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Influence of biologically active preparations on biochemical indicators of sows' blood and the survival level of sucking pigs

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ABSTRACT

The analysis of the influence of biologically active preparations on the biochemical status of the body of sows is given in the article. Nanoaquachelate of Ge (G18Ge and G9Ge groups) and Quatronan-Se (Q-Se group) were used 4 days before and 10 days after farrowing, Glutam 1M was used 3 days after the farrowing (GM1, G18Ge and G9Ge groups). Based on the results obtained, it has been found that use of preparations in the period from 4 days after the farrowing to weaning contributes to lower cholesterol level in the G18Ge, G9Ge and Q-Se groups by 21.7%, 29.2 % and 33.3%, respectively. Also, significant changes have been observed in the in the concentration of protein, in all groups to which the studied drugs were administered before weaning it tended to decrease by 9.9; 7.6; 6.6 and 6.3%, respectively, while in the group C (control) the difference was only 1.6%. In addition, a study of the influence of preparations on the body of piglets through sow milk shows that the level of piglets' survival in the GM1, G18Ge, G9Ge and Q-Se groups was higher than in the C group. The highest survival has been observed in the G18Ge group and on the day of weaning was 90.2%.

Keywords: Blood, Glucose, Nanoaquachelate, Piglets, Sows.

INTRODUCTION

One of the most important periods for sows is farrowing, characterized by several metabolic changes in their body, increased oxidative processes and physiological immunosuppression. The action of antigenic factors, violation of the technology of pregnant sows breeding and growing load on their body, associated with precocity and fertility, leads to defective fetal development and the birth of piglets with low viability (Ohorodnyk *et al.*, 2016).

To mitigate the effects of various stresses during pregnancy and farrowing for sows and postnatal adaptation in piglets, to increase their growth and safety, it is important to use environmentally friendly, low-toxic and highly effective biologically active substances (Hansen *et al.*, 2012; Lin *et al.*, 2021).

One of these substances is glutamate. Glutamate is the second most abundant substance in milk and plays an important role in the neonatal development and growth of pigs and has a favorable effect on the growth and health of piglets.

The results of research by R. Santos de Aquino *et al.* (2014) showed that glutamate and glutamine supplementation enhanced immune function in sows.

Trace elements also play an important role in the body of animals. An alternative to trace element salts are nanocarboxylates and nanoacquahelates of metals, which have an absorption rate of 90-95%. Due to their size of up to 100 nm, they easily pass through the cell membrane, and are quickly absorbed and broken down (Nischemenko *et al.*, 2018). One of these supplements containing nanocarboxylates of trace elements is Quatronan-Se, which contains Se, Cu, Mn, Cr and Ge. Each of these trace elements plays an important role in the body of animals. Selenium injections help to increase the live weight and resistance of animals. It increases the absorption of copper by about 17.2%, zinc by 10.2% and manganese by 35.2% and 32.1% (Pirova *et al.*, 2012). Copper cations help to increase the body's immunobiological resistance to the harmful effects of environmental factors (Espinosa and Stein , 2021; Hilal *et al.*, 2016). Mn plays a role in development, digestion, reproduction, antioxidant protection, immune function and hematopoiesis and affects mineral and carbohydrate metabolism (Hilal *et al.*, 2016). Ge has a stimulating effect on the synthesis of immunoglobulins, and interferon is involved in the process of oxygen transport in body tissues (Nischemenko *et al.*, 2018). The determination of biochemical parameters of blood is one way to assess the health of animals and the impact on their bodies of biologically active preparations.

In connection with the above, the study was aimed to determine whether the biologically active preparations Glutam 1M, Nanoaquachelate Ge and Quatronan-Se do not have a negative impact on blood biochemical indicators of sows and whether they affect the survival of suckling piglets.

MATERIALS AND METHODS

Research of the action of biotechnological preparations on the dynamics and biochemical parameters of the blood of sows has been conducted at the experimental farm "Stepne" in the Poltava region , Ukraine.

