

ВЕТЕРИНАРНА ГІГІЄНА, САНИТАРІЯ ТА ЕКСПЕРТИЗА

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Influence of the prebiotic Bio-active on natural resistance, safety and productivity of young pigsLyasota V.¹ , Malyna V.¹ , Bondarenko L.¹ ,Bolokhovska V.², Balatsky Y.¹ , Bukalova N.¹ ,Bogatko N.¹ , Khitska O.¹ , Tkachuk S.³ ¹ Bila Tserkva National Agrarian University² BTU-CENTER, Vinnytsia region³ National University of Life and Environmental Sciences of Ukraine

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The primary task of the livestock industry is to provide the population with high-quality food products, and the industry with raw materials. For this, it is necessary to ensure a high level of productivity and safety of young pigs. Studies carried out in recent years indicate an increase in the incidence of gastrointestinal diseases among young farm animals, leading to a decrease in the immunobiological reactivity of the piglets' organism and significant damage to farms. When performing the research, we used zootechnical, zoohygienic, biochemical, immunological and variational-statistical research methods. Research work was carried out during 2010-2018 at the Department of Animal Hygiene and Fundamentals of Veterinary Medicine of the Bila Tserkva National Agrarian University. Scientific and economic experiments and production tests were carried out in the farms of Progress LLC (Uzin, Bila Tserkva district) and Denisenko LLC (Skvirsky district, Kyiv region). Experimental studies were carried out in the Problem Laboratory of Immunology, Department of Animal Hygiene and Fundamentals of Veterinary Medicine, interfaculty laboratory of biochemical and histochemical research methods.

For the first time, the prebiotic Bio-active was used as a feed additive in the diet of young pigs on growing at industrial keeping, its positive effect on the safety, productivity, physiological and immunological state of their body was proved. For the first time, the optimal dose of the prebiotic Bio-active for growing pigs was established and a method of its use was developed. The optimal dose of the prebiotic Bio-active for growing young pigs is 5 g (5×10^7 CFU) per 10 kg of body weight when fed with compound feed once a day for 30 days, which contributes to an increase in the average daily weight gain of piglets by 17.2 % ($P < 0.01$) and 16.6 % ($P < 0.05$) on the 30th and 60th days of the study, respectively.

Feeding pigs with Bio-active promotes an increase in the content of total blood serum protein by 7.2 % ($P < 0.05$), albumin – by 5.2 %, γ -globulins – by 6.3 %, an increase in AST activity – by 23, 1 % ($P < 0.05$) and ALT – by 22.4 % ($P < 0.01$). In the peripheral blood of rearing pigs under the influence of the prebiotic Bio-active, the proliferation, differentiation and specialization of immunocompetent cells increase: an increase in the total number of *T*-lymphocytes by 5.43 % ($P < 0.05$), *B*-lymphocytes by 2.85 %, a decrease in the content of 0-lymphocytes – by 8.29 % ($P < 0.05$). The number of medium-avid *T*-lymphocytes also increases – by 9.19 % ($P < 0.05$) and *B*-lymphocytes – by 10.28 % ($P < 0.05$) due to a decrease in the level of low-avid immunocompetent cells. The use of the prebiotic Bio-active in an optimal dose promotes the activation of metabolic processes, antigen-nonspecific immunity and an increase in the body weight of pigs.

Key words: industrial pig breeding, rearing young pigs, housing conditions, gastrointestinal canal, prebiotic, immunobiological reactivity, metabolism, safety.

Problem statement and analysis of recent research. The primary task of the livestock industry is to provide the population with quality food and industry with raw materials. To do this, it is necessary to ensure a high level of productivity and safety of young pigs. Today, one of the reasons for the decline and rise in price of pork is the high death rate of young animals (35-45%) [1, 2]. The cost of feed in the cost of pig products is 65-70%, so it is important to find not only cheap feed, but also ways to increase its digestibility and improve the use of nutrients [3].

Studies conducted in recent years show an increase in the incidence of gastrointestinal diseases of young farm animals, leading to a decrease in the immunobiological reactivity of piglets and significant damage to farms [4].

An important factor from the standpoint of microecology of the digestive tract is the time of its population by microorganisms of certain species [5]. The digestive tract of piglets, immediately after birth, due to contact with the environment and adult animals, is populated by mesophilic aerobic and facultatively anaerobic microorganisms, opportunistic pathogens. These are lactobacilli, streptococci, bifidobacteria, propionic acid bacteria, bacteria of the genera *Escherichia*, *Proteus*, *Klebsiella*, *Clostridium*, *Salmonella*, *Streptococcus*, *Staphylococcus*, *Pseudomonas*. The influence of negative environmental factors contributes to the increase of opportunistic and pathogenic microorganisms, which, in turn, leads to the development of diseases of the gastrointestinal tract and death of animals [7].

The use of antibiotics for the treatment of animals and prevention of gastrointestinal diseases leads to the selection and circulation of pathogenic and opportunistic microorganisms with increased resistance to antibiotics, the appearance of secondary dysbacteriosis, resulting in reduced effectiveness of these drugs, which poses a potential threat to human health. The use of antibiotics for therapeutic and prophylactic purposes leads to the development of colitis caused by staphylococci, klebsiella, proteus, pseudomonads, in the intestine the number of *Cl. perfringens* and enterococci increases [8]. According to the literature, antibiotics disrupt the intestinal normocenosis and often lead to diarrhea [10].

Since January 2005, according to the decision of the European Parliament, the use of antibiotics as growth stimulants has been banned. Legislation restricting the use of antimicrobials is also being developed and implemented in Ukraine [11].

The ban on the use of antibiotics for the prevention of animal and poultry diseases in Europe has led to a global trend towards the use of alterna-

tive strategies to suppress pathogenic microflora and, consequently, to preserve the health and productivity of livestock [12, 13].

The idea of forming a healthy normocenosis of the gastrointestinal tract belongs to the founder of domestic immunology I.I. Mechnikov, who proposed to introduce a culture of lactic acid bacteria into the digestive tract to prevent the development of putrefactive microflora. This was the beginning of research on pathological conditions associated with the violation of the intestinal microbiota, and their prevention [14]. After discovering the ability of certain microorganisms of certain groups to inhibit the growth of other microorganisms that can enter the animal's body with food and water, a number of scientists have worked on studying the use of the phenomenon of microbial antagonism [15]. As an alternative, new generation drugs are being developed: phyto-, pro- and prebiotics. The most researched and used are probiotics [16].

