EFFECT OF DIETARY MANNAN-OLIGOSACCHARIDES AND ESSENTIAL OILS ON GROWTH PERFORMANCE OF PIGLETS

Krzysztof Lipiński[1], Jan Tywończuk[1], Cezary Purwin[1], Saulius Petkevičius[2], Paulius Matusevičius[3], Barbara Pysera[1]
[1]*Department of Animal Nutrition and Feed Management, University of Warmia and Mazury*
Oczapowskiego 5, 10-718 Olsztyn, Poland
[2]*Department of Infectious Diseases, Lithuanian Veterinary Academy,*
Tilžės 18, LT-47181 Kaunas, Lithuania; Tel.: +370 37 36 35 59
[3]*Department of Animal Science, Lithuanian Veterinary Academy,*
Tilžės 18, LT-47181 Kaunas, Lithuania; Tel.: +370 37 36 35 05; e-mail: paulmat@lva.lt

Summary. The aim of the study was to determine the effects of replacing feed antibiotics with the feed additive (mannan-oligosaccharides with essential oils) on rearing results in piglets. Twenty five standardized litters selected randomly were divided into five equal groups, each of 50 to 60 piglets. The piglets were weaned at 30 days of age. Two days before weaning the animals received a diet recommended for weaners, which was then fed for consecutive 39 days. Piglets of the negative control group were given a diet without antibiotics both before and after weaning. Piglets of the other groups were fed diets with the same composition as the control diet (I), but supplemented with various feed additives. Piglets of the positive control group (II) received a diet that contained the antibiotic colistin (120 mg/kg). Piglets of the experimental groups (III, IV, V) were given diets with the feed additive (mannan-oligosaccharides with essential oils), in the amount of 4, 5 and 6 kg/t (diets for suckling piglets) or 2, 3 and 4 kg/t (diets for weaned piglets). Body weights, daily gains, feed intake and feed conversion ratios were monitored over the experimental period. The observations concerned also the determination of the general health condition of piglets and mortality rates. It was found that production results deteriorated following antibiotic withdrawal from diets for suckling and rearing piglets. Replacing colistin with feed additive (mannan-oligosaccharides with essential oils) in the amount of 4 kg/t enabled to achieve comparable daily gains and feed conversion ratios as well as to reduce mortality rates, as compared with the control group (a diet without antibiotics).

Keywords: piglets, feed additives, mannanoligosaccharides, essential oils, production results.

MANANOLIGOSACHARIDŲ IR ETERINIŲ ALIEJŲ ĮTAKA PARŠELIŲ MITYBAI IR AUGIMO RODIKLIAMS

Krzysztof Lipiński[1], Jan Tywończuk[1], Cezary Purwin[1], Saulius Petkevičius[2], Paulius Matusevičius[3], Barbara Pysera[1]
[1]*Gyvūnų mitybos ir pašarų ūkio vadybos katedra, Olštino Varmijos-Mozūrijos universitetas*
Oczapowskiego 5, PL-10-718 Olštinas, Lenkija
[2]*Užkrečiamųjų ligų katedra, Lietuvos veterinarijos akademija*
Tilžės g. 18, LT-47181 Kaunas tel. (8~37) 36 35 39
[3]*Gyvulininkystės katedra, Lietuvos veterinarijos akademija*
Tilžės g. 18, LT-47181 Kaunas (8~37) 36 35 05; el. paštas: paulmat@lva.lt

Santrauka. Tyrimo tikslas buvo nustatyti pašarų priedų (mananoligosacharidų su eteriniais aliejais) poveikį paršelių auginimo rezultatams. Analogų principų atrinktos 25 standartinės vados suskirstytos į penkias vienodas grupes, po 50–60 paršelių kiekvienoje. Paršeliai nujunkyti sueįus 30 dienų. Dvi dienas iki nujunkant jie pradėjo gauti nujunkymui rekomenduojamą racioną, kuriuo buvo šeriami 39 dienas. Kontrolinės grupės (I) paršeliai gavo racioną be antibiotikų tiek iki, tiek po nujunkymo. Kitų grupių paršeliai šerti tokios pat sudėties racionu, kaip ir kontrolinės (I), bet papildytu skirtingais pašarų priedais. Kontrolinės grupės (II) paršeliai gavo racioną, kuriame buvo antibiotiko kolistino (120 mg/kg). Bandomųjų grupių (III, IV, V) paršeliai šerti racionais, papildytais fitobiotiniu pašarų priedų (mananoligosacharidais su eteriniais aliejais) po 4, 5 arba 6 kg tonai pašaro žindomiems ir 2, 3 ir 4 kg tonai pašaro nujunkytiems paršeliams. Bandymo laikotarpiu buvo nustatytas paršelių kūno svoris, paros priesvoris, pašarų konversija. Įvertinta bendra paršelių sveikatingumo būklė ir gaištamumas.

