THE EFFECT OF "BONVITAL", A PROBIOTIC PRODUCT CONTAINING *ENTEROCOCCUS FAECIUM* ON THE FATTENING PERFORMANCE, CARCASS CHARACTERISTICS AND MEAT QUALITY OF PIGS UNDER PRODUCTION CONDITIONS

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Summary. Two performance trials with fattening pigs was conducted on Lithuanian agricultural farms. The objective of the study was to determine the effect of a probiotic product containing *Enterococcus faecium* (trade name "Bonvital") on the fattening performance and carcass characteristics of pigs as well as on meat quality under production conditions. Each trial comprised two groups, a control group (I) and an experimental group (II). Animals of group II were fed a diet supplemented with the probiotic product Bonvital (*Enterococcus faecium* DSM 7134, 0.3x109 CFU/kg feed). Group I animals received the same diet, but without the addition of the probiotic. Diet composition matched the nutrient requirements of high-performance pigs.

Both trials went according to the plan. There were no health problems. Nevertheless, the performance levels achieved in both trials differed distinctly (trial 1: average daily gain - 688 g, 3.49 kg feed/kg gain, trial 2: average daily gain - 870 g, 2.4 kg feed/kg gain, in control groups). A performance enhancing effect of Bonvital was observed in both trials, leading to an increase in daily gains (3% in trial 1 and 1.5% in trial 2) and an improvement in the feed conversion ratio (3% in trial 2). The above effect was statistically significant ($p<0.05$) and numerical ($p>0.05$). There were small differences between control and experimental animals with respect to carcass characteristics and meat quality.

Keywords: probiotic, fattening pigs, growth, feed conversion, carcass quality characteristics, meat quality.

PROBIOTIKO „BONVITAL", Į KURIO SUDĖTĮ ĮEINA *ENTEROCOCCUS FAECIUM*, POVEIKIS KIAULIŲ PENĖJIMUISI, SKERDENOS KOKYBEI, MĖSOS CHEMINEI SUDĖČIAI IR FIZINĖMS SAVYBĖMS

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Santrauka. Lietuvos žemės ūkio įmonėse atlikti du bandymai su penimomis kiaulėmis. Bandymų tikslas – nustatyti probiotiko, į kurio sudėtį įeina *Enterococcus faecium* (prekės pavadinimas „Bonvital"), poveikį kiaulių priesvoriui, skerdenos kokybei, mėsos cheminei sudėčiai ir fizinėms savybėms. Kiekvieno bandymo metu tirtos dvi kiaulių grupės – kontrolinė (I) ir tiriamoji(II). II grupės kiaulės buvo šeriamos pašarais, papildytais probiotiku „Bonvital" (*Enterococcus faecium* DSM 7134, 0,3x109 CFU/kg pašaro). I grupės kiaulės buvo šeriamos tokiais pačiais pašarais, bet be probiotinių priedų. Maistinė pašarų sudėtis atitiko didelio produktyvumo kiaulių pašarų reikalavimus.

Abu tyrimai vyko pagal planą. Kiaulės buvo sveikos, tačiau abiejų tyrimų metu nustatyti dideli produktyvumo skirtumai. Kontrolinių grupių pirmojo tyrimo metu vidutinis paros priesvoris – 688 g, pašarų sąnaudos 1 kg priesvorio – 3,49 kg; antrojo tyrimo metu vidutinis paros priesvoris – 870 g, pašarų sąnaudos 1 kg priesvorio – 2,4 kg ($p>0,05$). Teigiamas „Bonvital" produktyvumą skatinantis poveikis buvo akivaizdus abiejų tyrimų metu: probiotikas didino vidutinį paros priesvorį (3 proc. pirmojo tyrimo ir 1,5 proc. – antrojo tyrimo metu) ir gerino pašarų konversiją (3 proc. antrojo tyrimo metu) ($p<0,05$). Tarp kontrolinės ir tiriamosios grupių pastebėti nežymūs kiaulių skerdenos kokybės ir mėsos cheminės sudėties bei fizinių savybių skirtumai.

Raktažodžiai: probiotikas, penimos kiaulės, priesvoris, pašarų konversija, skerdena, mėsos kokybė.