A total of 25 sows were selected for the study by the analog method, animals were selected by age, farrowing, live weight and origin. Sows were divided into five groups. The average live weight of sows was 200-220 kg. The live weight of piglets was determined by weighing on the day of birth, on the 11th day of the suckling period and on the day of weaning, respectively. In the control group the live weight of piglets during these periods was 1.56, 2.84, 4.53 kg; GM1 - 1.53, 3.22, 5.07 kg; G18Ge - 1.76, 3.49, 5.5 kg; G9Ge - 1.55, 3.19, 4.85 kg; Q-Se - 1.58, 3.27, 5.05 kg. To eliminate stress for sows, drugs have been individually added to a dry feed in the morning once a day. For the purity of the experiment, sows in the C group (control) saline were administered to the feeding 4 days before and 10 days post-farrowing as well. For animals of the GM1 group Glutam 1M for 3 days after the farrowing at a dose of 18 mg/kg of a live weight has been used. For sows of the G18Ge experimental group nanoaquachelate of Ge at a dose of 5 mg/kg 4 days before and 10 days after farrowing was introduced; and Glutam 1M – 18 mg/kg – in 3 days after the farrowing. In the G9Ge group preparations have been used according to the same scheme as for the animals of the G18Ge experimental group. The difference was the dose of Glutam 1M in the G9Ge group, it was 9 mg/kg of a live weight. Quatronan-Se at a dose of 0.02 ml/kg of body weight has been used in the Q-Se group of animals for 4 days before and 10 days after farrowing. The scheme of application of biotechnological drugs is also shown in Table 1.

The dose of Glutam 1M was determined in preliminary studies, taking into account the research of other scientists, and the most effective doses were 18 mg/kg and 9 mg/kg. Separately from Glutam 1M, the doses of administration of Germanium nanoaquahelate were determined. After several studies, it was decided to use 5 mg/kg in the following studies. Quatronan-Se was used on pigs for the first time, so the recommended dose of 0.02 ml/kg was used, which was used for cattle.

The active ingredient of Glutam 1M is sodium glutamate (sodium salt of glutamic acid). The drug is manufactured by Farmak LLC following the requirements of DSTU:4881:2007 (State Standard of Ukraine). In previous studies, we have already established that Glutam 1M has a

Table 1. The scheme of drug administration to experimental sows

Groups	Number of days of administration of drugs before farrowing	Drugs	Dose per kg	Number of days of administration of drugs post-farrowing
C (control)	4	Saline solution	0.08 ml	10
	-	GM1	-	Glutam 1M
G18Ge	-	Glutam 1M	18 mg	3
	4	Nanoaquachelate Ge	5 mg	10
G9Ge	-	Glutam 1M	9 mg	3
	4	Nanoaquachelate Ge	5 mg	10
Q-Se	4	Quatronan-Se	0.02 ml	10

positive effect on the reproductive capacity of sows, thereby reducing the interval between generations and stimulating piglet growth through sow milk. In our studies, we also used Quatronan-Se, which contains nanoparticles of trace elements Cu, Se, Cr, Ge, and Mn in the form of carboxylates. Carboxylates and nanoaquahelates are produced by the method of erosion-explosive nanotechnology in the laboratory of Nanomaterials and Nanotechnologies LLC. It is known that blood parameters are indicators of changes in the body. Because in the research, sows were fed with drugs containing substances (sodium glutamate and trace elements) that affect metabolic processes in the body, it was decided to conduct a study of blood chemistry.

To make sure that the animal received the full dose, a ball of concentrated feed was formed before feeding and the drugs were added. Each sow was fed the ball individually. The amount of concentrated ones used to form the feed ball was taken into account in the total amount of the daily dietary allowance of the experimental animals.

Blood from experimental sows was taken in the morning on the day of farrowing, on the 4th day and on the day of weaning. Samples for research have been taken from the ear vein in sterile tubes with a capacity of 15 ml.

