THE EFFECT OF PROBIOTICS AND PHYTOBIOTICS ON MEAT PROPERTIES AND QUALITY IN PIGS

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Summary. The demand of safe and qualitative meat on the market has considerably increased nowadays. The producers are eager to use natural and safe non-chemical forage supplements, which positively effect animal health, increase their productivity and improve quality of the production. The experiments were performed to study the influence of probiotics YEASTURE, MICROBOND and phytobiotics YUCCA, QUILLAJA on pigs growth rate and meat quality. The experimental animals in the first group were fed with mixture of grain and bean flour supplemented with probiotics - 2 kg/t flour, and in the second group with mixture of grain and bean flour supplemented with phytobiotics – 120 g/t flour, respectively. The daily weight gain of pigs given probiotics was on 18.0-20.3 % higher compared to the control group of pigs ($P>0.05$). Probiotics increased the carcass output in the experimental group of pork on 2.0–2.1 %. These preparations improved the culinary properties of pork: cooking loss decreased on 5.4 – 6.1 %, water holding capacity increased on 1.8–3.2 % ($P>0.05$), meat hardness decreased on 6.9–47.2 % ($P>0.05$). The effect of phytobiotics on experimental pigs daily weight gain and carcass output was unsignificant compared to the controls ($P<0.05$). Phytobiotics YUCCA and QUILLAJA lowered meat hardness on 35.9 % and on 46.4 % compared to the control group ($P<0.05$), respectively.

Keywords: probiotics, phytobiotics, pigs, carcass, weight gain, meat quality.

PROBIOTIKŲ IR FITOBIOTIKŲ ĮTAKA KIAULIŲ MĖSINĖMS SAVYBĖMS IR MĖSOS KOKYBEI

Santrauka. Rinkoje didėjant kokybiškos ir saugios gyvulininkystės produkcijos paklausai, gamintojai stengiasi naudoti natūralius, saugius pašarinius priedus, kurie teigiamai veikia gyvulių sveikatingumą, didina gyvulių produktyvumą ir gerina produkcijos kokybę. Bandymuose tirta probiotikų YEASTURE, MICROBOND ir fitobiotikų YUCCA, QUILLAJA įtaka kiaulių augimo spartai ir jų mėsos kokybei. Į grūdų ir pupų miltus tiriamųjų grupių gyvuliams buvo įmaišomi probiotikai santykiu 2 kg/t miltų, 120 g/t fitobiotikų. Kiaulių, gavusių probiotikų, priesvoriai per parą atitinkamai buvo 20,3% ir 18,0% ($p>0,05$) didesni nei kontrolinės grupės kiaulių. Probiotikai 2,0 – 2,1% padidino tiriamųjų grupių kiaulių skerdenos išeigą. Šie preparatai gerina kiaulių mėsos kulinarines savybes: 5,4 – 6,1% sumažina virimo nuostolius, 1,8 – 3,2% padidina vandens rišlumą, 6,9 – 47,2% ($p>0,05$ ir $p<0,05$) sumažina mėsos kietumą. Fitobiotikai kiaulių priesvoriams per parą įtakos neturėjo. Panaudojus fitobiotikus 1,7 – 1,3% padidėja kiaulių skerdenų išeiga. Kiaulių pašarams panaudojus YUCCA, mėsos kietumas vidutiniškai buvo 35,9%, o panaudojus QUILLAJA – 46,4% ($p<0,05$) mažesnis negu kontrolinės grupės.

Raktažodžiai: probiotikai, fitobiotikai, kiaulės, skerdena, priesvoris, mėsos kokybė.

Introduction. Recently great attention to the production quality and safety has been paid as in the countries of the European Union so in Lithuania. The demand of safe and qualitative meat on the market has considerably increased nowadays, so the producers are eager to use natural and safe forage supplements, that positively effect animal health, increase their productivity and improve quality of the production.

