Danish Pig Production

Effect of zinc and organic acids on diarrhoea in the weaner period

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Abstract

This trial investigated the effect of adding organic acids and zinc to weaner diets on treatments for diarrhoea, mortality and productivity in weaners. The trial was conducted in one herd with established diarrhoea problems caused by E. coli O149 and Lawsonia towards the end of the weaner period. The trial comprised three groups, 40 replicates and a total of approx. 3,200 pigs.

Group 1 (control):	Control feed.
Group 2 (acid):	As 1 with the addition of 1% lactic acid, 1% formic acid and 0.5% benzoic acid.
Group 3 (acid + zinc):	As 2. In addition, the pigs were given 2,500 ppm zinc the first 14 days post-weaning.

There were significantly fewer treatments for diarrhoea when organic acids were added (group 2) and when acid was added for the entire period in combination with additional zinc the first 14 days post-weaning (group 3). Mortality was furthermore significantly reduced in the entire weaner period when acid and zinc were added to the feed (group 3).

Based on daily gain and feed conversion, the production value was calculated using the same feed price in all groups. There was no significant difference in production value between the three groups, which means that the pigs did not grow faster or utilized the feed better even though 2.5% organic acids were added.

If health and productivity are calculated in the same index, it is revealed that the pigs in group 3 obtained the highest index and thereby the greatest economic value per pig. There is a difference of approx. DKK 8 per pig compared with group 1. This is the actual difference one must pay for the increased costs of adding acid and zinc.

Overall, the trial showed that feed to which 2.5% organic acids were added had a slightly less reducing effect on the prevalence of diarrhoea in the weaner period. Feed to which 2.5% organic acids were added in combination with 2,500 ppm zinc the first 14 days post-weaning significantly reduced the prevalence of diarrhoea and mortality. Daily gain and feed conversion were unaffected by whether acids and zinc were added to the feed.

Background

Trials and experience have shown that additional zinc oxide (2500 ppm Zn) to newly weaned pigs improves the daily gain and reduces the prevalence of post-weaning diarrhoea (1, 2). The Danish Veterinary and Food Administration have permitted the use of 2,500 ppm zinc oxide prescribed by the vet the first 14 days post-weaning. As most producers with diarrhoea problems in their herd are assumed to be using zinc post-weaning, it is relevant to test the effect of other measures in combination with zinc in the feed.

Several trials have found a positive effect of adding organic acids in doses higher than 1% in feed on pigs' production results (3,4,5,6). In vitro trials at the Danish Institute of Agricultural Sciences (DIAS) revealed the following order of organic acids in relation to their bactericidal effect measured on coli bacteria (listed with increasing effect, ie. the acid mentioned first had the smallest effect): propionic acid, formic acid, butyric acid, lactic acid, fumaric acid, benzoic acid (not published). A previous trial with a high dose of benzoic acid in weaner feed (2% benzoic acid in diet 1 + 1% in diet 2) showed a significantly positive effect on daily gain and feed conversion and a reducing effect on the prevalence of diarrhoea (3). Benzoic acid is approved for use in weaner feed as a flavour enhancer.

As organic acids are expected to reduce the prevalence of potential pathogenic bacteria and thereby the prevalence of diarrhoea, and as we know that high doses of zinc oxide also reduce the prevalence of diarrhoea, it is relevant to establish whether there is an additive effect of acid and zinc, and also to establish the effect, if any, on health of a high dose of acid in the weaner period.

The aim of this trial was to investigate the effect of a high dose of acid in feed (with and without 2,500 ppm zinc the first 14 days post-weaning) on health and productivity in the weaner period in a herd with established problems with diarrhoea and Lawsonia.

Materials and method

The trial was conducted in one herd with established diarrhoea problems caused by E. coli O149 and unfamiliar pig pathogenic E. coli bacteria post-weaning and Lawsonia intracellularis towards the end of the weaner period. The preliminary diagnoses were made by way of weekly faecal samples and post-mortems of dead pigs in a weekly batch of weaners that had not been treated with antibiotics post-weaning. During the trial, pigs were submitted for examination, and blood samples and faecal samples were collected for analysis of coli and Lawsonia.

Pigs weighing 7 kg were purchased for the herd in which weekly batch operation was practised. Upon transfer, the pigs were sorted according to large and small pigs and subsequently placed in 2x3 pens in a section. The trial was conducted as a blinded trial, ie. the herd owner was unaware of the content of the diets.

The pigs' average weight at penning was 7.7 kg. At the end of the trial after approx. 41 days the pigs had an average weight of 24.7 kg. The trial comprised the three groups shown in table 1 below.

A gradual change was made from diet 1 to diet 2 starting from day 14 post-weaning.