Biochemical analysis of blood has been performed on an automated biochemical analyzer Vitros-250 (USA) using a set of ortho-clinical diagnostics reagents (UK). In the serum of sows there have been determined: the content of cholesterol, triglycerides, lactate, total protein, concentrations of urea, creatinine, albumin, globulins and albumins/globulins ratio. Comparison were considered statistically significant at a level of $P<0.05$. The biometric processing of the research results was carried out using the programmable module "Data Analysis" in Microsoft Excel.

RESULTS AND DISCUSSION

Analysis of the biochemical parameters (Table 2) showed that the cholesterol content of sows after farrowing was lower in the GM1, G18Ge, and Q-Se groups , compared with the C group by 13.1%; 8.4 and 21.0%, respectively. In the G9Ge group this indicator was at the level of control (C) sows.

The level of triglycerides in the blood serum of sows after farrowing in the GM1, G18Ge, G9Ge, and Q-Se groups was lower by 10.5%; 5.3%; 47.3% and 52.6% compared to C group . It should be noticed that in the Q-Se experimental group concentration of this indicator was lower compared to the GM1 experimental group by 52.9% ($P<0.05$).

Analysis dynamics of the total protein content reflects the state of protein metabolism and gives a clearer idea of the state of health of animals. After the metabolism changes there are quantitative fluctuations Of A protein spectrum of blood (Perevoiko and Kosilov, 2014).

On the first day of blood sampling, that is, on the day of farrowing, the total protein was higher in the group Q-Se by 3.0%; 5.2%; 6.2 and 1.9% compared to the control (C) and GM1, G18Ge, G9Ge groups, respectively. In the GM1 and G18Ge groups of sows, the concentration of

Table 2. Biochemical parameters of sows' blood biochemical blood parameters on the day of farrowing (n=5)

Parameters	Groups				
	C	GM1	G18Ge	G9Ge	Q-Se
Cholesterol (mmol/L)	1.52±0.20	1.32±0.14	1.42±0.09	1.52±0.12	1.2±0.09
Triglycerides (mmol/L)	0.38±0.08	0.34±0.05	0.36±0.12	0.20±0.04	0.18±.04*
Lactate (mmol/l)	9.35±1.15	10.18±1.0	11.94±1.29	8.72±1.16	8.02±0.91**
Total protein (g/l)	68.55±3.59	66.96±1.21	66.24±0.71	69.06±2.80	70.64±1.93
Albumins (g / l)	41.55±2.13	42.04±1.41	36.20±6.53	42.42±1.57	44.62±2.32
Globulins (g / l)	26.25±1.33	24.92±1.13	24.04±1.87	26.64±2.42	26.02±0.88
Albumins / Globulins	1.62±0.06	1.71±0.13	1.82±0.20	1.64±0.150	1.73±0.14
Glucose (mmol/L)	5.73± 0.39	5.64±0.42	5.70±0.36	5.62±0.16	6.08±0.34
Urea (mmol/L)	5.33±0.55	4.70±0.35	4.40±0.36	4.76±0.73	5.28±0.55
Creatinine (μmol/l)	139.75±11.6	165.6±19.9	166.8±15.0	165.0±23.8	161.8±19.3

*P<0.05 – compared to GM1; **P<0.05 – compared to G18Ge

Table 3. Biochemical parameters of sows' blood on the fourth day of the suckling period (n=5)

Parameters	Groups				
	C	GM1	G18Ge	G9Ge	Q-Se
Cholesterol (mmol/L)	2.98±0.25[a]	3.16±0.29	3.22±0.27	3.08±0.26	3.3±0.31
Lactate (mmol/l)	13.05±0.95	10.74±1.70	11.12±1.22	11.2±0.63	12.14±0.74
Total protein (g/l)	75.98±3.52	80.0±1.73	81.42±2.98	77.84±2.45[b]	81.28±2.58[a]
Albumins (g / l)	43.4±1.86	44.98±0.83	44.2±0.88[b]	46.0±0.79	46.12±0.46
Globulins (g / l)	32.58±1.67	35.02±1.21	37.10±3.64	31.82±2.85[b]	35.16±2.77
Albumins / Globulins	1.33±0.02	1.28±0.03	1.25±0.15	1.51±0.19	1.35±0.15
Glucose (mmol/L)	8.28±0.50	6.8±0.43**	7.08±0.38	8.60±0.94	7.16±0.69
Triglycerides (mmol/L)	0.5±0.12	0.26±0.05	0.34±0.04	0.3±0.07	0.44±0.12
Urea (mmol/L)	6.18 ± 0.590	7.38±0.56	6.32±0.67	6.24±0.74	5.62±0.43*
Creatinine (μmol/l)	132.75±20.29	134.6±11.90	117.4±5.24	117.4±4.40	122.4±7.05