The most modern and gaining high popularity natural forage supplements nowadays have been probiotic preparations – probiotics, prebiotics, symbiotics, phytobiotics. These preparations are considered to be biologically active preparations, created by the biotechnological methods and having antagonistic activity against the pathogenic microflora, improving the microbiological balance of the digestive system, improving animal health and quality of the production (Bakulina et al., 2001; Kavrus and Mihaljuk, 2001).

Probiotics – are forage supplements produced of the alive microorganisms, which are able positively effect the composition of the digestive microflora. Numerous data about the positive effect of probiotic preparations on the health of animals and birds, their productivity and quality of the production have been recently obtained, they are becoming more and more popular among the farmers. It is necessary to stress that the effect of these microbiological preparations on the animal productivity in the complicated animal ecosystem has been studied insufficiently. The experiments with probiotic preparations are important as in scientific so in practical aspects. (Beauchemin et al., 2003; Peltonen et al., 2000; Klaenhammer T. R., 2000; Koloev B., 2002). Probiotic microorganisms in the organism of a healthy animal stimulate non-specific immune response and enhance the system of the immune protection. They can also be applied in order to remove the pathogenic and conditionally pathogenic bacteria from the organism. Due to the probiotic preparations the metabolic activity of the bacterial flora in the organism is intensified, that leads to the better assimilation of the nutritive substances, and that cause higher productivity and better quality of the production. Probiotic preparations seem to be a wonderful alternative means for the treatment of the digestive infections by antibiotic preparations and other chemotherapic substances. The organism of the animal is able to tolerate these preparations (Boyaka et al., 2001;

Kavrus and Mihaljuk, 2001, Ziemer and Gibson, 1998; Jadamus, et al., 2002; Jakubczyk and Kosikowska, 2000; Rastall, 2004).

Phytobiotic preparations are the preparations of vegetative origin as well as their chemical constituents, that positively effect the microflora of the digestive system. The phytochemical substances of the vegetative forage are grouped according to their structure and activity in the organism: carotinoides, poliphenoles, phytoestrogenes, sulphides and thioles, saponines and others. The action of these substances in the organism is related to the supression of the degenerative processes. It is related to the antioxidative inhibition, stimulation of the detoxicative enzymes, effect on the cells functions, bind of the excess of some substances and the effect on the intestine microflora. The substances of the vegetative origin saponines are able to bind cholesterole, decrease its resorbtion and remove it from the organism, they also have secretomotoric and secretolytic properties, can enhance the immune system of the animal and destroy the pathogenic microflora. (Colina et al., 2001; Hristov et al.,1999; Turner et al., 2002; Wang et al., 2000).

The aim of the research was to study the effect of probiotics YEASTURE and MICROBOND and phytobiotics YUCCA and QUILLAJA on the meat properties and quality.

Material and methods. In order to determine the effect of probiotics and phytobiotics on the pigs‘ growth rate and meat quality the experiments were carried out on the pig farm in the Marijampole region. The 45-day piglets were selected by the principle of analogous for the experiments. All the groups contained 15 animals – German Landrasses and Pjetren crossbreds fed and grown under the same conditions. The animals of the experimental group were given probiotic preparations. The pigs were fed dry barley – wheat mixture (40:60) and bean flour. 200 kg of bean flour were added to the 1 tone of grinded grain mixture. The composition of the mixture is given in Table 1.

Table 1. **The composition of grain mixture**

Constituent parts	The forage contains
Wheat	32 %
Barley	48 %
Beans	20 %
1 kg of forage contains:	
metabolizable energy, MJ	13,13
kcal	3132,8
crude protein, g	138,7
crude fat, g	19,5
crude fiber, g	38,9

During the first experiment probiotic preparations were added to the grain-bean flour in the ratio 2 kg/t. The first group of the experimental pigs was given probiotic YEASTURE, the second – probiotic MICROBOND. Probiotic preparation YEASTURE contains *Saccharamyce cerevisiae, Lactobacillus casei, Lactobacillus acidophilus, Streptococcus faecium, Bacillus subtilis* microorganisms. Probiotic MICROBOND contains *Saccharamyce cerevisiae, Lactobacillus acidophilus, Streptococcus faecium, Bacillus subtilis* microorganisms, selenium and chromium. This preparation is distinquished by the absorbtion of mycotoxines and ability to decrease their amount in the forage.