Nustatyta, kad zootechniniai rodikliai pablogėjo, kai žindomų ir nujunkytų paršelių racione nebuvo antibiotikų. Kolistino pakeitimas fitobiotiniu pašarų priedų (mananoligosacharidais su eteriniais aliejais) 4 kg tonai pašaro leido pasiekti panašų paros priesvorį, pagerinti pašarų virškinamumą bei sumažinti gaištamumą.

Raktažodžiai: paršeliai, pašarų priedai, mananoligosacharidai, eteriniai aliejai, produktyvumo rodikliai.

Introduction. Preventive antibiotic treatment in farm animals has numerous advantages, including better production results and an improvement in the general health condition (Anderson et al., 2000). On the other hand, long-term low-dose antibiotic therapy may lead to antibiotic resistance (Hillman, 2001). Subtherapeutic doses of antibiotics inhibit the activity of antibiotic-sensitive bacteria, thus promoting the growth of antibiotic-resistant ones. Due to the potential risk of inducing antibiotic resistance, antibiotic growth promoters were withdrawn from sale in Europe, and the use of antibiotics as growth promoters in animal feed was

officially prohibited on January 1, 2006. However, feed antibiotics were known for their positive effect on production results, and their effectiveness was especially high under poor environmental conditions. The ergotrophic effect of feed antibiotics was found to be greater in young animals, particularly in piglets. Therefore, the withdrawal of antibiotics was expected to cause the most serious complications in this group of animals (Pfirter et al. 1998). This concerns especially diarrhea occurrence after weaning. In animals kept under optimum conditions antibiotics had a slight effect or no effect on production results. It follows that the administration of antibiotics at reduced doses or their complete withdrawal from diets for growing pigs require improvement in husbandry conditions, disease elimination as well as making certain alternations in the feeding program. The changes should include stimulation of natural immunity and stabilization of beneficial microflora in the digestive tract, which may be achieved with the use of properly balanced diets and feed supplements as well as modification of the levels of some nutrients (Hackl et al. 2000; Hillman, 2001; Mosenthin, Bauer 2000; Patterson, 2005). Active substances contained in some herbs show antibacterial effects similar to those revealed by antibiotics (Dedl, Elssenwenger, 2000; Dorman, Deans, 2000; Tschirch, 2000). Another approach to protect the pigs against pathogens would be to improve the beneficial activity of the microflora through specific ingredients in the diets, like prebiotics (Bahmer et al., 2005; Mosenthin, Bauer, 2000).

The aim of the study was to determine the effects of replacing feed antibiotics with the feed additive (mannan-oligosaccharides with essential oils) on rearing results in piglets.

Material and Methods. A production experiment was performed on a pig at research farm "Szyleny" (Poland) in 2008. 25 standardized litters selected randomly were divided into five equal groups, each of 50 to 60 piglets. Suckling piglets were fed a standard diet PP-pre-starter *ad libitum*. The piglets were weaned at 30 days of age. Two days before weaning the animals received a diet recommended for weaners, which was then fed for consecutive 39 days. Piglets of the negative control group were given a diet without antibiotics both before and after weaning. The composition and nutritive value of the control diet are presented in table 1. Piglets of the other groups were fed diets with the same composition as the control diet (I), but supplemented with various feed additives. Piglets of the positive control group (II) received a diet that contained the antibiotic colistin (120 mg/kg). Piglets of the experimental groups (III, IV, V) were given diets with the feed additive (mannan-oligosaccharides with essential oils) -FA, in the amount of 4, 5 and 6 kg/t (diets for suckling piglets) or 2, 3 and 4 kg/t (diets for weaned piglets).

The experimental diets were produced at the mash form. Their composition and nutritive value satisfied piglet nutrient requirements at that stage of rearing. Body weights, daily gains, feed intake and feed conversion ratios were monitored over the experimental period. The observations concerned also the determination of the general health condition of piglets and mortality rates, indicating death causes. Piglets showing the first symptoms of diarrhea were treated with antibiotics. The results of the experiment were verified statistically by a one-factor analysis of variance.