**P<0,01 – compared to C; [a]P<0,05; [b]P<0,01; – compared to farrowing day

this indicator in blood serum was 2.3 and 3.0% lower respectively than the control (C).

In the GM1and G18Ge groups of sows after the farrowing, the contents of albumin were at the level of control, while in the G18Ge it was lower by 12.9% compared to C, by 13.9% - compared to the GM1 group, by 14.7% – to the G9Ge, and by 18.9% – to the Q-Se group. Analysis of the level of globulins in the GM1 and G18Ge experimental groups showed its lower concentration by 5.1% and 8.4%, respectively, compared with control animals. The ratio of albumins to globulins in the GM1, G18Ge, G9Ge, and Q-Se experimental groups was higher compared to the C group by 5.6%; 12.3%; 1.2 and 6.8%, respectively.

In the study of lactate levels in the body of sows it was found that in the GM1 and G18Ge groups, the concentration of this metabolite was higher by 8.8% and 27.7%, and in the G9Ge and Q-Se groups – lower by 6.7 and 14.2%, compared to C. It should also be noted that the content of lactate of sows of the Q-Se group was 32.8% (P<0.05) lower than in the G18Ge.

Comparative analysis of glucose levels in terms of groups showed an increase in this metabolite in the Q-Se group, it was higher compared to the C group by 5.8% GM1- 7.2%, G18Ge - 6.25%, G9Ge - 7.6%, the difference is not statistically significant. There were also slight changes between the C, GM1, G18Ge and G9Ge groups, the difference was within 2.0%.

The highest urea content on the day of farrowing was found in the control group, which was 5.33 mmol/l, which is 11.8%, 17.5%, 10.7% and 0.94% higher than in GM1, G18Ge, G9Ge, and Q-Se groups . The level of creatinine in this group, on the contrary, was lower compared to the GM1, G18Ge, G9Ge, Q-Se experimental groups by 18.5 %, 19.4%, 18.1% and 15.8%, respectively.

Since, according to the study scheme, Glutam 1M was used for only three days after the farrowing, it was advisable to take blood samples of sows on the 4th day after the farrowing (Table 3).

According to these studies, in the GM1, G18Ge, G9Ge, and Q-Se groups , the cholesterol levels tended to increase by 5.6 %; 7.4 %; 3.2% and 9.7 % were higher compared to the control. Whereas the content of triglycerides in the blood of animals, that were administered the studied drugs (GM1, G18Ge, G9Ge, Q-Se) was lower than the control by 48.0%; 32.0%; 40.0% and 12.0%, respectively, but it corresponded to the physiological norm.

During this period, the level of lactate, which is an indicator of carbohydrate metabolism, in the GM1, G18Ge, G9Ge, and Q-Se experimental groups decreased by 17.7%; 14.8%; 14.2 and 6.9% compared to the control. The content of total protein in the body of sows where the drugs were administered increased respectively by 5.3%; 7.2%; 2.5 and 6.9% compared to control. Such changes in the GM1, G18Ge, and G9Ge groups administered with Glutam 1M may be due to the active ingredient glutamate sodium, which is a salt of glutamic acid. It is an essential amino acid that plays an important function in cellular metabolism and immune responses, and is a precursor to protein synthesis. It can be easily converted into nonessential amino acids, providing a sufficient set of all amino acids required for protein biosynthesis (Feng *et al.*, 2014). It has an anabolic effect and plays an important role in removing ammonia from the body, thus contributing to the urea synthesis cycle. This is evidenced by the level of urea in these groups. It can also be assumed that the slight increase in protein levels in the Q-Se group may be because of the drug Se contain. The trace element has an antioxidant effect and is transported by blood albumin and globulins after absorption. Also, the biological effect of the trace element is manifested in the form of selenocysteine, which is considered the 21st amino acid used in protein synthesis (Pecoraro et. al., 2022). In addition, the product contains such trace elements as Ge and Mn, which are known to enhance the body's immune response.