Over the past two decades, in the practice of human and veterinary medicine, for the prevention and treatment of disorders of the gastrointestinal tract, themicrobial drugs - pre- and probiotics have become widespread. They, unlike antibiotics, are not addictive to opportunistic pathogens, and the products of their vital activity do not accumulate in the organs and tissues of animals and do not affect the quality of products [17-19].

The mechanism of action of pre- and probiotics is based on inhibiting the growth of pathogenic microorganisms, increasing the activity of the immune system and more efficient absorption of feed nutrients in animals [20-25].

The most numerous microorganisms in the gastrointestinal tract of animals are lactic acid bacteria. They produce a significant amount of lactic acid, which promotes the development of microorganisms of the genera *Bifidobacteria*, *Propionibacteria*, *Butyriuvibrio*, *Roseburia*, resulting in enzymatic fermentation, the formation of organic acids, which lowers the pH in the large intestine and reduces the number of salmonella and other diseases [26-30].

Thereby, non-compliance of animal housing conditions with sanitary and hygienic requirements leads to a decrease in the immunobiological reactivity of the body of young pigs and, as a consequence, - to disorders of the gastrointestinal tract, reduced productivity and safety, increased feed conversion. The use of antibiotics as a preventive measure has a number of negative consequences. As a safe alternative to antibiotics, the pre- and probiotics have become widespread in Ukraine and many countries around the world in recent years for the prevention and treatment of digestive disorders. They are characterized by

normalization of digestive processes by correcting the qualitative and quantitative composition of microflora of the gastrointestinal tract, helping to increase the natural resistance of animals.

Currently, the use of feed additives with pre- and probiotic action on the basis of lacto-, bifidobacteria is the most effective means for the prevention and treatment of some diseases of the gastrointestinal tract of pigs, and the study of their biological properties is a promising area of research.

The purpose of the research is hygienic substantiation of the use of the prebiotic Bio-active and its influence on antigen-nonspecific immunity, safety and productivity of young pigs during their industrial breeding.

Material and methods of research. The research was performed during 2010-2018 at the department of animal hygiene and fundamentals of veterinary medicine, Bila Tserkva National Agrarian University. The scientific and economic experiments and production tests were conducted on the farms of LLC «Progress» (Uzyn, Bila Tserkva district) and PE «Denisenko» (Skvyra district, Kyiv region). The experimental studies were conducted in the problem laboratory of immunology of the department of animal hygiene and fundamentals of veterinary medicine, interfaculty laboratory of biochemical and histochemical research methods, vivarium of the faculty of veterinary medicine BNAU, department of veterinary sanitation and pathological anatomy named after J.S. Zagaevsky of Bila Tserkva NAU, testing laboratory of SE «Kyiv region standartmetrology», Bila Tserkva city sanitary and epidemiological station, laboratory of anaerobic infections of the institute of veterinary medicine of UAAS, Institute of biochemistry named after Palladin, problem research laboratory of feed additives of National University of Life and Environmental Sciences (Kyiv).

The work was carried out in accordance with the «European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes» (Strasbourg, 1995), «The General Ethical Principles of Animal Experimentation» (First National Congress on Bioethics, 2001) and in accordance with the order of the State Department of Veterinary Medicine № 7 from 17.02.1999 «On strengthening the control of veterinary drugs and feed additives».

The characteristics of the prebiotic Bio-active. The biologically active prebiotic Bio-active was developed by BTU-Center in Ladyzhyn, Trostyanets district, Vinnytsya region.

The drug is a powdery substance of gray color, containing the products of lactic acid bacte-

ria *Lactobacillus bulgaricus delbrueckii*, adsorbed on zeolite class of silicates of frame structure and is a natural drug that causes cation exchange and adsorption processes.

Regulatory and technical documentation has been developed and approved for the drug: technical conditions of Ukraine - TU U 15.7-30165603-019:2009 «Feed additives with probiotic action», approved by the State Research Control Institute of Veterinary Drugs and Feed Additives on 30.03.2010 and approved by the Main State Committee of Veterinary Medicine of Ukraine 09.04.2010

The lactic acid bacteria and the products of their vital activity, once in the intestines of animals, produce a complex of special enzymes - proteases, specific peptidases - prolidases, which hydrolyze proteins with a high content of proline and have unique properties of regulating biosynthesis.

The prebiotic contains amino acids for the synthesis of hormones, enzymes, vitamins, which are very important factors of metabolism in animals.

According to the results of biochemical studies, it was found that 1 g of the drug includes: lysine - 0.67 mg%; histidine - 1.0; aspartic acid - 33.77; threonine - 3.36; serine - 14.81; glutamic acid - 10.51; glycine - 10.59; alanine - 7.79; cysteine - 5.23; valine - 2.81; methionine - 0.3; isoleucine - 3.99; leucine - 0.37; tyrosine - 0.91; phenylalanine - 4.01 mg%.

According to the results of biochemical studies of the prebiotic Bio-active, it was found that 1 g of the drug contains B vitamins, namely: B1 - 0.13 µg / g; B2 - 0.17; B12 - 0.0012; carotenoids - 3.0; vitamin A - 0.627 and vitamin E - 3.0 mcg / g. The most active antioxidants and coenzymes of the drug are carotenoids and vitamins A and E.

In the studied farms, the pigs of large white breed and their crossbreeds are bred. The system of keeping animals is paddock (stall and paddock), with weaning of piglets of 45 days of age. The animals were kept indoors in group stalls for 25-30 animals, with walking areas under the regulated system. The paddocks with a semisolid surface are connected to the premises by holes for pigs of the following sizes: young pigs - height 0.8 m, width 0.5 m; adult livestock - 0.9 m and 0.6 m, respectively.

Premises of piggeries are typical, made of brick. The animals were kept in stalls made of metal rods and wooden beams, height as for sows, replacement and fattening young pigs - 1 m, and for piglets after weaning - 0.8 m, which corresponds to the "Departmental standards of technological design." Such a fence promotes better air exchange in the stalls and observation of animals.