Table 1. **Composition and nutritive value of the control diets**

Components	0-30 days	30-69 days
Wheat	31.51	38.48
Maize	20.00	10.00
Barley	10.00	30.00
Soybean mean	10.65	12.50
Fish meal	3.00	3.00
Dried whey	10.00	-
Soybean protein (HP-300)	5.00	-
Potato protein	3.00	-
Vegetable oil	3.20	2.00
L-lysine	0.55	0.62
DL-methionine	0.17	0.12
L-threonine	0.14	0.22
L-tryptophan	0.05	0.03
Limestone	0.79	1.36
Calcium formate	0.50	-
Calcium phosphate	0.61	0.73
Salt	0.11	0.33
Acidifier	0.20	0.10
Enzyme	0.02	0.02
Premix	0.50	0.50
Nutritive value:		
EM (MJ/kg)	14.00	13.50
Crude protein (%)	20.50	17.60
Lysine (%)	1.55	1.27
Methionine+cystine (%)	0.85	0.70
Threonine (%)	0.93	0.80
Tryptophan (%)	0.28	0.23
Calcium (%)	0.80	0.80
Available phosphorus (%)	0.40	0.37
Sodium (%)	0.22	0.18

Results. The mean birth weight of piglets (beginning of the experiment) was at a similar level in all groups – approximately 1.50 kg (Table 2). At 30 days of age (weaning) piglets of the control group fed a diet without antibiotics had the lowest body weights (7.03 kg). Diet supplementation with the antibiotic colistin (120 mg/kg) resulted in higher body weights (7.86 kg vs 7.03 kg in the control group). The feed additive (FA) added to diets for suckling piglets enabled to attain the highest body weights at weaning, as compared with both the negative control group and the group given a diet with colistin. The body weights of piglets of groups III, IV and V were 8.21, 8.09 and 7.96 kg respectively. Piglets of group III were the heaviest (8.21 kg). Due to high variation within the groups, these differences were statistically non-significant.

Table 2. **Results of piglet rearing**

Specification	I	II	III	IV	V	SE
1st day						
Number of litters, no.	5	5	5	5	5	–
Number of piglets/litter, no.	12.00	10.40	10.00	10.80	11.20	0.42
Piglet weight, kg	1.50	1.47	1.46	1.44	1.44	0.03
30th day						
Number of piglets, no.	10.60	9.20	9.60	10.40	10.00	0.35
Piglet weight, kg	7.03	7.86	8.21	8.09	7.96	0.22
Daily gains (d 0 to 30)	184	209	222	224	215	6.60
Feed intake, kg/piglet	0.96	1.09	0.85	0.86	0.79	0.05
Mortality rate to 30 days, %	11.29	9.62	4.04	3.65	9.77	1.76
Specification	I	II	III	IV	V	SE
30-69 days						
Number	50	46	47	51	49	–
Initial weight, kg	7.03	7.86	8.21	8.09	7.96	0.22
Final weight, kg	18.27^{Bc}	20.05^{ab}	19.47^{bc}	19.26^{bc}	21.11^{Aa}	0.28
Daily gains (d 30 to 69)	288^{B}	313^{AB}	289^{B}	287^{B}	337^{A}	5.86
FCR	2.54^{D}	1.55^{ABa}	1.70^{AB}	1.90^{BCb}	1.51^{A}	0.08
Mortality rate, %	5.45	0	1.54	1.54	1.82	1.18

a, b, c - $P \leq 0,05$
A, B, C - $P \leq 0,01$

During this part of the experiment the mean daily gains in group I (a diet without antibiotics) were 184 g. Colistin added to diets for suckling piglets affected a faster growth rate, by approximately 25 g. The replacement of this antibiotic with FA had no negative effect on daily gains. In fact, a slight increase in body weight gains was observed - by 13, 15 and 6 g respectively, depending on the level of the preparation in a diet (4, 5 or 6 kg/t), in comparison with piglets that received a diet with the antibiotic colistin (the differences were not confirmed statistically).

At the first stage of research (to 30 days of age) average feed intake was 0.96 kg per piglet in the negative control group, and 1.09 kg per piglet in the positive control group (colistin). Lower feed intake was recorded in the experimental groups (FA), i.e. 0.85, 0.86 0.79 kg per piglet in groups III, IV and V respectively. However, these differences were found to be statistically non-significant.

During the experiment the highest mortality rate was noted in the group fed a diet without feed antibiotics (11.29%), whereas the lowest – in the group fed a diet containing 5 kg/t of FA (3.65%). A low mortality rate (4.04%) was also recorded in group III (4 kg/t of FA). In groups II (colistin) and V (6 kg/t of FA) mortality rates were comparable – about 9.7%.

