

Influence of Probiotic Preparations on Meat Quality of Farm Animals

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Abstract— The use of probiotic additives that contribute to the normalization of microbiocenosis of the animal body, as well as their resistance to pathogenic microflora, which ultimately affects the increase in meat productivity is promising for the livestock industry. The aim of the research was to study the effect of probiotic preparation "Subtilis-C" on the productivity and quality, on the meat quality of pigs and rabbits in industrial technology.

Two groups of hybrid young animals (large white x Landras x pietren (terminal line MAXGRO™) of pigs of 35-day age of 15 heads were formed for carrying out scientific and economic experiment by the method of pairs-analogues. In the main period of the experiment, the animals of the control group received the main ration (MR), consisting of complete all-mash: SC 4-7; experimental – (MR) plus the preparation "Subtilis C" as part of the feed at a dosage of 0.4 g/kg of feed. The studies were conducted on the basis of the industrial complex to produce pork in the Liskinsky district of the Voronezh region. During the study animals were clinically healthy and were in the same conditions.

To evaluate the effect of the probiotic preparation "Subtilis" when fattening young rabbits 30 rabbits (males) of hybrid breeds, New Zealand red and Soviet chinchilla were selected at the age of 60 days, and on the principle of groups of analogues they were divided into 3 groups of with 10 heads in each. Studies were conducted concerning the number of young rabbits in the private sector of the Voronezh region in 2018. Rabbits of group 1 (control) received only all-mash PK-90, rabbits of groups 2 and 3 were given, in addition to the main diet, the probiotic preparation "Subtilis C" composed of all-mash in a dosage of 3 g/kg (rabbits of experimental group 1) and 4 g/kg of feed (rabbits of experimental group 2).

It was found that during the main period of scientific and economic experience the absolute increase in live weight of young pigs of the control group amounted to 79.70 kg, those of experimental – 82.60 kg, which is more than the animals of the control group, respectively, by 2.70 kg. The results of the control

slaughter showed that the slaughter live weight of pigs of the experimental group in comparison with the animals of the control group was higher, respectively, by 3.56 kg.

Upon reaching the slaughter age (120 days) rabbits of the 1st group (control) were characterized by live weight, which was less than the mass of individuals of the 2nd group (1st experimental group) by 138.0 g, or 4.31 % ($P < 0.05$), the 3rd group (2nd experimental group) - by 324.7 g, or 10.15 % ($P < 0.01$). The highest pre-slaughter weight of young rabbits was (3245 g) in experimental group 2 and in comparison with the control one it was higher by 165.7 g, or 5.38% ($p < 0.05$). The carcass yield in the 2nd experimental group was 62.33 %, which is more than in the control group and 1st experimental group by 6.86 and 2.12%, respectively.

The level of profitability of pork production was higher in the experimental group compared to the control group by 3.6%, rabbit production - by 1.8% (in the 1st experimental group) and 2.6% (in the 2nd experimental group) higher compared to the control group of rabbits. Thus, the preparation "Subtilis-C" is a promising product of a number of probiotics used in animal feeding and allows obtaining environmentally friendly products of pig and rabbit breeding with improved economic performance.

Keywords—probiotic preparation, number of young rabbits, hybrid young pigs, meat productivity.

I. INTRODUCTION

In recent years, the Russian meat market has entered a phase of stable development; the country has ceased to be the largest importer of raw meat; the industry faces the task of increasing export potential [1]. Natural and economic resources of the Voronezh region and prioritization of livestock development contributed to the fact that in terms of food security, the region is profitable, while the region covers its own meat needs by 300%. Niches of ethnic organic products, including lamb, rabbit

meat [2, 12, 14-20, 24-26, 29], are growing and fixed in the market.

In modern conditions, serious attention is paid to food safety. In order to maintain its position in the domestic highly competitive market and for Russian producers to enter the external market, it is necessary to introduce a system of food safety that meets international standards - HACCP (Hazard Analysis and Critical Control Points) [3] the basis of which is a systematic approach, covering the parameters of food safety from obtaining the raw materials to the use of the finished product by the consumer [32-34].

