

ORGANIC ACIDS IN COMBINED FORAGES FOR GROWING PIGS**

G.Valchev*

Institute of Animal Science, Kostinbrod, Bulgaria

* Corresponding author: gevalchev@abv.bg

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Abstract: The purpose of this paper is to determine the effect of replacement of nutritive antibiotics in compound feed for starter pigs with acidifier Acid Lac as growth promoters. Acid Lac is a new generation acidifier a combination of appropriately selected organic acids – Fumaric, Propionic, Citric, Formic and Lactic acids, with pronounced anti-bacterial effect.

Two experiments were carried out with total of 126 growing pigs from 6 to 20kg live weight to determine the effect of organic acids as growth promoters.

The results of these experiments show that acidifying of feed for growing pigs with product Acid Lac in doses 0.3 and/or 0.5 percent, improves the average daily gain from 7 to 9 per cent, and better feed efficiency from 8 to 13 percent ($P<0.05$), decrease the number of pathogenic and relative-pathogenic microorganisms, compared to pigs with or without nutritive antibiotics Flavophospholipol in combined feed.

Under the present investigation might be concluded that organic acids could be successfully used as growth stimulators, replacing nutritive antibiotics in pig diets.

Key words: pigs, antibiotic, organic acids, Acid Lac Dry, pig performance

Introduction and literature review

The use of antibiotics as feed additive for over 50 years proved to be effective by improving nutrient utilization leading to improved feed conversion ratio and better growth rate.

Over 20 years ago *Zimmerman* (1986) summarized data from 239 separate experiments and reported that average improvement response to antimicrobial feed additive in starter pig was 15%, for growth rate and 6% for feed efficiency.

However, the use of antibiotics in livestock production, and in particular for growth enhancement has been linked to an increased prevalence of antibiotic resistant bacteria (*Langlois, B.E. et al.*, 1986; *WHO*, 1998; *Benzoen, A. et al.*, 1998; *Close, W.*, 2000; *Mathew and Ebner*, 2005).

The ban of antibiotics as a feed additive in the EU requires alternative to stabilize the health and performance particularly of the young animals. Intensive research has been focused on the development of alternative strategies to maintain health and performance status in livestock production, as mannan-oligosaccharides, probiotics, prebiotics, enzymes and phytobiotics (*Adams, C.*, 1999; *McMullin, P.*, 2000; *Cromwell*, 2001; *Spring, P.*, 2002; *Valchev, G. et al.*, 2003; *Valchev, G. et al.*, 2005; *Valchev, G. et al.*, 2006).

The objective of this investigation was to determine the effect of replacement of nutritive antibiotics in combined feed for starter pigs with acidifier Acid Lac as growth promoters.

Material and Methods

Acid Lac dry is a new generation acidifier, a combination of appropriately selected organic acids – Fumaric, Propionic, Citric, Formic and Lactic acids, with pronounced anti-bacterial effect. Kemin Ltd., USA, manufactures the product.

Two experiments were carried out with total of 126 growing pigs from 6 to 20kg live weight to determination of the effect of organic acids as growth promoters.

Table 1. Schema of experiments

Tabela 1. Shema ogleda

Trials/Groups Ogledi/Grupe Supplements/ Dodaci	I experiment/ogled		II experiment/ogled	
	Control/ Kontrola	Experimental/ Ogled	Control/ Kontrola	Experimental/ Ogled
Number of pigs/ Broj svinja	12 (2 x 6)	12 (2 x 6)	51 (3 x 17)	51 (3 x 17)
Flavomicin	-	-	5 g/t	-
Acid Lac dry	-	5 kg/t	-	3 kg/t

The first experiment was carried out with a total of 24 (2 x 6) pigs in the farm of Institute of Animal Science – Kostinbrod. The pigs were distributed into two groups—control and experimental, each one having two replicates, from 9 - 20kg live weights. The pigs of control groups did not receive any growth promoters.

The second experiment was conducted in the pigs farm Oskar Ltd. Plovdiv with a total of 102 animals, from 6 to 20kg live weight, immediately

after weaning, each group having three replicates. The pigs of the control group received antibiotics – Flavophospholipol, as growth promoter. Experimental setting and quantities of the growth stimulators added to feed are presented in Table 1.

Animals were bred on the cages for the first experiment and on the floor for the second experiment, feeding was *ad libitum* with balanced combined forages in regard to nutritional content, in full compliance with pigs' category (Table 2), and access to drinking water was free.

The following indices were controlled: the pH-value of the feed; the pH-value of the urine and faeces of pigs; pigs weight, at the start and at the end of the trial, for each pig individually; feed intake – daily; chemical composition of combined feed – components and final product; animals' health status – daily; microbiological analysis of feces (second experiment). The results were statistically processed by the Statgrafics Software.