Introduction. Probiotics are viable forms of specific micro-organisms which are continuously supplied to the animal organism via feed, in order to support gut colonization in a biological way. The growth of beneficial bacteria is promoted whereas the development of pathogenic micro-organisms is inhibited and suppressed. According to the latest EU Regulation No. 1831/2003 on additives for use in animal nutrition, probiotics fall within the category "zootechnical additives". Probiotics used in animal nutrition can be classified into one of the following three

groups:

- lactic acid bacteria (*Lactobacillus, Bifidobacteria, Enterococcus*),
- Bacillus spores (e.g. *B. subtilis, B. licheiformis, B. cereus*),
- yeasts (*Saccharomyces cerevisiae*).

Similarly as feed antibiotics, probiotics were authorized for use as feed additives before their mode of action had been fully elucidated. Despite intensive research, in particular over the last 10 years, it remains only partially understood. The newest insights into this topic have been presented recently by Tarak et al. (2009). The first powerful probiotics for animal nutrition were introduced into the market in 1985 (AWT, 2004). The products have gained importance since the complete ban on antibiotic growth promoters in animal feeds (1st January 2006) in the European Union, as probiotics are often proposed as an alternative to feed antibiotics.

Numerous trials have been conducted to prove the influence of probiotic feed additives on animal performance and health parameters. Given that housing and feeding conditions affect the effectiveness of probiotics, such experiments should be carried out under production conditions.

The objective of the present study was to determine the effect of a probiotic product containing *Enterococcus faecium* (trade name "Bonvital") on the health status, fattening performance and carcass characteristics of pigs as well as on meat quality under conventional feeding conditions on Lithuanian production farms.

Materials and Methods. The tested probiotic product containing *Enterococcus faecium* (Bonvital) belongs to the group of lactic acid bacteria probiotics and it is manufactured by Lactosan GmbH & Co. KG, A-8605 Kapfenberg (a company of the Schaumann-Group). The diets for the experimental groups (II - Ex) was supplemented with the mineral feed Schaumalac M 55 (Schaumann) containing $10x10^9$ CFU *Enterococcus faecium* per kg. The diets for the control group (I - C) contain a mineral feed with almost identical composition (Dynaphos M 2000), but without the tested probiotic.

The effect of Bonvital was tested during two performance trials with fattening pigs, on two agricultural farms in Lithuania. Trial 1 was conducted on a pig farm of GAG "Eigirdžių agrofirma" (12.000 animals), in the District of Telšiai. The animals were hybrids produced by mating Lithuanian White sows to Pietrain or Norwegian Landrace boars. Trial 2 was carried out on the farm owned by V. Giedraitis (2000 animals), in the District of Jurbarkas, and it also involved hybrid pigs (Norwegian Landrace, Yorkshire females × Norwegian Duroc boars). The experimental design is shown in Table 1. Trial 1 lasted for 15 weeks and it was divided into two phases: pre-fattening (63 days) and final fattening (42 days). Trial 2 also lasted for 15 weeks (105 days), but it involved a single-phase fattening system.

Table 1. **Experimental design**

Trial	Group	N° animals	Mode of fattening
1	I – (C - control)	26 (2x13)	two-phases: pre-fattening (20-60 kg BW) final fattening (60-95 kg BW)
	II – (Ex – Control feed + Bonvital)	26 (2x13)	
2	I – (C – control)	16 (2x8)	single-phase fattening (20-115 kg BW)
	II – (Ex – Control feed + Bonvital)	16 (2x8)	

During the trials the animals were fed *ad libitum* and they had free access to water. Each pen was equipped with an automatic drinker and an automatic feeder with access from both sides. In trial 1, 13 animals were held per pen (0.6 m² per animal), and in trial 2 – six (0.8 m² per animal). Animals from both trials were fed via the same automatic feed dispenser. The concrete floor of the pens was covered with sawdust. The pens were placed in the middle of conventional fattening houses. Average indoor temperature was 18-20°C, and average relative humidity was 70%. The other microclimate parameters corresponded to the relevant standards.

