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Productivity and mineral exchange in the body of young pigs when feeding probiotics

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The productivity and mineral exchange in the body of young pigs of large white breed was studied. Pigs of research groups, in absolute weight gain, exceeded control by 1.9-5.7 (P<0.01). Pigs of the third and fourth research groups had the highest absolute gains over the entire period of the experiment. Theirfeed was mixed with Protecto-active at the rate of 1.5 and 2.0 g per 10 kg body weight, or (3 and 4 g per 1 kg of feed). The balance of calcium and phosphorus in the body of pigs of all groups was positive, but calcium and phosphorus of pigs of the 3rd and 4th experimental groups were better absorbed, although no significant difference was found.
Keywords: Young pigs; rations; probiotic; protecto-active; productivity; calcium balance; phosphorus balance; mixed feed

Introduction

In order to improve the productivity of young pigs and increase the level of assimilation of nutrients of diets in feeding, new biologically active feed supplies are widely used, such as: probiotics, prebiotics. They are necessary components in the modern development of pig breeding, when cost-effective pork is produced on its own feed.

However, now it is also important to assess the environmental impact of the activities of the pig industry. Manure masses can be a source of various pollutants of mineral, organic and biogenic origin into the environment. There are cases of negative impact, which leads to an increase in greenhouse gas emissions (methane and helium oxide nitrogen, or nitrous oxide).

Studying the effect of biologically active feed supplies on the productivity of pigs, the digestibility of nutrients of feed, is the current direction of increasing the productivity of pigs and the production of ecologically clean food (Babenko et al., 2013; Bindjug et al., 2013; Ljubichev et al., 2013).

Some scholars state that prebiotic Bio-Mos, as a feed additive during the whole period of fattening, helps to increase the intensity of pigs growth on fattening due to changes in the number of conditionally pathogenic and symbiotic microorganisms.The accumulation of symbiotic microflora in feces provides harmful effects on the environment and does not cause infection of animals and humans (Kuzmenko et al., 2018).

Enrichment of diets by feeding animals with new feed supplies, including bacterial drugs-probiotics (Veterinarna praktika, 2014;Tao Ma et al., 2018) contributes to the achievement of positive results in growing pigs.

Probiotics effectively inhibit pathogenic and conditionally pathogenic intestinal microflora in pigs (Dorota Zielińska et al., 2017), they are immunomodulators and increase the body's resistance (Marianna Roselli et al., 2017), promote high growth rate, form and stabilize the normal healthy microflora of the gastrointestinal tract in pigs for growing and fattening (Runjun Dowarah et al., 2017 normalizes metabolism, indirectly contributes to improved feed digestion and increased animal productivity (Tkachuk, 2014). Due to the synthesis of biologically active substances-vitamins, amino acids and lactic acid, the animal's body counteracts the gastrointestinal disease without the use of antibiotics (Shengfa F. Liao et al., 2017),which increases the safety of livestock. At the same time, products (meat, milk, eggs) remain environmentally friendly, and probiotic drugs have no contraindications to use.

The probiotic Protecto-active created by LLC BTU-Center (Ladyzhin, Ukraine) belongs to feed supplies of microbiological origin. Protecto-active-a drug based on live lactic acid bacteria *Lactobacillus delbrueckii sp. bulgaricus* and biologically active substances.

Scientists state that when using such drugs, quantitative indicators of protein and residual nitrogen increase, plasma protein regeneration increases, protein biosynthesis improves and the ratio of protein fractions in blood serum is normalized, Krebs cycle reactions are activated (Kuzmenko, 2009).

Therefore, the purpose of our research was to investigate the effect of probiotic Protecto-active on the productive qualities of animals in order to obtain environmentally safe, competitive products of pig breeding.

Material and methods of research

The study was conducted on young pigs of a large white breed. For the experiment, five groups of pigs of 15 animals each were formed on the principle of analogs. Piglets from all groups received the same rations. The experience lasted 107 days and consisted of two periods: equalization-15 days and the main one-92 days. During the equalization period, we monitored the growth rate of animals by weighing and determining the similarity of selected animals. At the end of the period, 10 animals were left from each group for each group-5 hogs and 5 pigs.
The main period provided for the feeding of pigs according to the scheme of the experiment (Table 1).

Table 1. Scheme of the experiment.