In weaned piglets, the lowest mean body weight was recorded in the negative control group (7.03 kg), whereas in the other groups it was at a similar level (approximately 8 kg). The differences in body weights were a consequence of the results attained at the first stage of research. At 39 days of age piglets of the control groups still had the lowest body weights (18.27 kg). The feed additive (FA), added to diets for weaners in the amount of 4 kg/t, caused a highly significant increase in body weights (21.11 vs. 18.27 kg; $P \leq 0.01$). Also piglets of groups II (colistin – 120 mg/kg), III (FA – 2 kg/t) and IV (FA – 3 kg/t) were characterized by higher body weights, in comparison with the control group.

The mean daily gains of piglets of group I (a diet without antibiotics) were 288 g. Colistin added to diets for weaned piglets affected a faster growth rate, by approximately 25 g. The replacement of this antibiotic with FA, in the amount of 2 or 3 kg/t, had no considerable effect on daily gains, which were comparable to those noted in the control group. Piglets of group V (FA – 4 kg/t) were characterized by the highest daily gains (337 g). The differences between the control group (I) and groups III and IV were statistically highly significant.

The feeding program had a profound effect on feed conversion ratios (FCR). The highest feed intake per kg of body weight gain was recorded in the control group (2.54). The differences between this group and the other groups were statistically highly significant. The best feed conversion was observed in groups II (colistin 120 mg/kg) and V (FA – 4 kg/t), and slightly worse – in groups III and IV (FA -2 and 3 kg/t respectively).

The highest mortality rate was recorded in the group fed a diet without feed antibiotics (5.45%), and the lowest – in the group that received a diet with colistin (0%). Very low mortality rates (about 1.5%) were also observed in groups III (FA – 2 kg/t), IV (FA – 3 kg/t) and V (FA – 4 kg/t).

Discussion. The results obtained suggest that diets supplementation with mannan-oligosaccharides and essential oils (FA) has a beneficial effect on performance

parameters in piglets.

It was found that production results deteriorated following antibiotic withdrawal from diets for suckling piglets. Replacing colistin with FA enabled to achieve comparable body weights and daily gains, and to reduce mortality rates. Taking into account the above results and economic conditions, it may be concluded that suckling piglets should receive the feed additive (FA) in the amount of 4 kg/t. It was found that daily gains decreased, mortality rates increased and feed conversion ratios deteriorated following antibiotic withdrawal from diets for weaned piglets. Replacing colistin with FA in the amount of 4 kg/t enabled to achieve comparable daily gains and feed conversion ratios as well as to reduce mortality rates, as compared with the control group (a diet without antibiotics).

Prebiotics have been widely used as feed additives in pig nutrition (Mosenthin, Bauer 2000). Several authors reported improved growth performance and feed efficiency in combination with a reduction of diarrhea or wet faeces when prebiotics were included in diets for young pigs. A lot of patents have claimed that supplemental oligosaccharides in the diets improves growth performance and alleviate post-weaning diarrhea in young pigs (Hidaka et al., 1985, 1986; Katta et al., 1993). In pigs, MOS (mannan-oligosaccharides) have been shown to produce improvements in live-weight gain and feed conversion efficiency comparable to that obtained with olaquindox, or with a combination of Zn-bacitracin and toyocerin (Bouldan et al., 1997).

Herbs have been widely used as feed additives in animal nutrition. Wang et al. (1998) points out that herbs in and of themselves tend act slowly require substantial dosages. Therefore, most nutritionalists use essential oil extracts. Many essential oils have antibacterial activity (Dorman, Deans, 2000), but their influence on growth performance of farm animals species has not been sufficiently documented. In several trials, the inclusion of peppermint, garlic, clove, cinamon or echinacea in weanling pig diets produced contradictory or inconsistent results (Turner et al., 2001).

In our early trial introduction oregano oil and into the diet of suckling piglets enhanced the growth rate (Lipiński, Tywończuk, 1997). The results obtained in the other trial suggest that diet supplementation with extract from *Macleaya cordata* has a beneficial effect on production parameters in piglets (Lipiński, Tywończuk, 2008). In other studies (Jost, 1996) it was found that diet supplementation with another herbaceous component (garlic), in the amount of 0.05%, had a positive effect on production results of piglets. The positive effect of plant extracts on diarrhea incidence in piglets was also reported by other authors (Kamel, 2001).

Conclusions

The results of the study permitted drawing the following conclusions:

1. Production results deteriorated considerably following antibiotic withdrawal from diets for suckling and weaned piglets.

2. Replacing colistin with mannanoligosaccharides and essential oils (FA) in diets for suckling piglets enabled to achieve comparable body weights and daily gains, and to reduce mortality rates. Taking into account the above results and economic conditions, it may be concluded that suckling piglets should receive the FA in the amount of 4 kg/t.