Feed was delivered to the premises and supplied to the feeder with the help of mobile feeders.

Water from wells on the farm is used for watering, preparation of fodder, sanitary and technical purposes. Water supply is centralized. Manure was removed from the premises daily, in the morning, using a TSN-3B scraper conveyor and taken in trailers to the manure storage.

To obtain maximum production, the optimal microclimate (temperature, relative humidity, concentration of harmful gases, air velocity, lighting, bacterial contamination, etc.) was maintained by natural intake and draft ventilation system in the premises for keeping pigs for rearing. The lighting is natural and artificial-by means of fluorescent lamps.

Concentrated diets balanced according to zootechnical standards, taking into account live weight, age and productivity, were used for feeding pigs. To the main diet (MD) of pigs was added prebiotic Bio-active in the following doses: 1; 3; 5 and 10 g per 10 kg of body weight, once a day for 30 days. The animals were fed 2 times a day.

Determination of the optimal dose of prebiotic Bio-active for young pigs on rearing was performed according to the experimental scheme (Table 1).

Table 1 – Scheme of the experiment to determine the optimal dose of prebiotic Bio-active for young pigs on rearing

Group of animals	Number of animals in the group, n	Dose and frequency of application (g/per 10 kg of body weight), 1 time per day for 30 days
Experimental 1	20	MD + 1,0 (1×10 ⁷ CFU)
Experimental 2	20	MD + 3,0 (3×10 ⁷ CFU)
Experimental 3	20	MD + 5,0 (5×10 ⁷ CFU)
Experimental 4	20	MD + 10,0 (10×10 ⁷ CFU)
Control	20	MD

Animals of all experimental groups were given the prebiotic Bio-active together with food, once a day for 30 days. Piglets of the first experimental group were given a prebiotic at a dose of 1 g (1 × 10⁷ CFU) per 10 kg of body weight of the animal, the second experimental group - 3 g (3 × 10⁷ CFU) per 10 kg of body weight, the third - 5 g (5 × 10⁷ CFU) per 10 kg of body weight, the fourth - 10 g (10 × 10⁷ CFU) per 10 kg of body weight. The study took into account the body weight, average daily gain and safety of piglets. Animals of the control group were fed only compound feed. Water was given to the animals at will.

Biochemical studies: determination of total calcium in blood serum was performed by the method of arsenazo III, inorganic phosphorus - in the reaction of UV detection of phosphomolybdate complex, calcium and magnesium - using a set of reagents NVF «Simko Ltd» (Lviv).

The content of iron in the serum was determined by reaction with disodium salt without deproteinization using a set of reagents LLC «Agate-Med» (Moscow), zinc - spectrophotometric method with 5-Br-PAPS with a set of reagents «DAC-SpectroMed SRL», copper - in the reaction with bathocuproine (a set of reagents «Bio-Test, Lachema Diagnostica s.r.o.»).

The activity of alanine aminotransferase and aspartate aminotransferase was determined by the Reitman-Frenkel method with the sets of reagents of SPF «Simko Ltd» (Lviv) [6].

Immunological studies: the number of T- and B-lymphocytes, their subpopulations in the peripheral blood were determined by the method of rosette-formation of E-RUK and EAK-RUK; isolation of mononuclear cell fractions and preparation of indicator erythrocytes to assess the reproductive activity of the T-immune system was carried out according to the method of M. Jondal et al. (1972) [9]. Determination of the content of B-lymphocytes and preparation of indicator erythrocytes to assess the reproductive activity of the B-system of immunity was performed according to the method of C. Bianco et al. (1970), [11], avidity of lymphocytes - according to Pustovar A.Ya. (1988) [11].

Statistical processing of the obtained results was performed using the methods of variation statistics (Student's criteria). The computer calculation system «Maple-12» and «Microsoft Excel» were used in the processing. The results of the mean values were considered statistically significant at $p \leq 0.05$; $p \leq 0.01$, $p \leq 0.001$ [9].

Results of the research. Determination of the optimal dose of prebiotic Bio-active for young pigs on rearing according to productivity indicators. For the experiment, 45-day-old piglets, after weaning from sows, were selected on the principle of analogues, taking into account the breed, live weight and general physiological condition. Five groups of 20 animals each were formed: four experimental groups and one control group. The keeping and feeding conditions of the animals were the same, and the diet was balanced according to the norms considering the live weight and age of the piglets. The animals in four experimental groups were given additionally to the main diet the prebiotic Bio-active in the amount of: for the first group of piglets - 1 g, the second - 3 g, the third - 5 g, the fourth - 10 g per 10 kg of body weight, once a day for 30 days.

An important indicator in the technological process of pork production is the safety and productivity of livestock.

The indicators of survival of piglets, their growth and development were determined after 30 (Table 2) and 60 days from the start of prebiotic feeding (Table 3).

Table 2 – Survival and growth of piglets 30 days after feeding probiotic Bio-active, $M\pm m$

Indicators, units of measurement	Group of animals, dose (per 10 kg of body weight)				
	Control	1 g	3 g	5 g	10 g
Number of animals					
a) the beginning	20	20	20	20	20
b) the end	17	18	19	18	18
Survival, %	85	90	95	90	90
Body weight of the whole group of animals, kg					
a) the beginning	203,20	220,40	209,40	206,80	186,48
b) the end	292,06	323,51	331,02	352,83	327,96
Body weight of one piglet, kg					
a) the beginning	10,16 \pm 0,12	11,02 \pm 0,14	10,47 \pm 0,34	10,34 \pm 0,42	10,86 \pm 0,22
b) the end	17,18 \pm 0,38	19,03 \pm 0,27*	18,39 \pm 0,58	18,57 \pm 0,34*	18,22 \pm 0,14*
Average daily weight gain during the study period, g	234,1 \pm 12,07	261,9 \pm 8,78	264,2 \pm 26,79*	270,0 \pm 18,63*	245,2 \pm 9,25
Increase of the average daily growth of one piglet,					
g	–	27,8	30,1	35,9	11,1
%	–	11,8	12,8	15,3	4,7
Additional weight gain during the study period, kg					
a) one piglet	–	0,810	0,9	1,2	0,8
b) the whole group	–	13,8	16,2	23,0	15,1

Note: * $P < 0,05$, compared to the control group.