Group	Periods of experiment	
	equalization (15 days)	**the main (92 days)**
Control 1	Main ration (MR)	Main ration (MR)
Experimental 2	MR	MR+Protecto-active (1 g per 10 kg body weight, or 2 g per 1 kg of feed)
Experimental 3	MR	MR+Protecto-active (1.5 g per 10 kg body weight, or 3 g per 1 kg of feed)
Experimental 4	MR	MR+Protecto-active (2.0 g per 10 kg body weight, or 4 g per 1 kg of feed)
Experimental 5	MR	MR+Protecto-active (2.5 g per 10 kg body weight, or 5 g per 1 kg of feed)

Experimental animals of all groups were fed the same ration in the form of mixed feed, which included wheat, barley, corn, soybean cake, sunflower cake, chalk, vitamin-mineral concentrate "biotan" and salt. In the main period of the experiment, animals were fed feed (for the control group-without probiotic, for research-they included probiotic according to the scheme of the experiment).
Protecto-active was added into the mixture of feed by multi-stage mixing with the components of the diet. The feeding of the experimental pigs was grouped with daily allowance for the feed eaten. The experiment took into account the consumption of feed by animals, the dynamics of their live weight and average daily gain by monthly individual weighing. The chemical composition of the feed and its nutritional value were determined by the method of (Petukhova et al., 2010).
Digestibility of feed and metabolism in experimental pigs was studied on three animal analogues in a physiological experiment, according to the method of M. A. Kovalenko in order to study in depth the influence of probiotic Protecto-active (Kovalenko, 1977). The content of calcium and phosphorus macronutrients was determined according to (DSTU ISO 6491:2004; DSTU ISO 6490-1:2004).The chemical composition of samples of feed, feces, and urine of experimental animals was determined according to methods generally accepted in zootechnics (Kozyr et al., 2002; In-t biologii tvarin UAAN, 2004).
Biometric processing of the obtained research results was carried out using MS Excel. The probability of the difference between the indicators was estimated by Student's criteria (Melnichenko et al., 2006).

Results and discussion

When conducting research, we determined the growth rate of piglets depending on the number of fed probiotic, which was introduced into the feed (Table 2).

Table 2. The dynamics of the live weigh to experimental pigs, kg, $\bar{X} \pm S_{\bar{X}} \left(n=10\right)$.

Age, days	Group				
	Control	Experimental			
	1	2	3	4	5
Equalization period					
45	9.8 ± 0.19	9.79 ± 0.30	9.79 ± 0.22	9.8 ± 0.26	9.79 ± 0.21
Main period					
60	13.2 ± 0.24	13.2 ± 0.37	13.2 ± 0.28	13.2 ± 0.33	13.2 ± 0.28
91	25.8 ± 0.41	25.7 ± 0.45	25.9 ± 0.36	26.2 ± 0.62	26.0 ± 0.57
121	38.9 ± 0.53	39.1 ± 0.57	39.8 ± 0.48	39.8 ± 0.70	39.4 ± 0.66
152	55.6 ± 0.86	56.4 ± 0.73	58.0 ± 0.54*	57.8 ± 0.63	57.5 ± 0.85

*P <0.05, **P<0.01, *** P<0.001 in the comparison to the control group.

The main indicator by which the performance of pigs is evaluated is the dynamics of their live weight. According to the scheme of research, during the entire accounting period, the live weight of piglets was determined monthly.
At the beginning of the equalization period, the piglets of all groups had almost the same live weight. After the equalization period, the live weight of the research piglets averaged 13.2 kg in the group.

The data in Table 2 indicate that different doses of feeding a probiotic Protecto-active have different effects on the growth of young pigs. For example, during the first month-long period of the experiment, the live weight of piglets from the 2nd and 3rd experimental groups were at the control level whereas the live weight of pigs from the 4th and 5th research groups exceeded the live weight index of the control pigs by 1.6 and 0.8%. At the age of 152 days, the live weight advantage of the experimental pigs of the 2nd, 3rd, 4th and 5th groups, which were fed the Protecto-active probiotic drug, was 1.4; 4.3 (P<0.05) 4.0 and 3.4% relative to the control.
In accordance with the changes in the body weight of the experimental animals, the absolute increase in pigs also varied at different periods of the experiment (Table 3).

Table 3. Dynamics of absolute gains in experimental pigs, kg, $\bar{X} \pm S_{\bar{X}}\ (n=10)$.

Age, days	Group				
	Control	Experimental			
	1	2	3	4	5
Equalization period					
45-60	3.4 ± 0.07	3.4 ± 0.08	3.4 ± 0.08	3.4 ± 0.08	3.4 ± 0.08
Main period					
61-91	12.6 ± 0.27	12.5 ± 0.26	12.7 ± 0.17	13.0 ± 0.35	12.8 ± 0.34
92-121	13.1 ± 0.44	13.4 ± 0.33	13.9 ± 0.32	13.6 ± 0.27	13.4 ± 0.29
122-152	16.7 ± 0.50	17.3 ± 0.30	18.2 ± 0.42*	18.0 ± 0.30*	18.1 ± 0.29*
60-152	42.4 ± 0.70	43.2 ± 0.48	44.8 ± 0.37**	44.6 ± 0.41*	44.3 ± 0.65

