinophils in the blood of the animals of the control and experimental groups did not differ significantly.Monocytes are active phagocytes that capture and digest both microbes and fragments of destroyed cells of the body. Penetrating to the place of inflammation from the blood, monocytes are transformed into macrophages - giant phagocytic cells that participate in the processes of cellular immunity. There were no significant differences in the amount of monocytes between the groups, but there was a tendency to a slightly larger content in the experimental groups.Lymphocytes play an important role in the development of protective reactions and preservation of the integrity of the organism. They have the ability to distinguish between "one's own" and "another's" in the body, based on the antigenic differences in the proteins of the body's own tissues and foreign proteins. Lymphocytes not only destroy pathogenic agents, but also protect the body from any foreign tissues and proteins.The content of lymphocytes in animals of the 2nd experimental group was 1.00% higher than in the control group, 0.50% compared to the 1st experimental group and 0.03% to the 3rd experimental group.Thus, the use of bentonite in the Zyryanskoe origin in the rations of young pigs on fattening had a positive effect on the morphological, biochemical and immunological reference ranges of peripheral blood. In this case, animals that received 3% of bentonite had a higher level of natural immune resistance.

5. INFLUENCE OF BENTONITE ON THE CONTENT OF ESSENTIAL AND TOXIC METALS IN ORGANS AND TISSUE OF PIGS.

Pollution of the environment and reduction of the sanitary culture of enterprises contributes to getting ofsubstances that pose a threat to the health of animals and humans into the food products. A special group of toxic substances are heavy metals. The problem of manufacturing environmentally friendly pig production requires a solution of a number of complex issues, including the search for ways to remove toxic elements from the organisms of the pigs. The use of detoxicants of natural and industrial production contributes to the removal of heavy metals from the body. The bentonite clay can be attributed to the group of detoxicants, which has sorption and ion-exchange properties.In this regard, at the end of the thisscientific experiment, a control slaughter was carried out for 3 pigs from each group to determine the content of copper, zinc, lead and cadmium in tissues and organs.Analysis of the results showed that the content of toxic elements in the organs and tissues of young pigs did not exceed the threshold limit value and corresponded the requirements of the Technical Regulations of Eurasian Customs Union "On the Safety of Meat and Meat Products" (TR TC 034/2013).The introduction of the bentonite of Zyryanskoe origin in the diets of fattened pigs did not have a significant impact on the copper content in muscle tissue, heart, lungs and kidneys, but contributed to a significant increase of its concentration in the liver and spleen (Fig.1)