One of the main biological risks in pig and rabbit breeding enterprises is the high sensitivity of livestock to pathogenic microflora. This factor is largely due to the high concentration of livestock per unit of area. Therefore, minimizing the reproduction of microflora in the animal's body is the main task of growing and fattening young animals in intensive technologies. For this purpose, antibiotics are used as feed additives, the mechanism of action of which is that they can reduce the competition of microorganisms in the fight for nutrients with the body and reduce their metabolites that inhibit the growth of the animal [4]. In the context of the struggle for food safety, the use of antibiotics in animal husbandry is unacceptable.

At present, probiotic forage preparations have been widely used as a potential replacement for antibiotics not only to maintain the microbial balance of the gastrointestinal tract, but also to increase the productivity of animals [5, 6, 7, 8, 12, 13, 23, 31].

It is proved that the positive results show probiotics, which are based on spore-forming bacteria of the genus *Bacillus*. On the basis of strains of bacteria *B. Subtilis* (strain VKM V-2250, patent RF № 2184774) and *B. Licheniformis* (strain VKM In - 2252, patent RF № 2203947) Institute of probiotics, a number of products with a wide spectrum of action is intended for use in intensive livestock production [9-11, 23]. Strains of bacteria of the preparation "Subtilis-C" have a pronounced antagonistic activity against *Clostridium perfringens*, *Escherichia coli*, *Salmonella typhimurium*, *Salmonella enteritidis*, *Staphylococcus aureus*, *Shigella sp.* and others;

The aim of the research is to study the effect of probiotic preparation "Subtilis-C" on the productivity and meat quality of pigs and rabbits in industrial technology.

II. MATERIAL AND METHODS OF RESEARCH

Two groups of hybrid young animals (large white x Landras x pietren (terminal line MAXGRO™) of pigs in 35-day age of 15 heads were formed for carrying out scientific and economic experience by the method of pairs-analogues. In the main period of the experiment, the animals of the control group received the main ration (MR), consisting of complete all-mash: SC 4-7; experimental – (MR) plus the preparation "Subtilis C" as part of the all-mash at a dosage of 0.4 g/kg of feed. The studies were conducted on the basis of the industrial complex for the production of pork in the Liskinsky district of the Voronezh region. During the study animals were clinically healthy and were in the same conditions.

To evaluate the effect of the probiotic preparation "Subtilis – C" in fattening young rabbits, we selected 30 rabbits (males) of hybrid breeds new Zealand red and Soviet chinchilla at the age of 60 days, which on the principle of groups of analogues were divided into 3 groups. Rabbits of all groups were kept in the same conditions and received the same basic diet. As the main ration we used all-mash PK-90-1, obtained on the basis of cereals, sunflower cake and amaranth, wheat bran, Jerusalem artichoke powder, herbal flour from alfalfa and green mass of Jerusalem artichoke and premix KVP P90-1K. Feed rations were calculated on the basis of physiological needs and existing norms of feeding rabbits. Rabbits of group 1 (control) received only all-mash PK-90-1 (main ration), rabbits of groups 2 and 3 were fed, in addition to the main diet, with probiotic preparation "Subtilis C" as part of the all-mash in a dosage of 3 g /kg of all-mash (rabbits of the 1st experimental group) and 4 g / kg of all-mash (rabbits of the 2nd experimental group).

To determine the meat efficiency, 3 heads of the rabbits from each group were slaughtered according to the method of all-Russian Institute of Animal husbandry, the meat quality was assessed according to standard procedures [22]. Studies were carried out using the material and technical base of the Institute of pathology, pharmacology and therapy (Voronezh).

III. RESULTS AND DISCUSSION

A. Effect of probiotic preparation "Subtilis-C" on productivity and quality indices of pigs raw meat

Feeding and meat qualities are considered to be main in the selection of technology elements for the production of pork on an industrial basis. Based on this, the aim of our research was to study the feed and meat qualities of pigs control and experimental groups.