Feed for both trials was blended from commercial raw materials and it was mixed with a mobile mixer, type "Propper NNX 6015". The diets were formulated using "Recept" software, based on the National Research Council recommendations (NRC, 1998). Metabolizable energy content was calculated according to the estimations-equations of the GfE (Jeroch et al., 2004). Mineral feed with and without Bonvital supplementation was produced by Schaumann. In experiment 1, the complete diet was made up of the following components (pre-fattening/ final fattening): 57.3/61.1% barley, -/15.0% wheat, 15.5/10.0% wheat bran, 5.3/- % sunflower meal, 12.5/9.5% soybean meal, 2.0/-% fish meal, 4.0/1.2% rapeseed oil, 3.4/3.2% mineral feed (macro- and microelements, vitamins, amino acids, Bonvital in group II) and other additives. The basal diet in experiment 2 had the following composition: 48.0% barley, 36.6% triticale, 12.0% soybean meal, 3.4% mineral feed (macro- and microelements, vitamins, amino acids, Bonvital in group II) and other additives. 1 kg feed mixture in experimental groups (II) contained 0.3x109 CFU *Enterococcus faecium*. Table 2 shows the content of metabolizable energy and selected nutrients in the diets. Nutrient content was analyzed by standard methods, approved by the EU (Naumann et al., 1993; Pašarų tyrimo metodai. Normatyvinių aktų rinkinys, 2003). Diet composition (content of ME, nutrients, vitamin supplements and other additives) met the nutrient requirements of fattening pigs (Jeroch et al., 2004). The levels of ME, nutrients, trace element and vitamin supplements in the diets were identical in both groups in trial 1 and 2.

Table 2. **Content of metabolizable energy** (ME) **and nutrients in complete diets**

Content	Trial 1		Trial 2
	Pre-fattening	Fattening	
Metabolizable energy (MJ/kg)[1]	12.6	12.4	12.6
Crude protein (g/kg)[2]	181	151	154
Crude fiber (g/kg)[2]	47	47	38
Calcium[2] (g/kg)	9.0	7.5	8.0
Total phosphorus[2] (g/kg)	6.0	5.0	7.0
Lysine[1] (g/kg)	11.5	9.3	8.5
Methionine + cystine[1] (g/kg)	5.7	4.3	4.2
Tryptophan[1] (g/kg)	2.1	1.6	1.8
Threonine[1] (g/kg)	6.3	4.8	4.8

[1]calculated values, [2] analyzed values

The live weight of animals was determined individually at the beginning and at the end of each trial, and between the trials, every 30 days. Feed intake was measured by weighing the offered feed and the feed refusals. At the end of each experiment the animals were slaughtered in a EU-certified slaughter house. Carcass dressing percentage, lean meat percentage, the physical and chemical parameters of meat (*M. longissimus dorsi*) were determined after slaughter. The live weight of pigs was determined in the slaughterhouse before slaughter. The animals were not fasted before slaughter. In the first trial, carcass dressing percentage was measured including the head and legs, while in the second trial - excluding the head and legs. Lean meat percentage was determined only in trial 1 (with the FOM device). The physical and chemical parameters of meat were analyzed by standard methods, at the Laboratory of Meat Characteristics and Quality Assessment of the Lithuanian Veterinary Academy (Antipova et al., 2001). The following determinations were made: meat pH - with a CP-315 pH-meter, cooking loss - according to Schilling (1966), water-holding capacity – by the Grau and Hamm method, meat color - with a spectrophotometer, shear force - by the Warner-Bratzler method. Meat constituents were analyzed by EU-approved methods (Antipova et al., 2001).

The results were verified statistically by an analysis of variance and Duncan's test, with the use of Statistica for Windows software (StatSoft Inc. 2009). Data in tables are given as means ± standard deviation.

Results. The health status of animals was monitored throughout the trials, and it was found to be normal. The animals were not administered any medications. In trial 1, one animal from group II died during the first week. In trial 2, two animals died in group II , in the first and in the third week. The cause of death was leg fracture.

The live weights and daily gains of animals in both trials are shown in Table 3. In trial 1, the tested probiotic significantly improved the growth rate of pigs during pre-fattening and over the entire fattening period. Daily gains were 4% higher in group II than in group I (no probiotic supplementation). During the final stage of fattening, average daily gains were 2% higher in the experimental group than in the control group, which shows that probiotic effects were lower at the final stage of fattening. Over the entire test period, experimental group pigs had 3% higher daily gains than control group animals. The differences between the groups were significant both during pre-fattening and over the entire fattening period ($p<0.05$).

