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Application of Probiotics Based on Lactic Acid Bacteria to Increase the Adaptive Capacity of Pigs and Meat Quality.

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ABSTRACT

A feed additive based on L. plantarum, L. johnsonii and L. paracasei strains was developed. As a result of the conducted research on probiotic additive it has been determined that its use in pigs contributes to an increase in the adaptation potential of animals by improving microflora of the digestive tract, optimizing biochemical processes and functions of organs and systems associated with them. The use of feed additive in pigs during the period of growing and fattening allows to get high rates of safety and productivity of animals, as well as to improve the quality of meat.

Keywords: pigs, ration, symbiotic probiotic, normoflora, blood, microbiocenosis, meat products

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INTRODUCTION

At the present time probiotics are widely used in animal husbandry. Probiotics make it possible to normalize the activity of the gastrointestinal microflora in animals and at the same time to improve the digestibility of plant food and to provide organism with biologically active substances [1, 3, 4].

The basis of most modern probiotics is the lactic acid bacteria of the genera *Lactobacillus, Bifidobacterium* and *Lactococcus*. Aspects of the use of these microorganisms affect a wide range of issues and problems associated with the normalization of the intestinal microbiocenosis and improvement of the metabolism of animals [2, 5, 6].

The aim of the research was the development and determination of the pharmacological activity of the additive from probiotic lactic acid bacteria, as well as the evaluation of its effect on the body of pigs and the quality of raw meat.

METHODOLOGY OF RESEARCH

The bases of the probiotic additive were the strains of lactobacilli picked out from the luminal microflora of pigs of various ages. Two strains of lactobacilli were selected in piglets at the age of 60 days. The strain "G" was identified as a representative of the species *Lactobacillus plantarum*, the strain "D" was a representative of the species *Lactobacillus johnsonii*. In more adult animals (during the fattening period), lactobacillus strains representing the following species were picked out from the luminal microflora: *Lactobacillus paracasei*; *Lactobacillus sakei*; *Lactobacillus reuteri.* The strains were deposited in the All-Russian Collection of Microorganisms (VKM) in G.K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, where they were assigned the following registration numbers: *L. plantarum* strain – BKM B-2558 D; *L. johnsonii* strain – BKM B-2559 D, *L. paracasei* strain – BKM B-2560 D. Selected strains were the most promising in terms of physiological, biochemical and biotechnological properties, characterized by the following indicators: resistance to pH below 3.9; rate of increase of the titer to 10^{12} in 24 hours; temperature range of growth from +29 °C to +40 °C (with an optimum of 37 °C); composition of the produced acids (in%): lactic – 1.59 and propionic – 0.05.

The probiotic feed additive with the following composition was created: for piglets up to 3 months old – based on *L. plantarum* and *L. johnsonii* strains; for piglets older than 3 months – based on *L. paracasei* strain.

Nutrient medium for cultivation of these microorganisms was created on the basis of dry cow milk with fat content up to 1%, which made it possible to obtain samples of the additive with the amount of lactobacilli 10^{10}–10^{12} CFU/g, which were put into the rations of animals.

The experiments determined the dose of making the probiotic additive in the feed for pigs of various ages, which amounted to 20 ml per head per day – for piglets from two weeks to two months old and 10 ml per head every other day – for piglets during the period of growing and fattening (from 60 to 180 days). For piglets of one to two weeks old the probiotic additive is used by wetting nipples of sows with it, and the concentration of lactobacilli is 10^{10}–10^{11} CFU/g.

To study the influence of probiotic lactobacillus additive on the organism of pigs and the quality of meat, scientific and economic experiment was conducted. For this purpose two groups of piglets of 60-days old were formed, 40 animals each. One group of animals (1 – control) received a basic ration used in the household, the second group of piglets (2 – experimental) additionally got the probiotic additive with the feed in a dose of 10 ml per animal every other day for 3 months. The implementation of the additive in the feed was carried out using a sprayer of the type Gloria E-45, which allows spraying the additive to the feed when it is distributed to the feeders.