Table 3 – Survival and growth of piglets 60 days after feeding probiotic Bio-active, $M\pm m$

Indicators, units of measurement	Group of animals, dose (per 10 kg of body weight)				
	Control	1 g	3 g	5 g	10 g
Number of animals					
a) the beginning	20	20	20	20	20
b) the end	16	18	18	19	18
Survival, %	80	90	90	95	90
Body weight of the whole group of animals, kg					
a) the beginning	203,2	220,40	209,4	206,80	186,48
b) the end	440,0	480,96	543,60	581,40	538,92
Body weight of one piglet, kg					
a) the beginning	10,16 \pm 0,12	11,02 \pm 0,14	10,34 \pm 0,42	10,47 \pm 0,34	10,36 \pm 0,22
b) the end	27,50 \pm 1,02	30,60 \pm 1,06*	28,60 \pm 0,84	30,20 \pm 0,62*	28,94 \pm 0,16
Average daily weight gain during the study period, g	289,0 \pm 11,17	326,3 \pm 17,78*	304,3 \pm 16,48	328,8 \pm 10,43*	309,6 \pm 17,97
Increase of the average daily growth of one piglet,					
g	–	37,0	15,3	39,5	20,6
%	–	12,9	5,3	13,6	7,12
Additional weight gain during the study period, kg					
a) one piglet	–	2,2	0,92	2,4	1,2
b) the whole group	–	39,6	16,6	45,6	21,6

Note: * $P < 0,05$, compared to the control group.

As a result of research, it was found that the use of prebiotics Bio-active has a positive effect on the safety of animals. Thus, during 30 days of research in the control group, 3 young animals died and the survival rate was 85%. In the second experimental group, 1 animal died, in the first, third and fourth - 2 animals each and the survival rate was 90% and 95%, respectively. The farm is prosperous in terms of infectious animal diseases

and the main cause of death of young pigs was disorders of the gastrointestinal tract.

The average body weight of piglets in the experimental and control groups at the beginning of the study had no significant difference. After feeding the prebiotic for 30 days, it was found that the average live weight of piglets in the groups had a significant difference, which is confirmed by the average daily weight gain of animals.

The results showed that the largest average daily weight gain was in animals of the third experimental group, which received a prebiotic at a dose of 5 g per 10 kg of body weight, and was by 35.9 g (17.2%) more compared to the control group.

The dose of probiotic in 1 g and its increase to 3 and 10 g per 10 kg of body weight also led to an increase in average daily weight gain compared to animals in the control group, but were lower than of the second experimental group.

Re-weighing of piglets was performed after 60 days.

The analysis of research results shows that the dynamics of the positive effect of prebiotics on the productivity of young animals was maintained.

Thus, in the next 30 days after the first weighing, only one animal died in the control group, and among the piglets of the first, second, third and fourth experimental groups there were no deaths. The highest survival was observed with piglets of the third experimental group 60 days after the start of prebiotic feeding and was 95%, which is 5% more than in the control group.

The average daily weight gain was higher in the first experimental group by 12.8%, the second - 5.2%, the third - 13.6%, the fourth - 7.1%, compared with the control group.

Thus, the average daily weight gain of the third experimental group was 35.9 g, or 13.6% higher compared to the control analogue. The average body weight of all animals in the experimental groups 60 days after the start of prebiotic feeding was equalized and was in the range of 28.94-30.60 kg.

Thus, as a result of research it was found that the prebiotic Bio-active has a positive effect on the body of animals, as evidenced by the increase in the safety and productivity of young pigs on rearing.

The optimal dose of the prebiotic Bio-active and the method of using the preparation for young pigs were also established. The prebiotic should be fed in a group method together with compound feed for 30 days, starting from the moment of weaning at a dose of 5 g per 10 kg of body weight, once a day.

Study of the effect of prebiotic Bio-active on the content of biotic elements in the serum.

Micro- and macroelements are an important factor in increasing the natural resistance of the growing organism of young animals, so the study of the effect of feed additives, their content and assimilation is an important stage of research.

The study of the effect of the prebiotic Bio-active at a dose of 5 g per 10 kg of body weight on the content of macronutrients in the serum indicates a gradual increase in total calcium, inorganic phosphorus and magnesium in both groups. The difference between the groups is not statistically significant (Fig. 1).

The study of the effect of prebiotic on the content of trace elements in the blood serum of piglets shows a gradual increase in the content of iron, copper and zinc throughout the experiment in both groups with a statistically insignificant difference (Fig. 2).

Indicators of the content of macro and microelements in the blood serum were not reliable and were within normal limits.