During the second experiment, phytobiotic preparations in the ratio 120 g/t were added to the grain – bean mixture for the experimental animals. The pigs of the first experimental group were given phytobiotic YUCCA, the second – QUILLAJA. YUCCA and QUILLAJA are the powder of the tree trunks containing saponines.

During the experiments water was given to satiety. The weight changes were measured by weighing animals once monthly before morning feeding and at the beginning and the end of the experiments. On the basis of these data daily weight gain was calculated. At the end of the experiments control slaughter was completed and the physico-cehmical properties of the m.longissimus dorsi were studied according to the generally accepted methods (Antipova et al., 2001).

The data were statistically evaluated according Student’s method (Sakalauskas,1998).

Results and discussion. The dynamics of pigs‘ growth are given in Table 2. The data evidently demonstrate that probiotic preparations stimulate the pigs‘ growth. The average weight gain of the experimental group of pigs during the first period of fattening (up to 103 d.) was: in the I experimental group – 22,7 % and in the II experimental group -26,0 % higher, during the second period of fattening (more than 103 d.) – 17,6 and 11,1 % respectively higher than in the analogous of the control group. The weight of the experimental animals during the whole experiment increased respectively by 15,3 and 12,7 kg or 15,8 and 13,2 % higher if to compare to the pigs of the control group.

The average daily weight gain during the whole experiment in the I experimental group of pigs was by 113 g or 20,3 % higher, in the second experimental group – 100 g or 18,0 % higher than in the pigs of the control group.

The results of the control slaughter and bone removal are presented in the Table 3. These data evidently demonstrate that probiotic preparations increased the carcass output by 2 % ($P>0,05$). The effect of probiotic preparations on the other parameters of the experiments was no observed.

The physico-chemical properties of the m. longissimus dorsi are presented in the Table 4.

Table 2. **The dynamics of weight and weight gain in the fattening pigs** (n = 15)

Age of the animals (days)	Weight and daily weight gain of the animals					
	Control group		YEASTURE		MICROBOND	
	weight, kg	daily weight gain, g	weight, kg	daily weight gain, g	weight, kg	daily weight gain, g
45	14,8 ±0,34	–	14,3 ±0,31	–	14,3 ±0,33	–
73	25,5 ±1,92	382 ±30,5	27,8 ±2,12	482 ±38,6	28,3 ±2,31	500 ±47,2
103	42,5 ±3,21	567 ±40,7	48,3 ±3,15	683 ±35,4*	49,2 ±5,55	697 ±78,3
134	61,7 ±5,72	619 ±50,3	75,0 ±7,11	861 ±70,1*	73,3 ±5,16	777 ±55,3*
164	87,5 ±6,80	860 ±66,8	100,8 ±8,10	860 ±68,8	97,5 ±6,89	807 ±49,9
188	96,5 ±8,14	354 ±31,4	111,8 ±8,84	458 ±37,1*	109,2 ±7,66	500 ±35,8*
During the whole experiment	–	556 ±43,9	–	669 ±60,5	–	656 ±53,3

* – P<0,05

Table 3. **Data of the control slaughter and bone removal** (n = 15)

Indicator	**Group**		
	Control	YEASTURE	MICROBOND
Carcass weight, kg	71,60 ±6,05	85,19 ±6,81	83,31 ±6,35
Carcass output, %	74,2 ±5,1	76,2 ±3,6	76,3 ±4,4
Weight of the left halve, kg	35,6 ±3,2	44,7 ±4,4	38,9 ±3,8
Ham weight, kg	11,3 ±1,05	12,7 ±1,15	11,8 ±0,98
Ham output, %	31,7 ±2,8	31,6 ±3,1	31,8 ±2,9
Tender meat output, %	89,4 ±6,8	88,2 ±5,7	89,8 ±6,3