The pharmacological activity of probiotics was assessed by the safety of animals, indicators of their body weight, changes in the biochemical and morphological factors of blood, as well as the quality of meat.

Blood samples for laboratory analysis and samples of intestinal contents were collected from 10 animals from each group twice – at the end of the growing period and at the end of the experiment.

Laboratory studies were conducted on a Vitalab Selectra Junior automated biochemical analyzer. Hematological analysis of peripheral blood was conducted on a Mythic 18 vet automated analyzer. The quality of animal meat after the use of probiotic additive was determined by the results of a veterinary and sanitary assessment. The amino acid composition of the meat was determined by HPLC using the Styer-UV/VIS Chromatography System.

RESULTS

As a result of the research it was found out that the developed probiotic additive contributed to a positive correction of the intestinal microbiocenosis of pigs (Table 1).

Table 1: Qualitative and quantitative composition of pig intestinal microbiocenosis while using the probiotic additive (n=10)

№	Microorganisms	Groups	Growing	Fattening
			lg CFU/g	
1	*Lactobacillus spp.*	1 – control	7.0	7.0
		2 – experimental	9.0	9.0
2	*Bifidobacterium spp.*	1 – control	8.0	8.0
		2 – experimental	11.0	10.0
3	*Clostridium spp.*	1 – control	4.8	5.4
		2 – experimental	2.2	1.6
4	*Enterococcus spp*.	1 – control	8.7	9.0
		2 – experimental	7.4	7.5
5	*Staphylococcus spp.*	1 – control	5.0	5.0
		2 – experimental	2.8	2.4
6	*Escherichia coli*	1 – control	6.8	7.2
		2 – experimental	7.0	6.7
7	Microscopic fungi (yeast, mold)	1 – control	4.0	4.2
		2 – experimental	1.5	1.3

The increase in the number of lactobacilli (1) and bifidobacteria (2) in the intestines of pigs both in growing and fattening period proves the positive corrective effect of the probiotic lactic acid additive on the intestinal microbiocenosis of animals. The difference in the quantitative content of microorganisms of the genus *Lactobacuillus* in the contents of the luminal intestinal of animals from the control and experimental groups was 28.6%, and according to *Bifidobacterium* it was 31.3% in favor of experimental animals. The implementation of probiotics contributed to the reduction of conditionally pathogenic microorganisms – clostridia, staphylococci, mold and yeast fungi in the intestinal tract of pigs.

Improvement of the intestinal microbiocenosis of pigs on the background of the use of the probiotic additive had a positive effect on the growth and safety of animals. Thus, the average daily weight gain of pigs from the experimental group was on higher by 18.5% compared with the control, while the safety of these animals over the entire experiment period was 95% against 82.5% in the control group.

When conducting laboratory studies of the blood of pigs, it was revealed that the pharmacodynamic properties of the probiotic additive were manifested by optimization of a number of biochemical and morphological factors of blood (Table 2).

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Table 2: Influence of the additive on the biochemical and morphological indicators of pigs (M±m; n=10)

Indicators	Growing		Fattening	
	1 – control	2 – experimental	1 – control	2 – experimental
Red blood cells, 10^{12}/l	5.22±0.13	5.93±0.07*	6.12±0.09	6.48±0.21
Hemoglobin, g/l	107.7±3.6	123.2±1.4**	111.0±4.1	125.5±3.9*
Total protein, g/l	62.2±2.9	67.3±1.8*	73.1±1.6	78.1±1.5**
Urea, mmol/l	3.6±0.17	3.8±0.26	3.4±0.21	4.1±0.34
Glucose, mmol/l	4.2±0.83	4.7±0.65**	5.4±0.44	6.1±0.37**
Calcium, mmol/l	2.6±0.03	2.7±0.09	2.5±0.05	2.6±0.02
Phosphorus, mmol/l	2.3±0.01	2.4±0.04	2.4±0.03	2.3±0.01
AST, IU/L	55.9±1.81	48.8±1.27	43.7±2.29	39.8±1.15
ALT, IU/L	28.4±0.14	25.8±0.45	26.3±0.47	23.4±0.11

Note: * P≤0.05; ** P≤0.01 – degree of reliability relative to control

Thus, an increase in red blood cells by 13.6% (P≤0.05) was recorded in the animals of the experimental group during the growing period and by 5.9% during the fattening period. The hemoglobin concentration revealed a significant increase in this indicator relative to control by 14.4% and 13.1%, respectively by periods.