The results of the study showed that the use of the probiotic "Subtilis" in the composition of complete all-mash SK-4-7 did not have a negative impact on the dynamics of live weight and average daily growth of the studied pigs (table 1).

During the study it was found that during the main period of scientific and economic experience, the absolute increase in live weight of young pigs of the control group was 79.70 kg, those of experimental - 82.60 kg, which is more than the animals of the control group, respectively, by 2.70 kg. The level of growth intensity was also higher in young pigs of the experimental group: pigs for the period of experience exceeded the average daily gain of live weight of analogues from the control group by 6.5%. At the same time, clinical parameters of animals during the experiment were within the physiological norm.

Indices that determine the intensity of pig breeding are feed consumption per unit of growth and precocity. For feed efficiency advantage was noted in experimental animals.

The results of the control slaughter showed that the slaughter live weight of the pigs of the experimental group in comparison with the animals of the control group was higher by 3.56 kg, respectively (table 2). A similar pattern in experimental animals was revealed on the chilled carcass weight. As a result of researches it is established that the pigs of the experimental group received the studied preparation by the weight of the

cooled carcass surpassed the animals of the control group by 4.13 kg.

TABLE I. THE DYNAMICS OF LIVE WEIGHT AND VALUE OF THE GAINS OF THE EXPERIMENTAL ANIMALS ACCORDING TO THE BREEDING PERIODS (N=15)

Indices	Group	
	control	experienced
Growing period		
Live weight, kg: at the beginning	30.00± 0.05	29.90 ±0.12
at the end	64.20 ±0.24	66.51± 0.18
Weight gain: absolute, kg	34.20 ±0.14	36.61 ±0.12
average daily, g	570.00±2.23	601.00±6.00
% of control group	100.00	107.00
The fattening period		
Live weight, kg: at the beginning	64.20± 0.24	66.51± 0.18
at the end	109.70±0.38	112.50±0.24
Weight gain: absolute, kg	45.50± 0.34	47.01± 0.30
average daily, g	650.0 ±3.34	672.0 ±7.14
% of control group	100.00	103.40
For the overall experiment		
Weight gain: absolute, kg	79.70 ±0.44	82.60 ±0.41
average daily, g	613.10±3.30	653.10 ±5.00
% of control group	100.00	106.52
Exchange energy costs, ECU	3.87	3.53

TABLE II. SLAUGHTER AND MEAT QUALITIES OF EXPERIMENTAL ANIMALS (N=3)

Indices	control group	experimental group
Pre-slaughter live weight, kg	109.70 ± 0.42	113.5±0.60
Slaughter weight, kg	75.02± 0.57	78.58± 0.59
Slaughter output, %	68.30± 0.26	69.23 ±0.18
Chilled carcass weight, kg	73.32 ±0.51	77.45± 0.56
Weight of internal fat, kg	1.70± 0.06	1.13± 0.03
Backfat thickness at 6-7-th thoracic vertebrae, mm	25.07 ±0.19	23.97 ±0.18
The area of the "muscle eye", cm ²	30.80 ±0.24	31.90± 0.15

The area of the "muscle eye" in the gilts pigs of the experimental group in comparison with the analogues of the control group was higher by 3.57%. The thickness of the fat was higher in young pigs of the control group. They outnumbered the gilts of the experimental group in this index respectively by 4.39%. The data show the best expression of meat qualities in the pigs of the experimental group.

The quality of raw meat after processing should satisfy certain requirements. Post-slaughter evaluation of meat quality allows regulating the technological process and producing products of the planned quality.

The study of functional and technological properties showed the following: the pH of meat was in the range of 5.51-5.79. This index shows the normal process of maturation of meat and characterizes its high quality. Water-holding capacity was at a high enough level in the animals of the studied groups (55.2 – in the gilts of the control and 57.4 – of experimental

groups). A lower value of WHC indicates a tendency to PSE defect. That is, the animals of the experimental group are, to some extent, more stress-resistant, and less prone to this defect, which is important for industrial technology.