Table 4. **Meat physico-chemical properties** (n = 15)

Indicator	**Group**		
	Control	YEASTURE	MICROBOND
Dry matter, %	27,18 ±0,96	27,46 ±0,88	29,86 ±1,13
pH	5,43 ±0,11	5,42 ±0,15	5,44 ±0,10
Colour, EK	57,00 ±3,61	55,50 ±3,82	57,00 ±4,78
Cooking loss, %	43,42 ±3,62	37,99 ±3,38	37,31 ±3,12
Water holding capacity, %	75,21 ±4,14	77,01 ±3,86	78,46 ±2,95
Hardness, kg/cm^2	2,09 ±0,16	1,97 ±0,18	1,42 ±0,26*
Ash, %	1,06 ±0,18	1,48 ±0,21	1,07 ±0,09
Fat, %	4,57 ±0,32	4,46 ±0,30	5,01 ±0,41
Protein, %	19,55 ±1,56	19,52 ±1,48	20,78 ±1,62
Protein value	4,53 ±0,36	4,55 ±0,32	4,60 ±0,37

It is evidently demonstrated by the data of this table that the most considerable effect of probiotic preparations was observed on the meat cooking loss, water holding capacity and meat hardness. In case of probiotic preparation MICROBOND meat cooking loss was 6,11 % (II experimental group), and YESTURE (I experimental group) – 5,43 % lower than in the control group. Water holding capacity in the meat of the I group was by 1,8 %, and in the II group – 3,25 % higher than in the control group. Meat hardness which directly effects the quality of meat products and meat value was the best in the control group. The meat hardness of this group was by 47,18 % (P<0,05) higher than in the II experimental group, and by 6,9 % higher than in the I experimental group. Only probiotic MICROBOND positively effected the amount and value of protein.

The data of the experiments lead to the conclusion that probiotic preparations positively effet pigs‘ growth, daily weight gain, carcass output and some physico-cehmical properties of the meat. These preparations can also improve culinary properties.

The effect of phytobiotic preparations on the dynamics of pigs‘ growth is presented in the table 5. It can be concluded from these results that these preparations have no effect on the pigs‘ growth rate during the first month of the experiments. During the following two months of the experiments (from 76 d. to 137 d. of the age) the weight of pigs given YUCCA increased by 6,7 %, given QUILLAJA – 9,2 % more than in the control group of pigs (P>0,05). During the last month of the experiments the effect of these preparations on pigs‘ growth was insignificant. It can be concluded from the results of the experiments that the preparations YUCCA and QUILLAJA had no effect on pigs weight gain.

The data of control slaughter and bone removal are presented in the table 6. Obviously, these data demonstrate that phytobiotic preparations effected the carcass output. The carcass output of the pigs given preparation YUCCA was by 1,7 %, and QUILLAJA – 1,3 % higher than in the control group of pigs (P>0,05). The muscle area of the eye in the pigs given QUILLAJA was by 8,4 % larger than in the control group and by 7,0 % larger than in the pigs given preparation YUCCA. The tendency of increased output of ham tender parts was observed under the effect of phytobiotic preparations.

The physico-chemical properties of the m. longissimus dorsi are presented in the table 7.