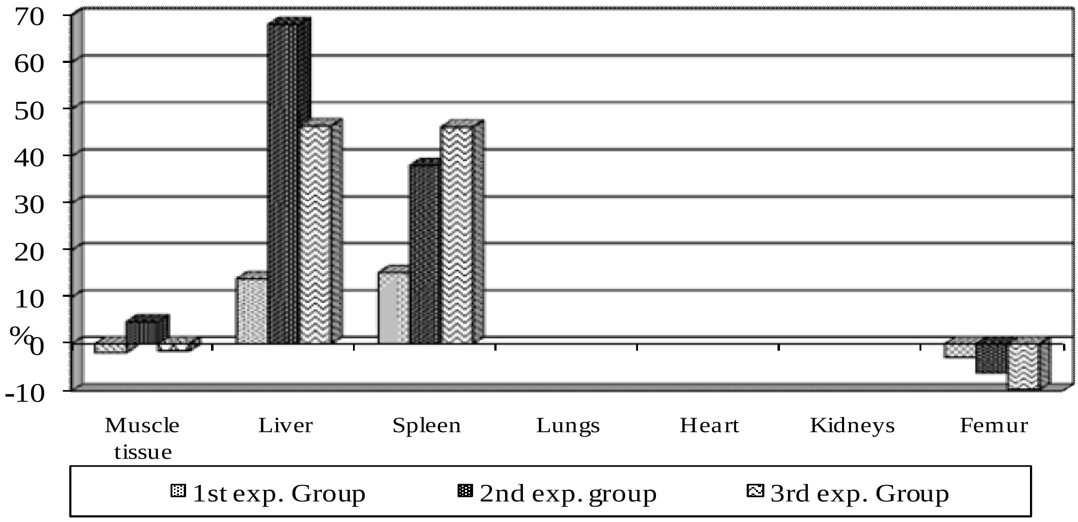

Figure 1 - Content of copper in organs and tissues of pigs, in %

The content of copper in the liver of animals of the 1st experimental group was 13.91%; 2nd experimental group - 68.10% (P <0.01); 3rd experimental group - 46.63% (P <0.05) more than in the control group. The level of copper in the spleen of the young pigs of the control group was 3.81 mg/kg, which is 13.91% less than in the 1st experimental group; 38.06% (P <0.05) than in the 2nd experimental and 46.19% (P<0.05) than in the 3rd experimental groups. In this case, bentonite promotes the excretion of copper from bone tissue. Thus, in the femur, the content of copper in pigs of the 1st experimental group was 2.82% less than in the control group, and in the 2nd experimental group by 6.12%, and in the 3rd experimental group by 9.64%.Thus, bentonite clay contributed to the deposition of copper in the liver and spleen. It can be assumed that this will opportunely affect the hematopoietic function.

Distribution of zinc in the body of young pigs is shown in Figure 2.

Analysis of the results of this studies showed that the zinc level in the liver of the animals of the control group was 21.88 mg/kg, which is 7.08% less than in the 1st experimental group; 29.30% less than in the 2nd experimental group; 23, 08% less than in the 3rd experimental group. The same regularity was observed in the content of zinc in the lungs and the femur. Its content in the bones of the first test group was 5.57% higher than in the control group and 12.08% (P <0.05) and 12.31% (P <0, 05) in the 2nd and 3rd experimental groups.