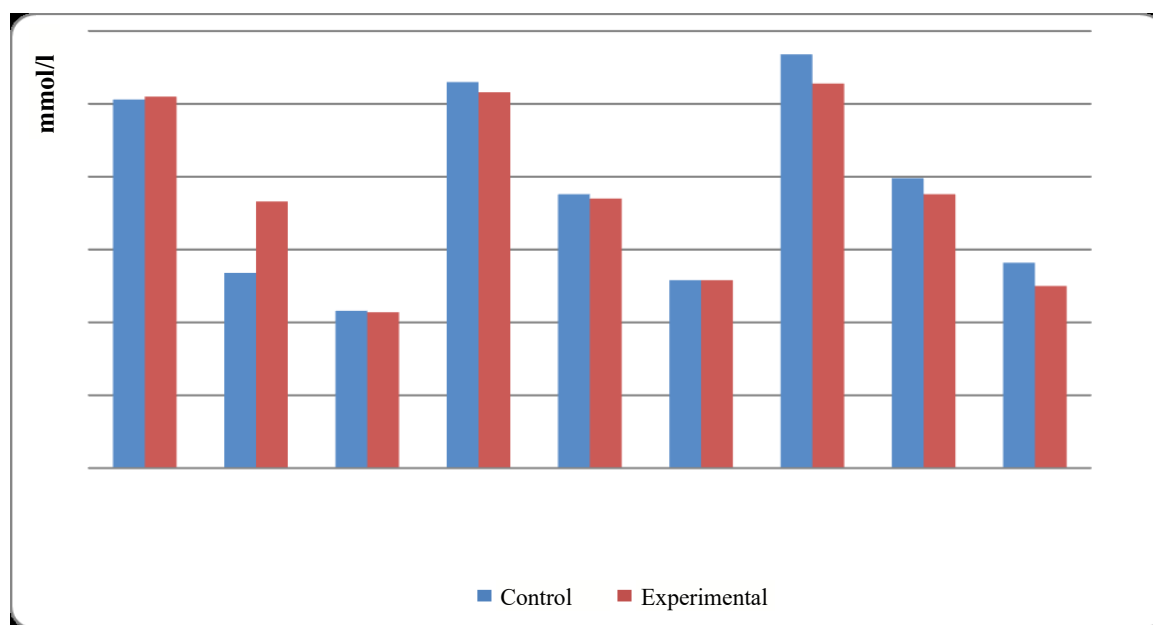


Fig. 1. The content of macronutrients in the serum of piglets using prebiotic Bio-active, mmol/l, $M \pm m$, $n = 16$

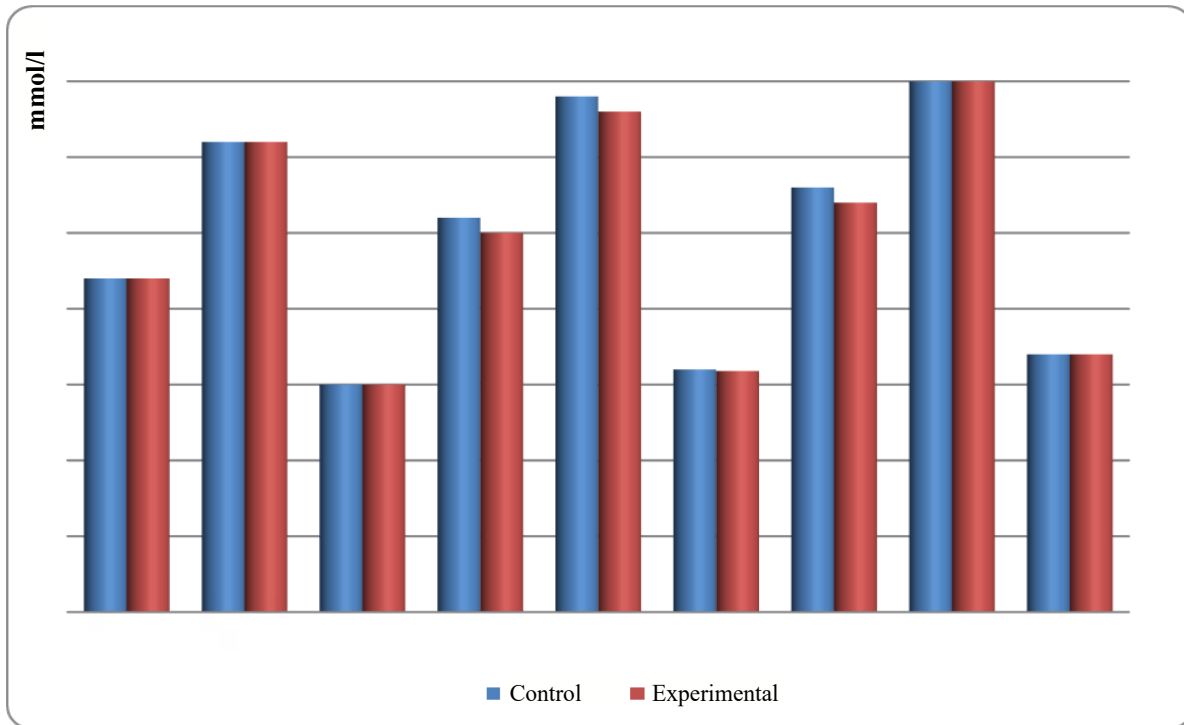


Fig. 2. The content of trace elements in the serum of piglets using prebiotic Bio-active, mmol/l, $M \pm m$, $n = 16$

Therefore, the use of the prebiotic Bio-active for young pigs on rearing at the optimal dose within the normal range increases the content in the serum of macronutrients such as total calcium, inorganic phosphorus, magnesium and trace elements such as iron, copper, zinc.

An important element of the study with the use of pre- and probiotics is their effect on the activity of aminotransferases, because these enzymes reflect the functional state of the liver and participate in transamination processes, therefore, in order to establish the effect of prebiotic Bio-active on the activity of transamination in blood serum, the activity of aminotransferase (AST) and alanine aminotransferase (ALT, Fig. 3) was investigated.

As a result of research, it was proved that the increase in the content of total protein in the serum of animals occurred due to the activity of the enzyme AST, starting from 30 days, with a statistically significant difference on day 60 of the experiment by 4.42 U / l ($P < 0.05$).

It was found that at the beginning of the experiment a significant difference between the indicators of the activity of the enzyme ALT in the serum of animals of the control and experimental groups was not detected. During the experiment in both groups there was a tendency to increase the activity of this enzyme and at the end of the experiment the activity of ALT in the serum of

experimental animals was higher by 22.39% ($P < 0.01$) relative to control.

Therefore, the use of prebiotics Bio-active for young pigs on rearing increases the activity of serum transaminases, which, in turn, provides physiological flow of metabolic processes in the body and stabilization of its homeostasis.

The effect of prebiotic Bio-active on the content of immunocompetent cells and their subpopulations in the peripheral blood of piglets. The body's immune defense is maintained by the functional activity of immunocompetent cells (T- and B-lymphocytes). The results of studies of the effect of the prebiotic Bio-active on the content of immunocompetent cells in the peripheral blood of young pigs are shown in table 4.

The results showed that before the study the number of immunocompetent cells in piglets of both groups did not differ significantly, and after the experiment there was an increase in the total number of T and B lymphocytes and a probable decrease in 0-lymphocytes in animals of the experimental group. Thus, the animals of the experimental group during the experiment increased the relative content of T-lymphocytes and at the end of the experiment their number was higher by 5.43% compared with animals of the control group, which indicated the activation of the cellular immune system.