*P <0.05, **P<0.01, *** P<0.001 in the comparison to the control group

According to Table 3, during the equalization period, the absolute increase in the live weight of the piglets of the experimental groups did not have an intergroup difference.
For the main period of the experiment, experimental animals of the 2nd, 3rd, 4th and 5th experimental groups in absolute weight gain exceeded the control by 1.9%, 5.7 (P<0.01), 5.2 (P<0.05) and 4.5%, respectively. Pigs of the third and fourth research groups had the highest absolute gains over the entire period of the experiment, in which were fed the Protecto-active at the rate of 1.5 and 2.0 g per 10 kg of live weight, or (3 and 4 g per 1 kg of feed). The increase in the dose of probiotic feeding to 2.5 g per 10 kg of live weight did not increase the productivity of animals.
The average daily gain in live weight in animals of the experimental groups was higher than in animals of the control group. But the best performance was obtained in the third and fourth experimental groups.
Studies have shown that enrichment of diets of young pigs in growing with various doses of the Protecto-active has a positive effect on performance, but the optimal dose in the feed for young pigs can be considered 1.5 g per 10 kg body weight, or (3 g per 1 kg of feed).
In the body of animals contains about 85 chemical elements. Mineral elements are of great importance for the body, they are actively involved in the processes of respiration, blood formation, digestion, absorption, synthesis, decomposition and excretion of metabolic products. Minerals create conditions for the full functioning of enzymes, vitamins, hormones, maintain acid-base balance and osmotic pressure.
Mineral elements are part of all cells and tissues of the body, but most of them are concentrated in the skeleton, and they are also contained in soft tissues and body fluids of the animal.
In our studies, a positive effect on the absorption of calcium and phosphorus in the body of young pigs was noted when adding the Protecto-active to the feed mixture (Tables 4 and 5).
From the data of Table 4 it can be seen that the balance of calcium in the body of pigs of all groups was positive. In the body of animals of all experimental groups received the same amount of calcium, whereas its excretion with the feces in pigs of the 2nd experimental group was less than the control by 1.7%. Animals 3 and 4 of the experimental groups were allocated with the feces, respectively, 3.2 and 3.5% less calcium than the control pigs. In pigs of the 5th experimental group, calcium was excreted with feces by 1.5% less compared to the control.

Table 4. Average daily calcium balance, g, $\bar{X} \pm S_{\bar{X}}\ (n=3)$.

Indicator	Group				
	Control	Experimental			
	1	2	3	4	5
Received with feed	17	17	17	17	17
Excreted with feces	7.48 ± 0.396	7.35 ± 0.272	7.24 ± 0.110	7.22 ± 0.112	7.37 ± 0.082
Excreted in urine	0.57 ± 0.040	0.56 ± 0.048	0.56 ± 0.019	0.55 ± 0.039	0.58 ± 0.025

Delayed in the body, g	8.95 ± 0.374	9.09 ± 0.224	9.20 ± 0.113	9.23 ± 0.146	9.06 ± 0.064

*P <0.05, **P<0.01, *** P<0.001 in the comparison to the control group

In the urine of pigs of the 2nd and 3rd experimental groups, there were1.8% less calcium compared to control. Animals of the 4th experimental group with urine calcium excreted less by 3.5% than pigs from the control group, whereas animals of the 5th experimental group excreted 1.7% more urine with calcium from control analogues.
By the amount of calcium that was postponed in the body, the animals of the 2, 3, 4th and 5th experimental groups were dominated by control analogs, respectively, by 1.6; 2.8; 3.1 and 1.2%. The use of consumed calcium was better in animals of the 3rd and 4th experimental groups, they exceeded the control by 1.5 and 1.7%, respectively, and pigs of the 2nd and 5th experimental groups absorbed consumed calcium better by 0.9 and 0.7% compared with the control group (Figure 1).
So, the pigs of the 3rd and 4th research groups, who were fed the Protecto-active at the rate of 1.5 and 2.0 g per 10 kg of live weight, were better assimilated, although no significant difference was found.

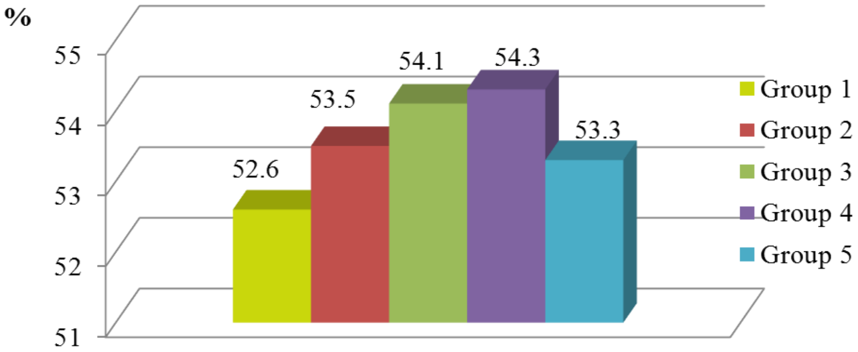

Figure 1. Calcium absorption as a percentage of consumed, %.