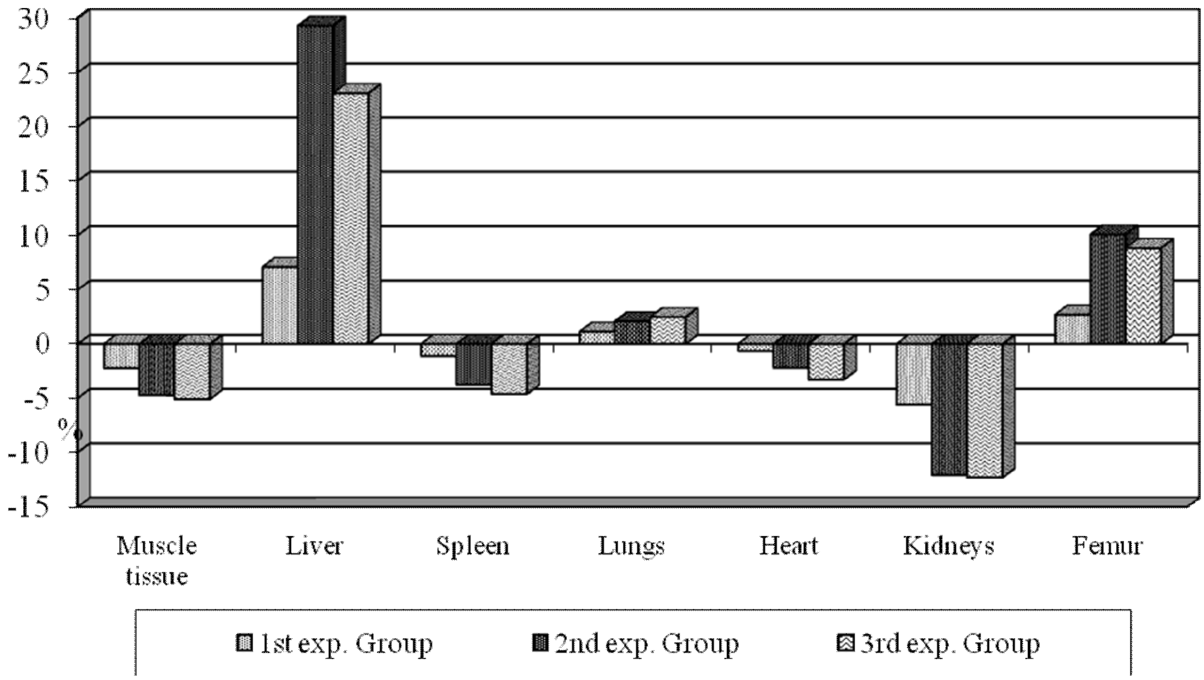

Figure 2 - Zinc content in organs and tissues of pigs, in %

Under the influence of bentonite additives, the amount of zinc in muscle tissue, spleen, heart and kidneys decreases. The maximum decrease in zinc concentration was observed in the kidneys, which is obviously related to the removal of zinc from the body as a whole and directly from the organ itself. The zinc content in the kidneys was 5.57%in the animals of the 1st experimental group, the 2nd experimental group - 12.08% (P <0.05) and 3rd experimental group - 12.31% (P <0.05) less than in the control group.Thus, the use of bentonite contributes to the deposition of zinc in the liver and bones, lesser in the lungs, and, on the contrary, removes it from muscle tissue, heart, spleen and kidneys.Cadmium is one of the most toxic elements that can accumulate in the body for many years [10]. The use of bentonite in young pigs'rations has made it possible to reduce its concentration in all organs and tissues, with reliable results obtained from the deposition of cadmium in muscle tissue, liver, lungs,heart, femur, and kidneys (Figure 3).

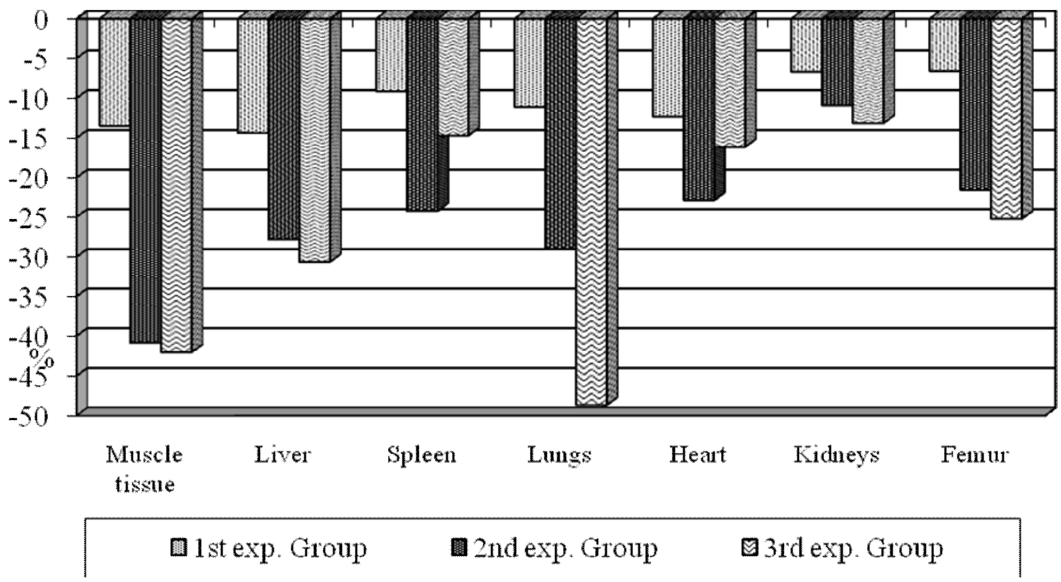

Figure 3 - Cadmium content in organs and tissues of pigs, in %

The use of bentonite contributed to a decrease of concentration of cadmium in muscle tissue in animals of the 1st experimental group by 13.47%, 2nd experimental group by 40.04% (P <0.05), and 3rd experimental group by 40.82% (P <0, 01) than in pigs of the control group.Study of the liver showed that the cadmium level in young pigs of the control group was 0.0209 mg/kg, which is 14.35% more than in the 1st experimental group, at 27.75% (P <0.05) in the 2nd experimental group and 30.62% (P <0.05) in the 3rd experimental group. In animals of the 1st experimental group the cadmium content in the lungs was 11.08%, 2nd experimental group - 28.92% (P <0.05) and 3rd experimental group - 48.67% (P <0.05) less than in control group. The cadmium content in the spleen and kidneys did not show significant differences between the groups, but there was a clear tendency of reducing this element in the experimental groups. The use of bentonite in rations of young pigs promotes the excretion of cadmium from bone tissue. Thus, in the femur, the cadmium content in the pigs of 1st experimental group was 6.58% less than in the control group; in the 2nd experimental group - 21.61%; in the 3rd experimental group - 25.23%.Along with cadmium, lead compounds are the most toxic to the body and can accumulate over the years. Figure 4 presents data on the effect of bentonite on the distribution of lead in tissues and organs of pigs.Analysis of the results showed that the level of lead in the main production of pigs - muscle tissue, was 0.2369 mg/kg in the control group, which is 18.958% (P <0.05) less than in the 1st experimental group; 29.84% (P <0.05) less than in the 2nd experimental group and 39.68% (P <0.01) less than in the 3ed experimental group. In the liver of pigs of 1st group the lead level was 21.46% less than in the control group; and lesser than in groups 2 and 3 - by 24.21% (P <0.05) and 30.07% (P <0.05). There were no significant differences in lead content in the spleen and kidneys, but there was a tendency of decreasingof the concentration of this element in the experimental groups.