Table 2. Composition of Basal diets

Tabela 2. Sastav osnovnog obroka

Experiments / Ogledi Row materials/Sirovine	I experiment/ogled IAS-Kostinbrod	II experiment/ogled Oskar Ltd. Plovdiv
Maize / Kukuruz	38.30	45,00
Wheat / Pšenica	20.00	13,45
Wheat bran / Pšenične mekinje	10.00	7,00
Sunflower meal /Suncokretova sačma	6.00	-
Soybean meal /Sojina sačma	19.00	21,50
Fish meal/ Riblje brašno	-	2,50
Meat Bone meal /Mesno koštano brašno	4.00	2,00
Mikromel (milk replacement)/ Zamena za mleko	-	4,00
L-lysine HCl	0.20	0,20
Sugar /Šećer	-	2,00
D-C-P	0.40	0,8
Limestone /krečnjak-kreda	1.20	0,90
Salt /so	0.30	0,30
Premix /premijs	0.50	0,25
Enzyme – HF	0.10	0,10
Acid Lac dry	-/+ 0.50	-/+ 0.30
Total/Ukupno:	100.00	100.00
Combined feed contents/Kombinovani sastojci hraniva: %		
ME, MJ/kg	12.55	13.30
Protein /Protein	19.23	19.50
Lysine /Lizin	1.10	1.18
Methionine +Cistine /Metionin+cistin	0.66	0.66
Fiber /Celuloza	4.50	4.20
Calcium /Kalcijum	0.83	0.84
Phosphorus, total /Fosfor, ukupno	0.64	0.65

Results and Discussion

Based on our and others previous investigations, Acid Lac action is expressed in the following directions: prevents development of undesired and pathogenic micro flora in fodder by lowering pH level, and prolonging storage shelf life; when taken by animals together with fodder, it lowers pH, suppresses development of pathogenic and relatively-pathogenic micro-organisms and creates opportunities for development of friendly micro flora – Lactic Bacteria; stimulates of the enzyme activity, by lowering pH in the stomach; increases the average daily body weight and improves fodder consumption; improves animals health status and has anti-stress effect, particularly within the period of transition from suckling to solid feed.

The Acid Lac is an acidifier with pH value of 2.1. Incorporated into our feed in dose of 0.5 per cent, the pH-value of mixture average for experimental periods, decreased by around 0.5 (1st experiment). These results are shown in Table 3.

The data of our experiments with pigs in the period after weaning or starter period are shown in Table 4.

Table 3. pH values

Tabela 3. pH vrednosti

	PH
Acid Lac Dry	2.1
<i>Combined forage/Kombinovano krmivo</i>	
- without Acid Lac/ bez Acid lac	6.2
- with 0.5 per cent Acid Lac / sa 0.5% Acid Lac	5.7

We have found that the addition of Acid Lac to combined feed had a considerable effect on pigs' growth. As regards the first experiment, the average daily gain of pigs from tested group increased by 7.1 percent compared to control pigs without the antibiotic growth promoters, but these differences are insignificant ($P>0.05$).

We got similar results for feed conversion as well. A better conversion ratio by 7.5 per cent was observed for pigs from the experimental group, as compared to control pigs.

In the field experiment (the 2nd experiment) there is a better result in tested group compared to the control pigs also, as well as at the first experiment, although the pigs from control group received flavophospholipol antibiotic as a growth promoter, in dose 5 g/ton feed.

The average daily gain of pigs from tested group increased by 8.6 per cent compared to control animals. These differences between groups are

significant at $P < 0.01$. The feed conversion ratio is improved by 12.7 percent compared to control group, differences being significant at $P < 0.05$.

Table 4. Growth indicators
Tabela 4. Indikatori porasta

Experiment/Groups Ogled/Grupe	I experiment/Ogled		II experiment/Ogled	
	Control/ Kontrola n = 12	Tested/ Testirano n = 12	Control/ Kontrola n = 51	Tested/ Testirano n = 51
Indicators/pokazatelji				
Live weight/Telesna masa -at the beginning/početna - at end of trial/na kraju ogleda	9,62 21,73	9,39 22,36	6,58 19,97	6,02 20,59
Feed intake, g/day/ Unos hrane, g/dan	0,814	0,806	570±10,3 ^b	542±37,9 ^b
Daly gain/Dn. prirast, g %	340 ± 23,1 100,0	364 ± 33,3 107,1	197 ± 70,6 100,0	214 ± 62,9 108,6
Feed conversion ratio/Konverzija hrane, kg %	2,395±0,19 100,0	2,215±0,24 92,5	2,895±1,4 ^a 100,0	2,528±1,0 ^a 87,3

*/ The values mark off same letters is significant at: a – $P < 0.05$; b- $P < 0.01$

*/ Vrednosti označene istim slovima su signifikantne na nivou t: a – $P < 0.05$; b- $P < 0.01$

As regards the health status in this experiment, of pigs' mortality of tested groups is 4 points straight lower, compared to control group. In support of this are the results of microbiological analysis of feces at the end of the field experiment (Table 5).