Phosphorus, like calcium, is involved in all metabolic processes of the body, being part of various proteins, phospholipids, nucleic acids and other organic compounds. The addition of the Protecto-active to the feed affected not only calcium metabolism in the body of research group pigs, but also phosphorus exchange.
From Table 5 it can be seen that all experimental pigs with feed received the same amount of phosphorus. However, its excretion with feces was not reliably less in animals of the 2, 3, 4, and 5th experimental groups, respectively, by 2.1; 2.5; 3.7 and 2.1% compared with the control group.

Table 5. Average daily phosphorus balance, g, $\bar{X} \pm S_{\bar{X}} \, (n=3)$.

Indicator	**Group**				
	Control	**Experimental**			
	1	**2**	**3**	**4**	**5**
Received with feed	8.6	8.6	8.6	8.6	8.6
Excreted with feces	4.32 ± 0.175	4.23 ± 0.112	4.21 ± 0.118	4.16 ± 0.135	4.23 ± 0.115
Excreted in urine	0.35 ± 0.016	0.35 ± 0.017	0.33 ± 0.009	0.33 ± 0.010	0.33 ± 0.013
Delayed in the body, g	3.93 ± 0.167	3.96 ± 0.119	4.07 ± 0.117	4.11 ± 0.145	4.04 ± 0.108

Excretion of phosphorus in the urine in pigs of the 2nd experimental group was the same as the control, whereas animals of the 3rd, 4th and 5th experimental groups excreted phosphorus in the urine by 0.9% less compared with the control group.
In the body of pigs of the 2nd group phosphorus was deposited by 0.8% compared with the control analogues, whereas in the body of animals of 3, 4 and 5th experimental groups, this indicator increased by 3.6; 4.6 and 2.8%.
The effective use of phosphorus in experimental animals is indicated by the ratio of the amount of the element absorbed to the consumed (Figure 2).

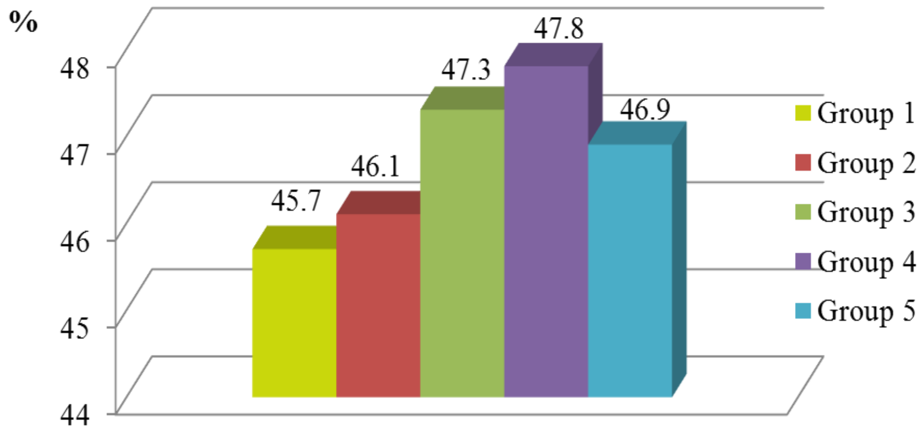

Figure 2. The absorption of phosphorus as a percentage of consumed, %.

The best (47.3 and 47.8%) this indicator was in pigs of the 3rd and 4th research groups. The difference between the animals of these groups and the control was respectively 1.6 and 2.1%. Pigs of the 2nd and 5th experimental groups exceeded the control by 0.4 and 1.2%, respectively.
So, the highest rate of phosphorus assimilation was in animals of the 3rd and 4th research groups, which were fed with a leak-active diet at the rate of 1.5 and 2.0 g per 10 kg of live weight, or 3 and 4 g per 1 kg of feed, although no significant difference has been established.
According to the results of the main period of experience, the optimal dose of the Protecto-active for young pigs should be 1.5 g per 10 kg of live weight, or 3 g per 1 kg of feed. The next increase in its dose does not lead to a corresponding increase in absolute and average daily gains, and also does not improve the digestibility of nutrients of the feed, absorption of nitrogen and mineral elements.

Conclusions

1. The productivity of all research groups of pigs was higher compared to animals of the control group, but the most effective doses of feeding the Protecto-active were 1.5 g and 2.0 g per 10 kg of live weight of pigs.
2. Calcium and phosphorus of pigs of the 3rd and 4th research groups were better absorbed, which were given the Protecto-active at the rate of 1.5 and 2.0 g per 10 kg of live weight, or 3 and 4 g per 1 kg of feed, although a significant difference not found.

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