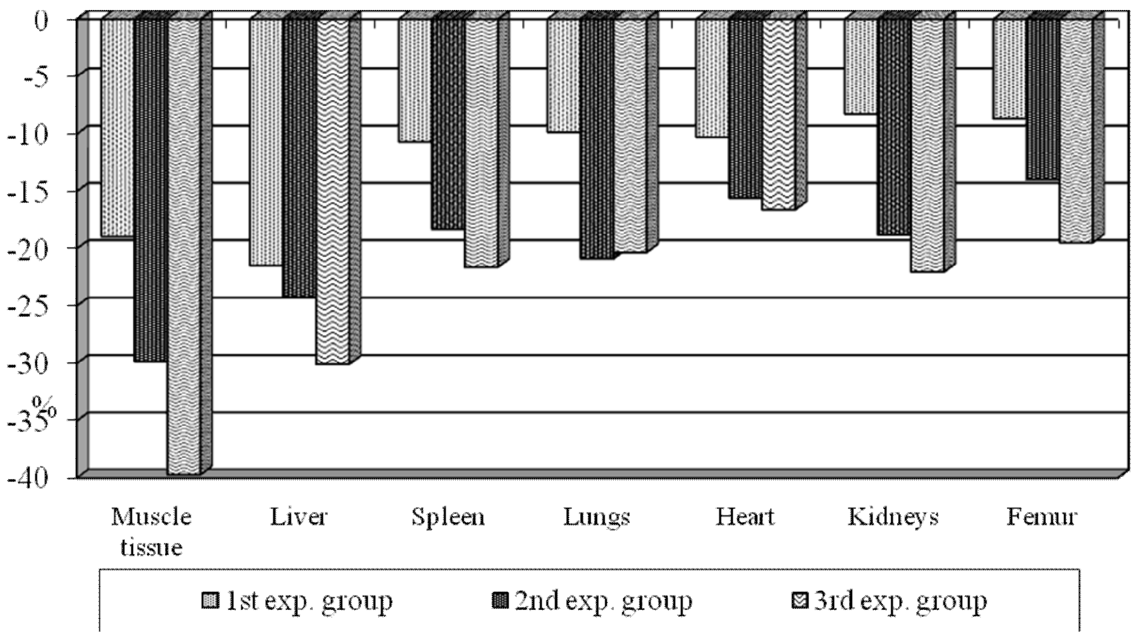

Figure 4 - Effect of bentonite on the content of lead in organs and tissues of pigs, in %

In the lungs and hearts of pigs of 1st experimental group the lead content was 9.82% and 10.27% respectively; the 2nd experimental group - 20.85% and 15.58%; and 3rd experimental group - 20.32% and 16.60% less than in the control group. In the animals of the 1st experimental group the lead content in the femur was 8.66% (P <0.05), 2nd group - 13.96% (P <0.01) and 3rd group - 19.47% (P < 0.01) less than in the control group.Thus, bentonite affects the distribution of heavy metals in organs and tissues. In this case, there is a need for a comprehensive study of the natural immune resistance of animals, since the features of the manifestation of reactions providing the protective functions of the pig's body have been poorly studied, knowledge of which will allow us to correctly solve the question about the most rational use of feed resources and to maximize the productivity and health safety of pigs.