Table 3. **Live weight** (kg/animal) **and daily gains** (g/animal) **in trials 1 and 2**

Trial	Parameter	Groups	
		C	Ex
1	Live weight at the beginning of the trial	$21.42^{a} \pm 0.58$	$21.48^{a} \pm 0.56$
	Live weight at the end of pre-fattening	$62.85^{a} \pm 1.37$	$64.50^{b} \pm 0.94$
	Live weight at the end of the fattening period	$93.00^{a} \pm 1.88$	$95.22^{b} \pm 1.26$
	Weight gains during pre-fattening	$668^{a} \pm 16$ (*100*)	$694^{b} \pm 11$ (*104*)
	Weight gains during final fattening	$718^{a} \pm 20$ (*100*)	$731^{a} \pm 18$ (*102*)
	Weight gains during the entire fattening period	$688^{a} \pm 15$ (*100*)	$709^{b} \pm 10$ (*103*)
2	Live weight at the beginning of the trial	$22.04^{a} \pm 0.66$	$22.56^{a} \pm 0.90$
	Live weight at the end of the trial	$114.25^{a} \pm 2.75$	$116.20^{a} \pm 3.17$
	Weight gains during the entire fattening period	$870^{a} \pm 23$ (*100*)	$883^{a} \pm 26$ (*101.5*)

Mean values within a row with the different letters (abc) differ significantly ($P \leq 0.05$)

Table 4. **Feed intake in trials 1 and 2** (kg/animal/day)

Trial	Stage	Groups	
		C	Ex
1	Pre-fattening	2.11 (*100*)	2.19 (*104*)
	Final fattening	2.81 (*100*)	2.92 (*104*)
	Entire fattening period	2.40 (*100*)	2.49 (*104*)
2	Entire fattening period	2.09 (*100*)	2.06 (*99*)

Table 5. **Feed conversion ratio** (kg feed per kg weight gain) **in trials 1 and 2**

Trial	Stage	Groups	
		C	Ex
1	Pre-fattening	3.16 (*100*)	3.16 (*100*)
	Final fattening	3.92 (*100*)	3.99 (*102*)
	Entire fattening period	3.49 (*100*)	3.51 (*101*)
2	Entire fattening period	2.40 (*100*)	2.33 (*97*)

Table 6. **Carcass characteristics of pigs in trials 1 and 2**

Trial	Parameter	Groups	
		C	Ex
1	Number of animals	26	25
	Carcass weight, kg/animal	71.77 ± 1.45	73.48 ± 1.17
	Dressing percentage, %	77.4	77.2
	Lean meat percentage, %	55.2	54.1
2	Number of animals	16	14
	Carcass weight, kg/animal	80.13 ± 2.14	81.04 ± 2.59
	Dressing percentage, %	69.6	69.7

Table 7. **Chemical and physical parameters of meat**

Trial	Parameter	Groups	
		C	Ex
1 (n=6)	Dry matter, %	25.76 ± 0.36	25.56 ± 0.37
	Crude ash[1], %	1.17 ± 0.05	1.16 ± 0.03
	Crude protein[1], %	19.09 ± 0.72	18.21 ± 0.58
	Crude fat[1], %	2.01 ± 0.23	2.07 ± 0.20
	pH	5.50 ± 0.00	5.52 ± 0.03
	Cooking loss, %	27.90 ± 1.46	30.24 ± 1.03
	Shear force, kg/cm²	1.01 ± 0.10	0.96 ± 0.07
	Water-holding capacity, %	52.94 ± 3.34	56.94 ± 1.90
2 (n=3)	Dry matter, %	26.31 ± 0.92	26.64 ± 0.52
	Crude ash[1], %	1.03 ± 0.05	1.15 ± 0.05
	Crude protein[1], %	20.26 ± 0.77	20.75 ± 0.52
	Crude fat[1], %	5.88 ± 0.31	6.76 ± 0.36
	pH	5.95 ± 0.03	5.94 ± 0.11
	Cooking loss, %	24.35 ± 3.65	22.86 ± 1.93
	Shear force, kg/cm²	1.66^{a} ± 0.35	1.16^{b} ± 0.04
	Water-holding capacity, %	58.73 ± 2.39	61.43 ± 1.46

[1] on fresh matter basis

Mean values within a row with the different letters (abc) differ significantly (P≤ 0.05)

The daily gains of control group animals were higher in trial 2 (870 g) than in trial 1, thus indicating that the stimulating effect of the tested probiotic was lower and non-significant (+1.5 %, p>0.05) in trial 2.