The analytical data show decreases of the number of pathogenic and relative-pathogenic microorganisms. The aerobic mesophilis decreased from 0.56×10^{10} to 7.1×10^7 , coliforms from 4.0×10^6 to 2.7×10^6 , staphylococci and micrococci from 7.66×10^6 to 5.3×10^6 etc., while the salmonella, bacteria anaerobic and listeria monocitogenes were not isolated from either group.

The growth results and microbiological analysis showed that there already existed a resistance of some microorganisms to the used antibiotic flavophospholipol.

While the effect of several organic acids on post-weaning performances has been well documented and reviewed by *Partanen* (2001), these is increasing body of evidence that organic acids may improve the performance of growing pigs as well (*Partanen et al.*, 2001a, 2001b). *Øverland et al.* (2000) reported a significant improvement in daily gain and feed efficiency in fattening pigs given organic acids. *Tsiloyannis et al.* (2001) observes that several organic acids reduced the severity of diarrhea in weaned piglets. According *Roth and Kirchgessner* (1997) dietary formic acid reduced E.colli counts in the small intestine.

Table 5. Microbiological analysis of feces
Tabela 5. Mikrobiološka analiza fecesa

Groups/Grupe	Control/Kontrola With Flavophospholipol		Experimental/Ogled With Acid Lac Dry	
	Start/ Početak	Finish/ Kraj	Start/ Početak	Finish/ Kraj
Aerobic mesophilis	0.68x10 ¹⁰	0.561x10 ¹⁰	0.4x10 ¹⁰	7.1x10 ⁷
Coli forms	0.46x10 ¹⁰	4.0 x 10 ⁶	0.16x10 ¹⁰	2.7x10 ⁶
Staphylococci and micrococci	2.66x10 ⁶	7.66x10 ⁶	2.0x10 ⁶	5.3x10 ⁶
Enterococci	3.63x10 ⁷	0.7x10 ⁶	2.2x10 ⁷	0.4x10 ⁶
Proteus	1.53x10 ⁶	1x10 ⁶	0.8x10 ⁶	0.7x10 ⁶
Fungi and yeas	1.86x10 ⁷	1.06x10 ⁶	1.6x10 ⁷	0.5x10 ⁶
Sulfite-reducing clostridia	5x10 ³	No	3x10 ³	no
Salmonellas	no	no	No	no
Bacteria anaerobic	no	no	No	no
Listeria monocitogenes	no	no	No	no

Conclusion

The results of these experiments show that acidifying of feed for growing pigs with product Acid Lac in doses 0.3 and/or 0.5 percent, improves the average daily gain from 7 to 9 percent, and better feed efficiency from 8 to 13 percent ($P < 0.05$), decreases the number of pathogenic and relative-pathogenic microorganisms, compared to pigs with or without nutritive antibiotics Flavophospholipol in combined feed.

Under the condition of the present investigation, there could be concluded that organic acids might be successfully used as growth stimulators, replacing nutritive antibiotics in pig diets.

Organske kiseline u kombinovanim krmivima za svinje u odgoju

G. Valchev

Rezime

Cilj ovog rada je bio utvrđivanje uticaja zamene antibiotika u ishrani u starter hranivima za svinje sa promoterom porasta - Acid Lac. Acid Lac je proizvod nove generacije koji predstavlja kombinaciju adekvatno odabranih organskih kiselina – fumarne, propionske, limunske, mravlje i mlečne kiseline, sa izraženim antibakterijskim uticajem.

Izvedena su dva ogleda na ukupno 126 svinja u odgoju od 6 do 20 kg telesne mase kako bi se odredio uticaj organskih kiselina kao promotera rasta.

Rezultati ovih ogleda pokazuju da je dodavanje kiselina u hraniva za svinje u odgoju korišćenjem proizvoda Acid Lac u dozama 0.3 i/ili 0.5 procenata uticalo na poboljšanje prosečnog dnevnog prirasta sa 7 na 9%, i bolje iskorišćavanje hrane sa 8 na 13 % ($P < 0.05$), smanjenje broja patogenih mikroorganizama, u poređenju sa svinjama bez ili sa antibiotikom u ishrani Flavophospholipol u kombinovanom hranivu.

Može se zaključiti da se organske kiseline mogu uspešno koristiti kao promoteri rasta i u potpunosti zamene antibiotike u ishrani svinja.

Ključne reči: svinje, antibiotik, organske kiseline, Acid Lac Dry, proizvodni rezultati svinja

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