7. CONCLUSIONS.

1. As a mineral additive for the growing and fattening of young pigs, it is expedient to use the bentonite of Zyryanskoe origin, which contains oxides of essential elements (in %): calcium - 1.89, phosphorus - 0.03, magnesium - 1.25, sodium - 0 , 47, potassium - 0.50, iron - 0.85, manganese - 0.01, copper - 0.08, zinc -0.04.
2. Using the 3% bentonite of Zyryanskoe origin increases the level of cellular immunity in the blood of young pigs. The phagocytic, lysozyme and bactericidal activity of their blood serum was higher than that of the control analogues by 3.73-9.39%.
3. Use of the 3% bentonite of Zyryanskoe origin in mixed fodder of pigs promoted the deposit of copper in the liver and spleen, as well as reducing the concentration of heavy metals in organs and tissues. In the animals of this group, in comparison with the control analoguess, the copper concentration was significantly higher by68.10 - 38.06%, the concentration of cadmium was lower by 21.61-40.04%; the lead content level is lower by 13.96-29.84%.

8. CONCLUSION.

The use of bentonite is a positive direction for improving the feeding system of young pigs for fattening, as their level of natural immune resistance increases; an increase of the concentration of certain essential elements in tissues and organs is noted; and the concentration of toxic elements in muscle tissue, liver, lungs, kidneys and bones decreases. On the basis of the obtained results, it can be stated that a more pronounced effect positively affecting the physiological state of the young pigs, is the feeding of the 3% betonite of Zyryanskoe origin in the concentrated animal feeds.

The advantage of using the natural minerals is the presence in their composition of a balanced complex of biologically active substances in a form readily available for digestion. It is also possible to use bentoniteZyryansky deposit in the feeding of pigs of other technological groups.

9. CONFLICT OF INTERESTS.

The authors confirm that the presented data do not contain a conflict of interest.

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REFERENCE

1. Mikolajchik I. Influence of bentonite on the productivity of young pigs // Pig breeding. 2004. № 6. P. 14.
2. Morozova L.A., Mikolajchik I.N. Milking of cows based on rations, enriched with padded grain mixture // Zootechnics. 2009. № 3. P. 11-13.
3. Mikolajchik I.N., Morozova L.A. Biological bases of application of a mineral-vitamin premix based on bentonite during milking of cows // Reports of the Russian Academy of Agricultural Sciences. 2009. № 3. P. 54-56.
4. Bulatov A.P., Mikolajchik I.N. Influence of natural sorbents on product quality and natural immune resistance of young pigs // Reports of the Russian Academy of Agricultural Sciences. 2006. № 1. P. 43-46.
5. Mikolajchik I. N., Bulatov A. P. Feeding of young pigs: theory and practice. Kurtamysh, 2008.235 p.
6. Bykova O.A. Morphological composition and metabolites of blood of young cattle // Agrarian Bulletin of Ural. 2017. No. 5 (159). C. 1.
7. Donnik I.M. Adaptation of imported livestock in the Ural region // Agrarian Bulletin of Ural ..2012. 24-26.
8. Tairova A.R., Sharifyanova V.R., Meshcheryakova G.V., Donnik I.M., Bykova O.A. Evaluation of the plastic resources of the organism of the calves of the early postnatal period of growth// Agricultural Bulletin of Ural. 2017. No. 8 (162). C. 7.

9. Donnik I.M., Loretts O.G., Bykova O.A., Shkuratova I.A., Isaeva A.G., Romanova A.A. USAGE OF NATURAL MINERALS FOR EFFECTIVE INCREASE IN BIOLOGICAL VALUE OF MILK IN ANIMAL INDUSTRY // International Journal of Advanced Biotechnology and Research. 2017. T. 8. № 4. P. 923-933.
10. Isaeva A.G., Krivonogova A.S., Donnik I.M., Shkuratova I.A., Drozdova L.I., Bespamyatnyh E.N. BIOLOGICAL FULL VALUE OF MEAT RAW MATERIALS OF PIGS IN THE TECHNOGENIC POLLUTION CONDITIONS OF TERRITORIES // Indo American Journal of Pharmaceutical Sciences. 2017. V. 4. 11. 11. P. 4130-4136.