On the day of blood sampling, the level of creatinine was lower for sows of the G18Ge, G9Ge, and Q-Se groups compared to the C group by 11.6%; 11.6% and 1.8%, respectively. It should be noted that this indicator was higher for sows of the GM1 experimental group by 1.4%; 14.7%; 14.7 % and 9.9% than in the groups C, G18Ge, G9Ge and Q-Se, respectively.

Also, studies have shown that on the fourth day after farrowing, the level of albumin increased in GM1, G18Ge, G9Ge, and Q-Se groups by 3.6%; 1.8%; 5.9 and 6.3 % compared to the C group. The content of globulins in the blood serum of sows of the GM1, G18Ge and Q-Se groups was also higher compared to the C group by 7.5%; 13.9 and 7.9%, respectively. It should be noted that in the G9Ge group the level of globulins was lower by 2.3%; 9.1%; 14.2 and 9.5% compared with control indicators, GM1, G18Ge and Q-Se experimental groups, respectively. The ratio of these protein fractions on the fourth day in the G9Ge experimental group was higher by 13.5%; 17.9%; 20.8 and 11.9% compared to the control and animals of the GM1, G18Ge and Q-Se experimental groups. The protein ratio in sows of experimental groups GM1 and G18Ge was lower than in the control, the difference was 3.8 and 6.0%, respectively.

Analyzing the level of metabolites of carbohydrate metabolism, we have found out that the level of glucose for animals of the G9Ge experimental group on the day of blood sampling (fourth day) was higher compared to the control and indicators in the GM1, G18Ge and Q-Se groups by 3.9%; 26.5%; 21.5 and 20.1%, respectively. It should also be noticed that in the GM1

experimental group, the content of this metabolite in the blood of sows was the lowest compared to the control (by 17.87%) and G18Ge (by 3.9%), G9Ge (by 20.9%), Q-Se (by 5.0%) experimental groups. The content of urea for animals of the GM1 experimental group prevailed the level of this indicator of other experimental groups: Q-Se by 23.8% (P<0,05), by 19.4% – control, 16.8% - G18G group, and 18.3% – G9Ge group.

On the 21st day, the day the piglets are weaned cholesterol content in sows G18Ge, G9Ge and Q-Se groups was higher by 18.3 %; 2.3 and 4.2% compared with control animals (Table 4), while in animals of the GM1 group, the level of this metabolite was lower by 10.8% compared with control, by 24.6% – compared to the G18Ge group, by 12.8% – to the G9Ge group and by 14.4% – to the Q-Se group. It should be noted that, the cholesterol content for the animals of the G18Ge group was significantly higher by 15.6%, compared to the G9Ge experimental group. Also, in this group there was an increase of triglycerides, the content of which was 0.46 mmol/l, which is 23.9% higher than the control, 45.6% compared to the GM1 experimental group, 30.4% – to the G9Ge and 39.1% (P<0.05) – to the Q-Se.

The lactate level on the day of selection in sows receiving the drugs increased and exceeded the control by 12.2%; 18.4%; 32.8 and 34.7% (P<0.05), respectively. Analyzing the content of this indicator in terms of experimental groups, we have found out that the lowest content was in the GM1 experimental group, the difference was 5.5%, 18.3 and 20.1% compared to indicators of the G18Ge, G9Ge and Q-Se groups, respectively.