Table 5. **The dynamics of weight and weight gain in the fattening pigs** (n = 15)

Age of the animals (days)	Weight and daily weight gain of the animals					
	Control group		YUCCA		QUILLAJA	
	weight, kg	daily weight gain, g	weight, kg	daily weight gain, g	weight, kg	daily weight gain, g
45	12,8 ±0,6		13,0 ±0,6		12,8 ±0,5	
76	31,6 ±2,4	606 ±46,1	31,6 ±3,1	600 ±54,2	30,8 ±2,8	580 ±46,4
107	46,6 ±4,2	483 ±43,4	48,0 ±4,8	529 ±51,2	47,6 ±4,1	541 ±46,5
137	68,7 ±6,1	737 ±64,8	71,2 ±6,9	773 ±74,2	71,3 ±7,0	790 ±77,4
168	100,0 ±8,4	1009 ±84,7	100,3 ±7,8	939 ±74,2	98,3 ±8,1	871 ±70,4
During the whole experiment		709 ±59,8		710 ±63,5		695 ±60,2

Table 6. **Data of the control slaughter and bone removal** (n = 15)

Indicator	**Group**		
	Control	YUCCA	QUILLAJA
Carcass output, %	69,9 ±4,9	71,6 ±4,1	71,2 ±4,7
Ham output, %	32,4 ±2,8	31,3 ±3,2	31,8 ±2,8
Tender meat output, %	90,7 ±5,2	91,1 ±6,3	91,6 ±5,7
Muscle area of the eye, cm^2	44,9 ±3,6	45,5 ±4,8	48,7 ±4,3

Table 7. **Meat physico-chemical properties** (n = 15)

Indicator	**Group**		
	Control	YUCCA	QUILLAJA
Dry matter, %	29,3 ±1,6	29,0 ±1,9	30,7 ±2,3
pH	5,64 ±0,14	5,65 ±0,12	5,63 ±0,16
Color, EK	73,0 ±5,1	65,0 ±4,7	74,0 ±5,5
Cooking loss, %	31,3 ±3,3	38,2 ±3,7	37,3 ±3,8
Water holding capacity, %	65,47 ±4,1	65,83 ±4,9	66,22 ±4,4
Hardness, kg/cm^2	2,09 ±0,19	1,34 ±0,09*	1,12 ±0,10*
Ash, %	1,15 ±0,09	1,05 ±0,08	1,01 ±0,08
Fat, %	3,8 ±0,7	4,5 ±0,8	5,6 ±1,2
Protein value	5,25 ±0,42	4,95 ±0,36	6,27 ±0,48

* – P<0,05

It can be seen from the data of the table that phytobiotic preparations effected meat physico-chemical properties. When phytobiotic preparation JUCCA was used meat hardness tended to be by 35,9 %, and when QUILLAJA was used - by 46,4 % (P<0,05) lower than in the control group. The protein value was by 19,4 % higher in pigs given QUILAJA than in the control group. The tendency of increased amount of fat was also observed under the effect of phytobiotics.

Meat hardness is directly related to the production quality. Subsequently, it can be concluded that YUCCA and QUILLAJA improve culinary properties of the meat, QUILLAJA also effects meat protein value.

Conclusions.

1. The daily weight gain of the pigs given probiotic preparations was respectively by 20,3 and 18,0 % (P>0,05) higher than in the control group. The effect of phytobiotics on the weight gain was no observed.

2. Probiotic preparations increased carcass output of the experimental pigs by 2,0 – 2,1 % (P>0,05). These preparations improved meat culinary properties as follows: cooking loss decreased by 5,4 – 6,1 %, water holding capacity – by 1,8 – 3,2 %, meat hardness – by 6,9 – 47,2 % (P>0,05 ir P<0,05).

3. Phytobiotic preparations increased pigs‘ carcass output by 1,7 – 1,3 % (P>0,05). Meat hardness decreased by 35,9 % under the effect of YUCCA, and by 46,4 % (P<0,05) under the effect of it if to compare to the control

group. The tendency of increased amount of fat was also observed. QUILLAJA increased protein value by 19,4 %.

References.

1. Antipova L. V., Glotova I. A., Rogov I. A. Methods of meat and meat products investigation. Moscow, Kolos, 2001. 376 p.