The data concerning feed intake are shown in Table 4. In trial 1, diet supplementation with Bonvital (group II) led to higher feed intake. This positive effect was observed during the entire test period. In trial 2, the differences in daily feed intake between both groups were minimal, thus suggesting that Bonvital had no effect on

feed consumption levels. Table 5 shows the feed conversion ratio (kg feed per kg weight gain). In trial 1, the groups did not differ in feed conversion. Higher feed intake in group II, compared with group I, was accompanied by a proportional increase in daily weight gains. In trial 2, experimental group animals consumed 3% less feed per kg weight gain in comparison with control group animals. Therefore, feed was better utilized in the experimental group. The values of the feed conversion ratio were highly satisfactory in trial 2, pointing to the beneficial effect of the tested probiotic.

Carcass characteristics were not significantly influenced by dietary Bonvital supplementation (Table 6). The trial results concerning meat quality are presented in Table 7. The tested probiotic had no significant influence on the chemical and physical properties of meat, except for shear force values. However, the obtained results should not be overrated due to a too small number of tested animals.

Discussion. The use of probiotics in pig nutrition is not a new topic. There has been increasing interest in probiotic supplements since the complete ban on antibiotics in animal feed in the EU. In the present study, the growth-promoting effects of the tested supplement were different in trials 1 and 2. The effect of Bonvital on average daily gains was higher in trial 1 than in trial 2 in which higher daily gains were noted in control group animals. The effect of the probiotic was statistically significant in trial 1, but not in trial 2. Previous experiments with probiotics yielded different results, including a zero effect and performance improvement of different magnitude (Freitag et al., 1998; Simon, 2001; Mosenthin, 2002; Richter et al., 2003; Jukna et al, 2005; Jerešiūnas et al. 2006). A evaluation of feeding trials with probiotics in fattening pigs, carried out by Freitag et al. (1998), showed effects of probiotics from -0.3 % to +6.7% for daily gains and of -1.4 to -7.1% for feed conversion, as compared with a control group without probiotic supplementation. In a study by Simon (2001), the performance enhancing effects (improved daily gains, a decrease in the feed conversion ratio) were significant in some cases only. Therefore, the results of the present trial are consistent with literature data. The results of experiments conducted in Lithuania to date are also different. Jukna et al. (2005) reported an extraordinarily high increase in weight gains (20%) due to the tested probiotic. Jerešiūnas et al. (2006) noted a 6% improvement in daily gains and a 12% reduction in feed conversion.

The reason for the differences in research results may be the mode of action of probiotics. If the microflora of the digestive tract is intact, i.e. if it remains in the state of Eubiosis, probiotics are likely to show no effects. However, the effects of such factors as nutrition mistakes, a drastic change in feed, low-quality feed components, feed components with anti-nutritional compounds and insufficient feed hygiene on the digestive tract are difficult to predict under production conditions and may lead to health problems and performance impairments. Hence, probiotics added to animal feed play a stabilizing role.

The health improving effects of probiotics have been documented in suckling and weaned piglets (Freitag et al., 1998; Simon, 2001, Stamati et al., 2006, Taras et al., 2005). A recent literature review of Simon et al. (2007) showed a clear reduction in diarrhea symptoms in weaned piglets due to the use of different probiotic supplements. Such effects were not reported in trials with fattening pigs. The low animal losses observed in the study were not related to the experimental factor.

At the achieved levels of performance enhancement (3% in trial 1 and 1.5% in trial 2), the influence of the tested probiotic supplement on carcass characteristics and meat quality could not be expected. Only distinct growth improvements could possibly lead to significant changes in the parameters of carcass and meat quality. The influence of probiotics on the above quality criteria remains poorly evidenced in literature. Jukna et al. (2005) reported a positive effect of the tested probiotic on water binding capacity at a spectacular improvement in weight gains of 20%.

Conclusion

The tested probiotic product containing *Enterococcus faecium* DSM 7134 (trade name "Bonvital") contributed to an improvement in the performance parameters of finishing pigs, which is remarkable from the practical point of view. Our findings are consistent with the results of other published studies investigating the use of probiotics in fattening pigs. The addition of the tested probiotic to pig diets could contribute to performance stabilization and enhancement.

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