During the entire suckling period, the concentration of protein in the body of sows of research groups had a trend to decrease. In the G18Ge and Q-Se groups this indicator was at the level of control, while in the GM1 and G9Ge groups the level of total protein decreased by 3.6 and 2.7%, compared to C group animals. The content of albumins and globulins, as well as the protein coefficient in sows that were administered with the studied drugs were at the level of group C.

The glucose level of the C and GM1 groups was similar and amounted to 5.0 mmol/l. In the G18Ge, G9Ge and Q-Se groups of sows, this indicator was higher in comparison with the C and GM1 groups by 4.6%; 6.7 and 16.4%, respectively. In addition, it is worth noticing that the blood glucose content of the animals of the Q -Se group was 16.4% higher (P<0.05) compared to the control.

On the day of weaning, the level of urea was lower for sows of the Q-Se experimental group by 3.9%; 5.2%; 19.6 and 7.8% compared to the control, GM1, G18Ge, and G9Ge groups. The concentration of this metabolite was higher in the blood serum of animals of the G18Ge experimental group compared to the C group and

Table 4. Biochemical indicators of blood serum of sows on the day of weaning (n=5)

Parameters	Groups				
	C	GM1	G18Ge	G9Ge	Q-Se
Cholesterol (mmol/L)	2.13±0.18	1.9±0.11	2.52±0.07**	2.18±0.09***	2.22±0.160
Lactate (mmol/l)	6.13±0.76	6.88±1.06	7.26±1.11	8.14±0.90	8.26±0.41*
Total protein (g/l)	74.73±4.42	72.08±1.19	75.18±1.51	72.70±4.34	76.14±2.33
Albumins (g / l)	41.13±2.14	39.60±1.20	41.2±1.30	39.12±1.10	41.86±2.82
Globulins (g / l)	33.6±2.69	32.48±0.41	33.98±1.12	33.58±4.01	34.28±1.82
Albumins / Globulins	1.24±0.09	1.22±0.04	1.22±0.06	1.22±0.11	1.24±0.130
Triglycerides (mmol/L)	0.35±0.06	0.25±0.10	0.46±0.05	0.32±0.04	0.28±0.04***
Glucose, mmol/l	5.0±0.25	5.0±0.30	5.24±0.15	5.36±0.48	5.82±0.24*
Creatinine, μmol/l	106.75±9.63	113.5±5.12	130.2±12.18	133.6±19.04	120.6±8.42
Urea, mmol/l	5.63±0.47	5.70±0.61	6.48±0.36	5.84±0.54	5.42±0.430

*P<0.05 – compared to C; **P<0.01 – compared to GM1; ***P<0.05 compared to G18Ge.

the GM1, G9Ge, and Q-Se groups , by 15.1%; 13.7%; 10.9 and 19.5%, respectively.

The concentration of creatinine on the day of weaning, compared to the control, was higher by 6.3% – in the GM1 group ; by 21.9% – in the G18Ge; by 25.2% – in the G9Ge; by 12.9% – in the Q-Se group.

Taking into account the fact that the drugs have been administered three days before and ten days after farrowing, it was important to study whether the residues of the components of the drugs that get into the milk do not have a negative effect for the health of piglets. In this regard, we determined the level of piglets' survival.

Analyzing the survival rate of piglets (Table 5), we have found out that after the introduction of drugs on the eleventh day of the suckling period in the experimental groups, this figure was higher compared to the group. The highest indicator of 94.1% was in the Q-Se experimental group, which is 10.0%; 19.1%; 7.2% and 4.5% was higher than the C group and GM1, G18Ge, and G9Ge groups. It should also be noted that the lowest survival was in the GM1 group – only 75.0%, which lower 9.1%; 11.9%; 14.6% and 19.1% ($P<0.01$) lower compared to the control , G18Ge, G18Ge and Q-Se groups.