B. Effect of the probiotic preparation "Subtilis-C" on the productivity and quality indicators of raw meat of rabbits

In the Russian Federation rabbit breeding is a promising industry for the production of dietary meat. The meat of rabbits contains all the essential amino acids for humans, as well as it is fine-fibrous and has a high digestibility.

The nutritional value of meat depends largely on the content of muscle and fat tissue in the carcass. In this regard, the chemical composition of the flesh forms the nutritional and biological value of meat. The chemical composition of meat is characterized by inconstancy; therefore, it can change under the influence of various factors.

The quality of rabbit meat is influenced by factors such as the method of fattening, the method of breeding and the time of slaughter. The most important factor affecting the quality and chemical composition of meat is the diet of animals. In this regard, to obtain high-quality production rabbits need in balanced diet with all the necessary nutrients. Promising in this regard is the use of probiotics obtained by combining different strains that contribute to the transformation of nutrients in the diet to meat products [27, 28, 30].

Our studies have shown that the use of the probiotic "Subtilis-C" in the diet of fattening rabbits led to an increase in the average daily growth and a decrease in feed conversion (table 3).

TABLE III. DYNAMICS OF LIVE WEIGHT OF RABBITS, G AND FEED CONVERSION, KG (X±S) (N=3)

Age, days	Group		
	Group 1 (control)	2 nd group (experimental 1)	3 rd group (experimental 2)
1	40.18 ±0.11	40.30 ±0.12	40.48 ±0.13
60	1517.12 ±20.47	1527.23 ± 15.54	1531.22 ±21.20
120	3200.5±20.17	3338.5±20.14	3525.2±16.00
Average daily increase	28.55±0.75	32.02±0.86	34.23±0.74
Safety, %	76.70	86.70	100.0
Number of heads	46.0	52.0	60.0
Feed conversion, kg	4.50±0.17	4.10±0.16	3.84±0.21

Upon reaching the age of slaughter (120 days), rabbits of the 1st group (control) were characterized by live weight, which was less than the mass of individuals of the 1st experimental group by 138.0 g, or 4.31 % (P < 0.05), the 2nd experimental group - by 324.7 g, or 10.15 % (P < 0.01) (table 3).

The conversion decreased in the 2nd group by 8.88% and in the 3rd — by 14.66% compared to the control. Moreover, the effect of the use of probiotics in young rabbits during the growing period was clearly dose-dependent.

To determine the meat productivity of rabbits at the end of cultivation, we carried out the slaughter (table 4).

TABLE IV. SLAUGHTER QUALITIES AND MORPHOLOGICAL COMPOSITION OF RABBIT CARCASSES (N=3)

Age, days	Group		
	Group 1 (control)	2 nd group (experimental 1)	3 rd group (experimental 2)
Pre-slaughter live weight, g	3079.5±11.12	3169.4±21.33	3245.2±16.50
The mass of steam carcass, g	1798.0±21.17	1889.5±21.17	2025.0±14.48
Relative % to control, %	100.0	105.0	115.9
Lethal output, %	58.38±0.15	59.62±0.21	62.39±0.17
Relative % to control, %	100.00	102.12	106.86
Raw fat mass, g	110.0±1.56	115.0±1.26	120.0±1.22
Raw fat output, %	6.11±0.54	6.09±0.66	5.94±0.58
The pulp weight, g	1293.0±12.10	1386.0±13.44	1548.0±15.32
Pulp output, %	71.91±2.45	73.35±2.49	76.44±3.18
Bone mass, g	395.0±3.44	388.5±3.78	357.0±3.10
The movement of the bones, %	21.96±1.12	20.56±1.15	17.62±1.14
Meat index	3.27±0.78	3.57±0.62	4.33±0.55

As can be seen from table 4, the highest pre-slaughter weight of young rabbits was in the 2nd experimental group (3245 g) and compared to the control - by 165.7 g more, or 5.38 % (P < 0.05). The carcass yield in the 2nd experimental group was 62.33 %, which is more than in the control group and the 1st experimental group - by 6.86 and 2.12%, respectively.

The mass of muscle tissue in rabbits of the experimental groups was 7.12 and 24.22% (p < 0.01), respectively, more than in the rabbits of the control group.