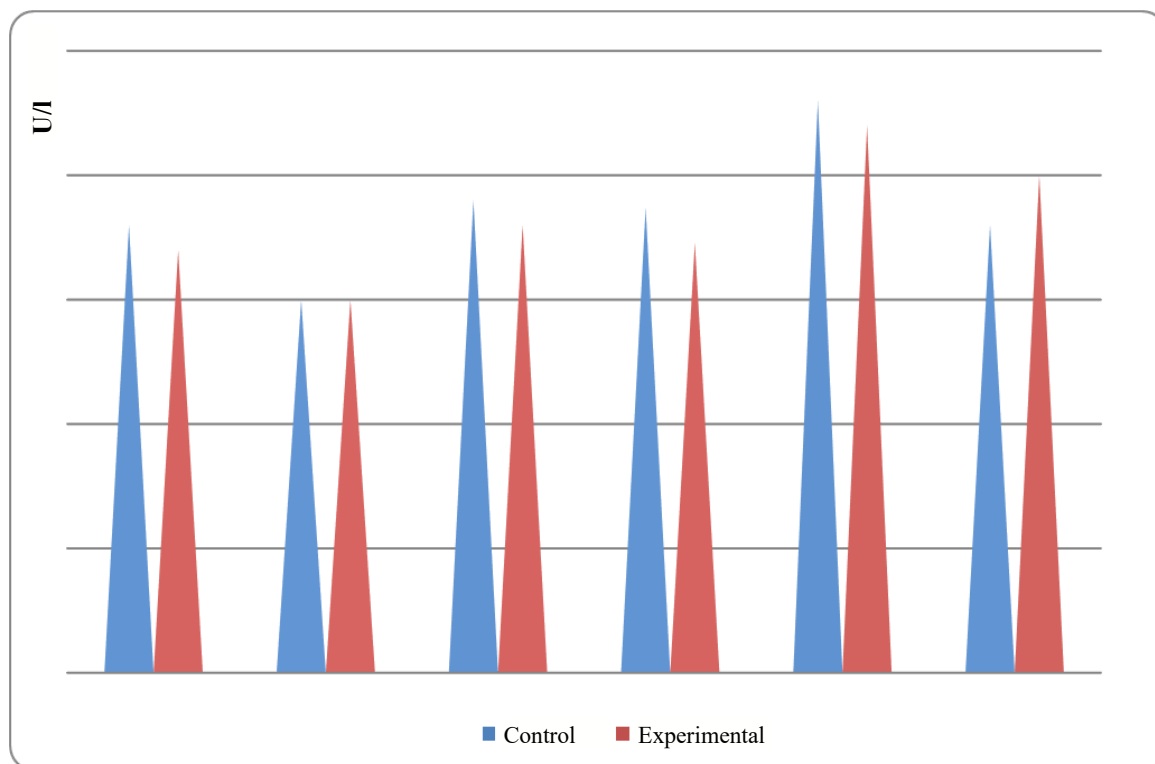


Fig. 3. Serum aspartate and alanine aminotransferase activity of young pigs reared under the influence of prebiotic Bio-active, U/l, $M \pm m$, $n = 16$

Table 4 – The content of lymphoid cells in the peripheral blood of piglets when fed prebiotic Bio-active, %, $M \pm m$, $n = 16$

Cell population	Research period, days			
	Before the start of the experiment	30	45	60
Lymphocytes	$\frac{68,39 \pm 3,14}{67,41 \pm 4,09}$	$\frac{70,94 \pm 2,77}{68,14 \pm 4,35}$	$\frac{71,44 \pm 2,63}{68,09 \pm 4,28}$	$\frac{72,42 \pm 2,56}{68,59 \pm 3,92}$
T- lymphocytes	$\frac{42,38 \pm 0,83}{43,30 \pm 0,79}$	$\frac{44,07 \pm 1,58}{42,60 \pm 0,80}$	$\frac{49,83 \pm 1,75}{45,08 \pm 1,79}$	$\frac{55,82 \pm 2,23^*}{45,39 \pm 2,01}$
B- lymphocytes	$\frac{14,06 \pm 1,29}{13,48 \pm 0,44}$	$\frac{15,49 \pm 1,74}{13,98 \pm 0,47}$	$\frac{17,10 \pm 0,90^*}{13,92 \pm 1,04}$	$\frac{17,22 \pm 1,32^*}{14,37 \pm 0,94}$
0- lymphocytes	$\frac{43,56 \pm 1,11}{43,22 \pm 0,85}$	$\frac{40,44 \pm 2,90}{43,43 \pm 0,95}$	$\frac{33,06 \pm 2,18^*}{41,00 \pm 1,49}$	$\frac{31,95 \pm 2,45^*}{40,24 \pm 1,68}$

Note: in the numerator - the experimental group, the denominator - the control group.

* $P < 0.05$, compared with the control group.

A significant increase in the relative content of T- and B-lymphocytes was noted throughout the experiment. Thus, on the 60th day of the experiment, their content was higher by 10.43 and 2.85%, compared with the control group. This indicates a positive effect of the prebiotic on the cellular and humoral activity of the immune system and, in particular, increase the natural resistance of young pigs.

Therefore, the use of the prebiotic Bio-active enhances the proliferation, differentiation and specialization of immunocompetent animal cells.

Moreover, studies were conducted on the effect of the prebiotic Bio-active on the state of the receptor apparatus of lymphoid cells (Table 5).

The data in table 5 show that during the experiment there was an increase in the percentage of medium-sized T- and B-lymphocytes and a

decrease in the level of low-avid immunocompetent cells in piglets, both control and experimental groups, with a significant difference of 30, 45 and 60th day. In animals that received the prebiotic in the optimal dose, the percentage of multireceptor lymphoid cells at the end of the experiment was higher by 9.19% ($P < 0.01$) for *T*-lymphocytes and 10.28% ($P < 0.05$) *B*-lymphocytes. The content of high-grade lymphocytes has not been established. A higher percentage of mean avid cells in animals of the experimental group indicates activation of the receptor apparatus of lymphoid cells after application of the prebiotic Bio-active to piglets.