Also, there has been conducted a study of the level of piglets' survival on the day of weaning, the results which show that in the control, G9Ge and Q-Se groups there was a decrease in this indicator, while in the GM1 and G18Ge groups it did not change and amounted up to 75% and 86.96%, respectively. Despite a slight decrease of 3.9% in the period starting from 11 days to the day of weaning, the highest rate of 90.2% remained in the Q-Se experimental group, and exceeded the C group GM1, G18Ge and Q-Se by 19.7 ($P<0.05$); 15.2; 3.2 and 2.3%, respectively.

In the C group, from the eleventh day to the day of weaning the level of survival decreased by 13.6%, while in the G9Ge and Q-Se – only by 1.7 and 3.9%, respectively.

Pig colostrum is known to provide passive immunity to piglets immediately after birth. It contains high concentrations of nutrients, immunoglobulins, immune cells and various antimicrobial substances, such as lactoferrin, so the administration of any drugs to sows before the farrowing and during the suckling period can have both negative and positive effects on the body not only of sows, but also of suckling piglets. In this regard, a study of the effect drugs of Glutam 1M, Quatronan-Se and nanoaquachelate of Ge on the metabolic status of sows and the level of survival of suckling piglets has been conducted. In addition, milk production may depend on the metabolic status of the sow.

Analyzing the obtained results of research on biochemical parameters of blood serum of experimental animals immediately after farrowing, it can be assumed that 4-fold administration of nanoaquachelates of Ge (G18Ge and G9Ge groups) and Quatronane-Se (Q-Se) do not cause a significant impact on the metabolic status of sows. There was no significant difference between group C, which received a physiological solution, and groups that received biotechnological drugs, all indicators did not exceed the physiological norm for this species of animals. Such results indicate that nanoaquachelates of germanium and nacocarboxylates, which are part of the Quatronan-Se, do no have a negative impact on the health of sows (Grushanska and Kostenko, 2017).

Biotechnological changes in the body of sows on the fourth day research period compared to the day of farrowing indicate that the level of albumins increases for the animals where drugs were administered. However, only in the G18Ge group were the changes statistically significant.

Table 5. Survival of piglets after the use of Glutam 1M, Nanoaquachelate Ge and Quatronan-Se, %

Groups	Indicator, M±m	
	11th day	Day of weaning
C	84.1±5.5	70.5±6.9
GM1	75±5.8	75±5.8
G18Ge	86.96±4.97	86.96±4.97
G9Ge	89.66±3.991 [1]	87.93±4.28*
Q-Se	94.12±3.292 **	90.2±4.16*[1]

*$P<0.05$– compared to C; [1]$P<0.05$ compared to GM1; **$P<0,01$ – compared to GM1.

It is known that albumins perform a transport function in the body, including for macro- and microelements, which can indicate the stimulation of the exchange of the albumin fraction of proteins and the positive effect of the applied drugs, since they include microelements (Grushanska and Kostenko, 2017). Another reason for the increase in this indicator may be related to the concentration of estrogens in the body of sows. Since albumins are carriers of this hormone. On the fourth day, an increase in protein levels was observed in all groups. In the G18Ge and Q-Se groups, the difference was statistically significant ($P<0.01$, $P<0.05$). The dynamics of cholesterol, which is a precursor of steroid hormones, can also indicate an increase in steroid hormones. In all groups concentration of this metabolite increased by 48.9% (C), 58.2% (GM1), 55.6% (G18Ge), 50.6% (G9Ge) and 63.6% (Q-Se) on the fourth day of the suckling period, the difference was not statistically significant. Eventhough Quatronan-Se contains Cr, our results of analysis of cholesterol dynamics do not coincide with literature data, which indicates that this trace element affects lipid metabolism and vice versa, reduces cholesterol and increases the content of triglycerides, less capable to peroxidation of lipids due to its chemical structure. However, in previous studies, we found that nanocarboxylates affect the synthesis of steroid hormones, which may be the reason for the increase in this indicator (Seba, *et al.*, 2016). It should also be noted that the drug also contains Mn, which in the body of animals acts as a cofactor of the enzyme mevalonate kinase, which converts mevalonic acid into scalene, which stimulates the synthesis of cholesterol (Perry *et al.*, 2021).