TABLE V. CHEMICAL COMPOSITION OF RABBIT MEAT, M±S

Indicator	Group		
	Group 1 (control)	2 nd group (experienced 1)	3 rd group (experienced 2)
Mass fraction of moisture, %	73.31±0.51	72.84±0.62	71.02±0.54
Mass fraction of protein, %	19.40±0.22	20.10±0.30	22.00±0.34
Mass fraction of fat, %	6.27±0.30	6.01±0.21	5.92±0.26
Ash mass fraction, %	1.02±0.04	1.05±0.02	1.06±0.03
Tryptophan, mg %	362.36±8.51	366.39±8.51	377.42±8.51
Hydroxyproline, mg %	66.77±8.51	64.78±8.51	63.81±8.51
PQI (protein-quality indicator)	5.42±8.51	5.65±8.51	5.91±8.51

Table 5 shows the chemical composition of rabbit meat. The highest protein content, as well as amino acids tryptophan and hydroxyproline, was noted in the meat of rabbits of the 2nd experimental group, which seems to be associated with a higher transformation of nutrients under the action of feed probiotic

additives "Subtilis C" in the protein component of muscle tissue.

According to the content of fat and ash, the rabbits of the experimental groups did not significantly differ from each other and the control group. From table 5 it follows that the content of tryptophan, the advantage was on the side of the rabbits of the experimental groups. The highest value of the protein-quality index was characterized by the meat of rabbits of group 3, which indicates a greater value of meat.

The organoleptic evaluation of meat and broth of rabbits of control and experimental groups showed a positive effect of probiotic feed additive "Subtilis-C" on the formation of flavor profile of both boiled meat and broth. The highest score was characterized by samples of boiled meat and broth obtained from the carcasses of the 2nd experimental group (8.7 and 8.3 points, respectively). Samples of boiled meat and broth obtained from the carcasses of rabbits of the control and the first group did not differ significantly (7.5 – 7.9 and 7.4 - 7.8 points, respectively).

The veterinary and sanitary examination of meat and products of slaughter of rabbits of control and experimental groups did not reveal deviations from the existing norms (table 6).

Physical and chemical parameters of the meat corresponded to indices for fresh meat with normal course of autolytic processes and maturation.

TABLE VI. INDICATORS OF VETERINARY AND SANITARY EXAMINATION OF MEAT AND PRODUCTS OF SLAUGHTER OF RABBITS

Indicator	Group		
	Group 1 (control)	Group 2 (1 experimental group)	Group 3 (2 experimental group)
Physical and chemical parameters			
pH	5.81±0.03	5.84±0.04	5.85±0.02
Reaction to peroxidase	+	+	+
Reaction with CuSO ₄	-	-	-
Volatile fatty acids	2.10±0.03	2.14±0.01	2.16±0.01
Amino-ammonia nitrogen	0.86±0.02	0.91±0.04	0.93±0.03

IV. CONCLUSION

Thus, the inclusion of the probiotic "Subtilis" for pigs in the groups of rearing and fattening, as well as feed stock of rabbits, in the complete compound feeds contributed to the improvement of productivity indicators, feed characteristics, and had a positive impact on the quality characteristics of raw meat.

It should be borne in mind that probiotics do not by themselves provide nutrients for additional products. But their biological potential helps to improve animal health, increase productivity, improve feed conversion. The use of the probiotic preparation "Subtilis-C" helped to reduce the cost of live weight gain of the experimental group of pigs, compared with the control. The level of profitability of pork production was higher by 3.6% in the experimental group compared to the control group. The rabbit production in the 1st and 2nd experimental

groups was higher by 1.8% and 2.6% respectively compared to the control group of rabbits. The use of the probiotic preparation "Subtilis-C" in the diet of young rabbits during the growing period has a positive effect on the growth rate and reduces feed costs.

Thus, the drug "Subtili-C" is a promising product of a number of probiotics used in animal feeding, which allows obtaining environmentally friendly products of pig and rabbit breeding while improving economic performance.

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