Since the mechanism of action of prebiotics is based on inhibiting the growth of pathogenic microorganisms, increasing the activity of the immune system and better absorption of feed nutrients in animals [20–25], the proliferation, differentiation and specialization of immunocompetent cells in the peripheral blood of young pigs on rearing increased under the action of Bio-Active, namely: the total number of *T*-lymphocytes increased by 5.43%, *B*-lymphocytes by 2.85%, and the content of 0-lymphocytes decreased by 8.29%. In addition, the number of medium-avid *T*-lymphocytes increased by 9.19% and

Table 5 – The effect of the prebiotic Bio-active on the state of the receptor apparatus of lymphoid cells in the peripheral blood of piglets, %, $M \pm m$, $n=16$

Avidity of lymphocytes	Research period, days			
	Before the experiment	30	45	60
<i>T</i> -lymphocytes, low-avid	$67,10 \pm 3,82$ $63,18 \pm 3,22$	$51,00 \pm 2,29^{**}$ $63,45 \pm 0,74$	$43,69 \pm 0,65^{**}$ $52,45 \pm 2,17$	$40,97 \pm 1,22^{**}$ $50,16 \pm 1,31$
<i>T</i> -lymphocytes, medium avid	$33,44 \pm 4,00$ $36,82 \pm 3,22$	$49,00 \pm 2,29^{**}$ $36,55 \pm 0,74$	$56,31 \pm 0,65^{**}$ $47,55 \pm 2,17$	$59,03 \pm 1,22^{**}$ $49,84 \pm 1,31$
<i>B</i> -lymphocytes, low-avid	$63,07 \pm 3,63$ $60,57 \pm 2,21$	$50,93 \pm 2,81^*$ $60,68 \pm 2,39$	$43,87 \pm 2,02^{**}$ $57,78 \pm 3,32$	$41,96 \pm 2,58^*$ $52,24 \pm 3,24$
<i>B</i> -lymphocytes, medium avid	$36,93 \pm 3,63$ $39,43 \pm 2,21$	$49,07 \pm 2,81^*$ $39,32 \pm 2,39$	$56,13 \pm 2,02^{**}$ $42,22 \pm 3,32$	$58,04 \pm 2,58^*$ $47,76 \pm 3,24$

Note: in the numerator - the experimental group, the denominator - the control group.

* $P < 0.05$; ** $P < 0.01$.

As follows, the prebiotic Bio-Active promoted the activation of cellular immunity in young pigs, which is confirmed by the growing number of populations of immunocompetent cells and the activation of their receptor apparatus.

Discussion. Today, experts in the field of animal husbandry and veterinary medicine are in urgent search of alternatives to effective antibiotics for the prevention and treatment of diseases of animals with signs of gastrointestinal dysfunction [31–33].

Analysis of research materials showed that from a biological, environmental and economic point of view, the use of probiotics is appropriate and justified for the prevention and treatment of diseases of the gastrointestinal tract of animals. This will allow to obtain safe, environmentally friendly products and reduce production costs [34–35].

Basing on the conducted researches, the necessity of application of prebiotic of Bio-active produced on the basis of lactic acid bacteria *Lactobacillus bulgaricus delbrueckii* by BTU-Center (Ladyzhyn, Trostyanets district, Vinnytya region) was proved. At the optimal dose, this drug promotes the activation of metabolic processes, antigen-specific immunity and weight gain of pigs ($P < 0,05$).

B-lymphocytes - by 10.28% due to a decrease of low-avid immunocompetent cells, which had a positive effect on the safety of young pigs on rearing.

The use of prebiotic Bio-active increases the content of total serum protein by 7.2%, albumin - by 5.2%, and increases the activity of AST - by 23.1%, ALT - by 22.4%.

When feeding young pigs on rearing 5 g (5×10^7 CFU) per 10 kg of body weight (optimal dose) of the drug Bio-active with compound feed, once a day for 30 days, there was an increase in average daily weight gain of piglets by 17, 2%, and within 60 days - by 16.6%, which indicates an increase in their productivity.

Conclusions. 1. Introduction to the diet of young pigs on rearing the prebiotic Bio-active in the optimal dose of 5 g (5×10^7 CFU) per 10 kg of body weight together with feed once a day for 30 days increases the average daily weight gain of young pigs by 17, 2% ($P < 0.01$), on the 60th day - by 16.6% ($P < 0.05$).

2. The use of Bio-active increases the content of total protein in the serum of pigs by 7.2% ($P < 0.05$), albumin - by 5.2%, γ -globulins - by 6.3% and increases the activity of AST by 23.1% ($P < 0.05$), ALT - by 22.4% ($P < 0.01$).

3. Indicators of peripheral blood of young pigs receiving prebiotic Bio-active were characterized by an increase in the total number of *T*-lymphocytes (by 5.43%), *B*-lymphocytes (by 2.85%), a decrease in the number of *0*-lymphocytes (by 8, 29%) due to increased processes of proliferation, differentiation and specialization of immunocompetent cells. Due to the decrease of low-avid immunocompetent cells, the number of medium-avid *T*-lymphocytes increased by 9.19 % and the number of *B*-lymphocytes increased by 10.28%.

Information on compliance with bioethical standards.

The procedures involving animal experiments were carried out in accordance with the «General Ethical Principles of Animal Experiments» approved at the First National Congress on Bioethics (Kyiv, 20 September 2001), in accordance with the provisions of the European Convention «About Protection of Vertebrate Animals used for research and other scientific purposes» (Strasbourg, March 18, 1986), in compliance with the requirements of Article 26 of the Law of Ukraine № 5456-VI of 16.10.2012 «On the protection of animals from cruel treatment» and the EU Directive 86/609/EEC of 24.11.1986, which is confirmed by the Act of Bioethical Expertise of the Commission of Bila Tserkva National Agrarian University №17, 2020.

Information about conflicts of interest. The authors declare no conflict of interest.