It can be assumed that the studied drugs affect energy metabolism, since in the experimental groups the glucose level in GM1 decreased by 17.8%, G18Ge - by 14.5% and Q-Se - by 13.5% compared to group C, but the difference was not statistically significant. The results of O. S. Pylypchuk contradict ours, since when Glutam 1M was administered to sows, the glucose level, on the contrary, increased by 13.2% during this period, and the creatinine concentration increased by 37% (Pylypchuk, 2016; Sheremeta *et al.*, 2017). The dynamics of glucose levels from the fourth day onwards shows an increase in all groups, the difference is not statistically significant.

In our research there was a significant decrease in creatinine content for the sows that were administered the studied drugs, this regard it can be assumed that the drugs lead to less degradation of muscle tissue of sows (Yefimov and Sofonova, 2015). The analysis of the obtained results of the conducted research shows that the content of globulins increased in all groups on the fourth day, the highest concentration of this metabolite was in the G18Ge and Q-Se experimental groups, where the drug Glutam M1 + nanoaquachelates of Ge and Quatronan-Se have been used. It can be assumed that components of these drugs have a positive influence on the immunobiological activity of the animal body, which confirms the results of other researchers. (Martynenko *et al.*, 2015; Vlizlo *et al.*, 2018).

On the day of weaning, compared to the 4th day after the farrowing, the total protein of the experimental animals decreased. If we compare the groups on the day of weaning, the highest concentration of this indicator, as well as on the fourth day of the sexual cycle, was in the G18Ge and Q-Se experimental groups. Total protein in these groups was higher due to an increase in the globulin fraction. Thus, it can be assumed that the introduction of Glutam 1M (18mg/kg) + nanoaquachelates of Ge and the Quatronan-Se drug have a prolonged effect. However, the analysis of the obtained results is similar to studies conducted by other scientists, it brings us to the opinion about the multidirectional effect of the applied trace elements on protein metabolism. The level of urea in animals of the GM1, G18Ge and G9Ge, experimental groups, which were administered Glutam 1M on the day of weaning, increased by 1.2%, 13.1% and 3.6%, respectively. According to the results of Pylypchuk, on the 4th day of the idle period, the urea content was lower than in the control, which may indicate a decrease in the rate of protein metabolism. Such results contradict the results of our research, which may be the result of the fact that the drugs were administered in different periods (Pylypchuk, 2016).

From the results obtained, it can be stated that Quatronan-Se has a positive influence on the resistance of the piglets' body. This the drug con-

tains germanium and selenium, which activate enzymes of the body's antioxidant system, cellular, humoral and phagocytic immune systems and enhance the non-specific resistance of animals (Seba *et al.*, 2016). The positive effect of Nanoaquachelate of Ge on animal immunity is confirmed by the results of the survival level of piglets of the G18Ge and G9Ge groups which were 86.96% and 87.93 %, respectively. At the same time, Acda and Chae (2002) reported that trace element do not affect the viability of piglets being fed to sows, do not coincide with our results (Ma *et al.*, 2020). Iskra and Vlizlo (2011) prove the positive influence of nanocarboxylates of trace elements on metabolic processes not only in the body of sows, but also in their fetuses and newborn offspring, which is confirmed by our research (Iskra and Vlizlo , 2011). From the obtained data of the first experimental group, where Glutam 1M was used within 3 days after the farrowing, it can be concluded that this drug does not affect the resistance of piglets.

CONCLUSION

Thus, from the results obtained, it can be assumed that the use of Glutam 1M, Nanoaquahelate Ge and QuatronanSe for sows helps to intensify metabolic processes in their body. In the experimental groups, on the 4th day after farrowing, an increase in cholesterol, total protein and a decrease in glucose were observed. The highest levels of total protein and albumin were in the G18Ge and Q-Se groups. It should also be noted that the experimental drugs had a positive effect on piglet survival. The highest percentage of piglet survival was in the G9Ge and Q-Se groups.

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