3. Replacing colistin with mannanoligosaccharides and essential oils (4 kg/t) in diets for weaned piglets allowed to achieve comparable daily gains and feed conversion ratios.

4. The experimental results show that feed additive (mannan-oligosaccharides with essential oils) is a viable alternative to antibiotics in diets for suckling and weaned piglets, and that the recommended dose of this preparation is 4 kg/t of feed.

References

1. Anderson D.B., McCracken V.J., Aminov R.I., Simpson J.M., Mackie R.I., Verstegen M.W.A., Gaskins H.R. Gut microbiology and growth-promoting antibiotics in swine. Nutr. Abstr. and Rev. Ser. 2000. 70 (2). P. 101-108.

2. Bolduan G., Schuldt A., Hackl W. Diet feeding in weaner piglets. Archiv für Tierzucht-Archives of Animal Breeding. 1997. N. 40. P. 95-100.

3. Bahmer B.M., Branner G.R., Roth-Maier D.A., Precaecal and faecal digestibility of inulin (DP 10-12) or an inulin/Enterococcus faecium mix and effects on nutrient digestibility and microbial gut flora. J. Anim. Phys. Anim. Nutr. 2001 N. 89. P. 388-396.

4. Dedl H., Elssenwenger T. Phytogenic feed additives – an alternative ? International pig topics. 2000. V. 15. N. 6.

5. Dorman H.J.D., Deans S.G. Antimicrobial agents from plants: antibacterial activity of plant volatile oils. Journal of Applied Microbiology. 2000. N. 83. P. 308-316.

6. Hackl W., Bouldan G., Beck M. Ferkelaufzucht ohne Antibiotika. Arch. Tierz. 2000. N. 43. S. 124-130.

7. Hidaka H., Eida T., Hashimoto K., Nakzawa T. Feeds for domestics Animals and methods for breeding them. European Patent Appl. 0133547A2. 1985. 15 p.

8. Hidaka H., Eida T., Hamaya T. Livestock feed containing inulo-oligosaccharides and breeding of livestock. European Patent Appl. 0171026A2. 1986. 11 p.

9. Katta Y., Ohkuma K., Satouchi M., Takahashi R., Yamamoto T. Feed for livestock. European Patent Appl. 0549478A1. 1993. 14 p.

10. Hillman K., Bacteriological aspects of the use of antibiotics and their alternatives in the feed of non-ruminant animals. In: P.C. Garnsworthy, J. Wiseman (Editors). Recent Advances in Animal Nutrition. Nottingham. 2001. P. 107-134

11. Jost M. Einsatz von Knoblauchpulver im Ferkelaufzuchtfutter. Agrarforschung 1996. N. 3. P. 479-481.

12. Kamel C. Tracing modes of action and the roles of plant extracts in non-ruminants. Recent Advances in Animal Nutrition 2001. Ed. P.C. Garnsworthy, J. Wiseman. Nottingham University Press. 2001. P. 135-150.

13. Lipiński K., Tywończuk J. Use of Ecodiar powder in the diet for suckling piglets. 48th Annual Meeting of the European Association for Animal Production, 96. 1997. P. 44-47.

14. Lipiński K., Tywończuk J. Testing the efficiacy of Macleya cordata as feed additive in pigs. Proceedings of International Scientific Conference „The topical problems of pigs and poultry nutrition. Quality of production". Kaunas. 2008. P. 82-84.

15. Mosenthin R., Bauer E. The potential use of prebiotics in pig nutrition. Asian-Aus. J. Anim. Sci. 2000. N. 13. P. 315-325.

16. Patterson J.A. Prebiotic feed additives: rationale and use in pigs. Advances in pork production. 2005. N. 16. P. 149-159.

17. Pfirter H.P. International report. 1998. ETH, Zurich. P. 102.

18. Tschirch H. Wykorzystanie ekstraktów roślinnych jako stymulatorów produkcyjności w nowoczesnej produkcji zwierzęcej. Zeszyty Naukowe AR we Wrocławiu. 2000. N. 376. P. 25-39.

19. Turner J. L., Dritz P.S.S., Minton J.E. Reviews: Alternatives to conventional antimicrobials in swine diets. Prof. Anim. Sci. 2001. N. 17. P. 217-226.

20. Wang R., Li D., Bourne S. Can 2000 years of herbal medicine history help us solve problems in the year 2000. Biotechnology in the Feed Industry. 1998. Nottingham University Press P. 231.

Received 19 January 2010
Accepted 25 May 2010