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Вплив пребіотики Біо-актив на природну резистентність, збереженість і продуктивність молодняку свиней

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Першочергове завдання галузі тваринництва – забезпечення населення якісними продуктами харчування, а промисловості – сировиною. Для цього необхідним є забезпечення високого рівня продуктивності та збереженості молодняку свиней. Дослідження, проведені за останні роки, свідчать про збільшення частоти шлунково-кишкових захворювань серед молодняку сільськогосподарських тварин, що призводять до зниження імунологічної реактивності організму поросят та значних збитків господарствам. Науково-дослідну роботу виконано впродовж 2010–2018 рр. на кафедрі гігієни тварин і основ ветеринарної медицини Білоцерківського національного аграрного університету. Науково-господарські дослідження та виробничі випробування проведено в господарствах ТОВ «Прогрес» (м. Узин Білоцерківського району) та ПП «Денисенко» (Сквирський район Київської області). Експериментальні дослідження проводили в проблемній лабораторії імунології кафедри гігієни тварин та основ ветеринарної медицини, міжфакультетській лабораторії біохімічних та гістохімічних методів досліджень. Під час виконання досліджень використовували зоотехнічні, зоогігієнічні, біохімічні, імунологічні та варіаційно-статистичні методи досліджень.

Уперше використано вітчизняний пребіотик Біо-актив, як кормову добавку до раціону молодняку свиней на дорощуванні за промислового утримання, доведено його позитивний вплив на збереженість, продуктивність, фізіологічний та імунологічний стан їх організму. Уперше встановлено оптимальну дозу пребіотики Біо-актив для молодняку свиней на дорощуванні та розроблено спосіб його застосування. Установлено, що оптимальною дозою пребіотики Біо-актив для молодняку свиней на дорощуванні є 5 г (5×10^7 КУО) на 10 кг маси тіла за згодовування з комбікормом один раз на добу впродовж 30-ти діб, що сприяє збільшенню середньодобових приростів маси тіла поросят на 17,2 (P<0,01) та 16,6 % (P<0,05) на 30- і 60-ту добу досліджень, відповідно. Згодовування свиням Біо-активу сприяє збільшенню вмісту загального білка сироватки крові на 7,2 % (P<0,05), альбумінів – на 5,2 %, γ -глобулінів – на 6,3 %, підвищенню активності АсАТ – на 23,1 % (P<0,05) та АлАТ – на 22,4 % (P<0,01). У периферичній крові молодняку свиней на дорощуванні під дією пребіотики Біо-актив відбувається посилення проліферації, диференціації та спеціалізації імунокомпетентних клітин. Показники периферичної крові молодняку свиней, які отримували пребіотик Біо-актив, характеризувалися збільшенням загальної кількості T-лімфоцитів (на 5,43 %), B-лімфоцитів (на 2,85 %), зниженням кількості 0-лімфоцитів (на 8,29 %) унаслідок посилення процесів

проліферації, диференціації та спеціалізації імунокомпетентних клітин. Завдяки зниженню рівня низькоавідних імунокомпетентних клітин збільшилася чисельність середньоавідних T-лімфоцитів (на 9,19 %) і B-лімфоцитів (на 10,28 %). Застосування пребіотики Біо-актив у оптимальній дозі сприяє активації метаболічних процесів, антиген-неспецифічного імунітету та збільшенню маси тіла свиней.

Ключові слова: промислове свинарство, молодняк свиней на дорощуванні, умови утримання, шлунково-кишковий канал, пребіотик, метаболізм, імунологічна реактивність, збереженість.

Влияние пребиотика Био-актив на естественную резистентность, сохранность и продуктивность молодняку свиней

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Первоочередная задача отрасли животноводства – обеспечение населения качественными продуктами питания, а промышленности – сырьем. Для этого необходимо обеспечение высокого уровня производительности и сохранности молодняку свиней. Исследования, проведенные за последние годы, свидетельствуют об увеличении частоты желудочно-кишечных заболеваний среди молодняку сельскохозяйственных животных, приводящие к снижению иммунологической реактивности организма поросят и значительному ущербу хозяйствам. При выполнении исследований использовали зоотехнические, зоогигиенические, биохимические, иммунологические и вариационно-статистические методы исследований. Научно-исследовательскую работу выполнено в течение 2010–2018 гг. на кафедре гигиены животных и основ ветеринарної медицини Белоцерковского национального аграрного университета. Научно-хозяйственные опыты и производственные испытания проведены в хозяйствах ООО «Прогресс» (г. Узин Белоцерковского района) и ООО «Денисенко» (Сквирский район Киевской области). Экспериментальные исследования проводили в проблемной лаборатории иммунологии кафедры гигиены животных и основ ветеринарної медицини, межфакультетской лаборатории биохимических и гистохимических методов исследований. Впервые использовано пребиотик Био-актив как кормовую добавку в рацион молодняку свиней на дорощивании при промышленном содержании, доказано его положительное влияние на сохранность, продуктивность, физиологическое и иммунологическое состояние их организма. Впервые установлено оптимальную дозу пребиотика Био-актив для молодняку свиней на дорощивании и разработан способ его применения.

Оптимальной дозой пребиотика Био-актив для молодняку свиней на дорощивании является 5 г (5×10^7 КОЕ) на 10 кг массы тела при скармливания с комбикормом один раз в сутки в течение 30-ти суток, что способствует увеличению среднесуточных приростов массы тела поросят на 17,2 (P <0,01) и 16,6 % (P <0,05) на 30- и 60-е сутки исследований, соответственно. Скармливания свиням Био-актива способствует увеличению содержания общего белка сыворотки крови на 7,2 % (P <0,05),

альбуминов – на 5,2 %, γ -глобулинов – на 6,3 %, підвищенню активності АсАТ – на 23,1 % ($P < 0,05$) і АЛТ – на 22,4 % ($P < 0,01$).

В периферическій крові молодняка свиней на дорациванні под дією пребіотика Біо-актив проиходит усиление пролиферации, дифференциации и специализации иммунокомпетентных клеток: повышение общего количества T -лимфоцитов на 5,43 % ($P < 0,05$), B -лимфоцитов – на 2,85 %, снижение содержания θ -лимфоцитов – на 8,29 % ($P < 0,05$). Также увеличивается количество среднеавидных T -лимфоцитов – на

9,19 % ($P < 0,05$) и B -лимфоцитов – на 10,28 % ($P < 0,05$) за счет снижения уровня низкоавидных иммунокомпетентных клеток.

Применение пребиотика Био-актив в оптимальной дозе способствует активации метаболических процессов, антиген-неспецифического иммунитета и увеличению массы тела свиней.

Ключевые слова: промышленное свиноводство, молодняк свиней на дорациванні, условия содержания, желудочно-кишечный канал, пребиотик, иммунобиологическая реактивность, метаболизм, сохранность.



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