The factors that determine the effectiveness of the adaptation of the organism are blood proteins. Studies have shown that under the influence of probiotic microorganisms occurs an increase in the nitrogen balance in the body of pigs, which is confirmed by an increase in the concentration of total protein by the middle of the experiment by 8.2% (P≤0.05) and by the end of the experiment – by 6.8% (P ≤ 0.01) relative to the control group.

The use of the additive had an influence on the blood sugar level of pigs, since the glucose concentration in the experimental group at all periods of the study was significantly higher than the control analogues by 11.9% and 13%.

To evaluate the physicochemical properties and the amino acid composition of the muscle tissue of pigs at the end of the experiment samples of the *longissimus dorsi* muscle were taken (Table 3). As a result of research, it was determined that the active acidity of meat (pH), which is an indicator of its suitability for storage and culinary processing, was 5.57 (in control) and 5.59 (in the experimental group).

Table 3: Influence of the probiotic additive on the physicochemical properties and amino acid composition of the *longissimus dorsi* muscle of pigs (M±m; n=10)

Indicators	Groups	
	1 – control	2 – experimental
Meat pH	5.57	5.59
Color intensity, units	92	89
Content of bound water,% to meat	57.1	53.6
Mass fraction of moisture, %	74.84	74.91
Mass fraction of protein, %	21.26	22.61
Mass fraction of fat, %	2.89	1.41
Mass fraction of ash, %	1.01	1.07
Amino acid content, g/100 g of protein:		
Lysine	8.01±0.09	7.78±0.07
Phenylalanine	6.05±0.04	7.03±0.08
Leucine	7.57±0.09	8.54±0.04
Isoleucine	6.78±0.06	7.51±0.09
Cystine	4.42±0.02	5.40±0.05

Methionine	2.34±0.03	3.29±0.03
Valin	5.62±0.07	5.21±0.04
Tyrosine	5.42±0.03	6.75±0.06
Threonine	4.59±0.04	4.97±0.05
Tryptophan	1.27±0.01	1.72±0.02

Water-holding capacity is a quality indicator of meat and characterizes the appearance of meat before cooking, the behavior of meat during cooking and its juiciness. This is especially true for shredded meat products, where the structure of the tissue is destroyed and, therefore, the outflow of juice released from proteins cannot be prevented. Muscles with a high content of intramuscular fat usually have a high water-holding capacity, while the use of probiotics reduced this figure to 53.6%, against 57.1% in control. This pharmacological effect of the additive occurs due to its influence on the protein metabolism of the body of pigs, which was manifested not only by an increase in the protein component of blood, but also by an increase in the mass fraction of protein in meat with a difference of 22.61% against 21.26% in control pigs.

All of the above mentioned indicators correlated with the improvement of the amino acid composition of meat obtained from experimental animals. The most significant difference in the content of amino acids in comparison with the control pigs was: for tryptophan in 1.35 times; for tyrosine by 24.5%; for methionine in 1.4 times.

CONCLUSION

Thus, as a result of the conducted research of the additive from the probiotic based on lactic acid bacteria it has been found out that its use in pigs contributes to an increase in the adaptive capacity of animals by improving the microflora of the digestive tract, optimizing biochemical processes and related functions of organs and systems. The use of feed additives in pigs during the period of growing and fattening allows getting high rates of safety and productivity of animals, as well as improving the quality of meat.

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