2. Bakulina L. F., Timofeev I. V., Perminova N. G. Probiotic preparations produced on the basis of sporeforming strains of Lactobacillus in veterinary research. Biotechnology. Moscow, 2001. N. 2. P. 48-56.

3. Beauchemin K. A., Yang W. Z., Morgavi D. P., Ghorbani G. R., Kautz W., Leedle J. A. Z.. Effects of bacterial direct-fed microbials and yeast on site and extent of digestion, blood chemistry, and subclinical ruminal acidosis in feedlot cattle. Journal of Animal Science, 2003. Vol. 81. N. 6. P. 1628-1640.

4. Boyaka P. N., Marinaro M., Jackson R. J. Ginkle F. W., Cormet-Boyaka E., Kirk K. L., Kensil C. R., McGhee J. R. Oral QS-21 Requires Early IL-4 Help for Induction of Mucosal and Systemic Immunity. The Journal of Immunology, 2001. Vol. 166. N. 4. P. 2283-2290.

5. Colina J. J., Lewis A. J., Miller P. S. Fischer R. L**.,** 2001. Dietary manipulation to reduce aerial ammonia concentrations in nursery pig facilities. Journal of Animal Science**,** 2001. Vol. 79. N.12. P. 3096-3103.

6. Hristov A. N., McAllister T. A., Van Herk F. H., Cheng K. J., Newbold C. J., Cheeke P. R. Effect of Yucca schidigera on ruminal fermentation and nutrient digestion in heifers. Journal of Animal Science, 1999. Vol. 77. N. 9. P. 2554-2563.

7. Jadamus A., Vahjen W., Schafer K., Simon O. Influence of the probiotic strain Bacillus cereus var.toyoi on the development of enterobacterial growth and on selected parameters of bacterial metabolism in digesta samples of piglets. Journal of Animal Physiology and Animal Nutrition, 2002. Vol. 86. N. 1-2. P. 42-54.

8. Jakubczyk E. Kosikowska M. Nowa generacja mlecznych produktow fermentowanych z udzialem probiotykow i prebiotykow, produkty synbiotyczne. Przeglad Mleczarski, 2000. N. 12. P. 397-400.

9. Kavrus M. A., Mihaljuk A. N. Probiotic preparations in the rations for the offspring of agricultural animals. Science – for production. Grodno, 2001. P. 255-257.

10. Klaenhammer T. R. Probiotic Bacteria: Today and Tomorrow. Journal of Nutrition, 2000. Vol. 130. N. 2. P. 415-416.

11. Koloev B. Lacto fermenting preparations as a means for chicken health improvement. Poultry. Moscow, 2002. N. 7. P. 27-28.

12. Peltonen K. D. El-Nezami H. S. Salminen S. J. Ahokas J. T. Binding of aflatoxin B_1 probiotic barteria. Journal of the Science of food and Agriculture, 2000. Vol. 80. N. 13. P. 1942-1945.

13. Rastall R. A. Bacteria in the Gut: Friends and Foes and How to Alter the Balance. Journal of Nutrition, 2004. Vol. 134. N. 2. P. 2022-2026.

14. SakalauskasV. Statistics and Statistics. Vilnius, 1998. 223 p.

15. Turner J. L., Dritz S. S., Higgins J. J. Herkelman K. L., Minton J. E. Effects of a Quillaja saponaria extract on growth performance and immune function of weanling pigs challenged with Salmonella typhimurium. Journal of Animal Science, 2002. Vol. 80. N. 7. P. 1939-1946.

16. Wang Y., McAllister T. A., Yanke L. J. Cheeke P.R. Effect of steroidal saponin from Yucca schidigera extract on ruminal microbes. Journal of Applied Microbiology. Oxford, 2000. Vol. 88. N. 5. P. 887-896.

17. Ziemer C. J. Gibson G. R. An overview of probiotics, prebiotics and synbiotics in the functional food concept: perspectives and future strategies. International Dairy Journal, 1998. Vol. 8. N. 5-6. P. 473-479.