Table 1. Trial design

Group 1 (control):	Control
Group 2 (acid):	As 1 with the inclusion of 1% lactic acid, 1% formic acid and 0.5% benzoic acid*
Group 3 (acid + zinc):	As 2, but the pigs were also given feed containing 2,500 ppm zinc the first 14 days post-weaning.

* Pure acid in the feed, ie. adjusted for the acid content of the products.

The composition of the diets is shown in Appendix 1. All diets were produced as expandat, ie. the feed was heat-treated, but not pelleted. The feed was produced at DLG, and the feed for the three diets was produced on the same day to ensure that the same batch of ingredients was used for all three groups. The pigs were fed ad lib, ie. they had access to feed all day.

Recordings

The following factors were recorded in the trial period: treatments for disease, mortality, culled pigs, daily gain and feed conversion.

All recordings were made at pen level. The pigs were weighed at transfer to the trial and at the end of the trial. The feed was supplied manually in feeders and was weighed and recorded each time feed was supplied. Furthermore, mortality and the frequency of treatments for diarrhoea and other diseases were recorded.

Treatments for disease

Treatments for coli diarrhoea, Lawsonia and respiratory disorders etc. were primarily conducted as individual treatments. As a general rule, all the pigs in a pen were treated when 50% of the pigs in the pen suffered from diarrhoea. This was changed early in the trial, and from that point on, collective treatment was allowed in cases of visible signs of diarrhoea. This change was made to keep mortality at an acceptable level. Preventive treatments for diarrhoea with antibiotics were not conducted.

Wash, protection against infections etc.
The routines of the herd were observed in terms of the use of boots and cleaning of the sections; ie. boots were washed before entering another section. The daily inspection always started with the youngest pigs, and in the individual sections, the healthy pigs were inspected first.

Production value
The production value based on an average of the last five years' weaner prices (September 2001 - September 2005) was calculated as: (kg gain x DKK per kg gain) – (number of declared FUgp x DKK per FUgp). The production value was calculated for the entire trial period for each pen and included the same feed price in all three groups. The value of gain (DKK 6.5 per kg) was calculated on the basis of the average weight at the start and end of the trial. The prices of the last five years are:

Price of a 7 kg pig:	DKK 214 per pig, ± DKK 8.52 per kg
Price of a 30 kg pig:	DKK 357 per pig, ÷ DKK 5.08 (15-30 kg) / + DKK 5.24 per kg (30-40 kg)
Diet 1:	DKK 2.74 per FUgp
Diet 2:	DKK 1.52 per FUgp

Besides the production value that only includes daily gain and the amount of feed used, the economic value was also calculated that included mortality and treatments for diarrhoea.

This production value including mortality and diarrhoea was calculated per pen as: production value – (number of dead pigs x DKK per pig + number of culled pigs x ½ x DKK per pig)/number of pigs penned per pen – number of treatments for diarrhoea per pig x DKK per treatment.

The loss of a dead pig was calculated to amount to DKK 212 per pig. The loss of a culled pig was set to half that of a dead pig. The price of a day's treatment for diarrhoea was set to DKK 1 and covers only the costs for medication.

Statistics
Mortality was analysed with logistic regression in Proc Logistic, SAS with p scale and with group, facility, block and pen for modelling of overspread. Treatments for disease were subjected to an analysis in Proc Mixed, SAS, with block and facility as random effects. The results are shown as LSmean calculated in Proc GLM in SAS. The number of treatments for diarrhoea per pig were calculated on the basis of pigs "at risk", ie. the number of pigs that were in the pen at any time.

The production value was analysed with weight at transfer as co-variable. The model included the following variables: block and group. Data were analysed for normal distribution and prevalence of outliers, and subjected to an analysis of variance in SAS under the GLM procedure. Significant differences are stated at 5% level adjusted for two comparisons in pairs (groups 2 and 3 with the control group) at a Bonferroni t-test.

Results and discussion

Feed
The declared nutrient content and the analysis results are shown in Appendix 2. There was generally good agreement between the declared and the analysed nutrient content. However, the analysis revealed a slightly lower content of lactic acid than expected (0.7-0.8% vs. 1% declared).

Productivity
One pen was excluded from the overall analysis as the pen was a significant outlier.

The production data are shown in table 2. The production results are calculated in a production value that was the result of the calculations mentioned above and that weighs up the production data obtained in the trial (daily gain and feed conversion). There were no significant differences between the three groups in production value. Previous trials have found varying effects of adding organic acids to weaner feed. However, these trials have generally demonstrated that daily gain and feed conversion improve when acid is used in weaner feed. However, this trial did not confirm this. In this trial, a fairly high dose of acid was used, but not higher than what has previously been investigated. However, the combination of the three acids has not been investigated previously.

Table 2. Productivity, treatments for diarrhoea, and mortality			
Group	1	2	3
Treatment	Control	Acid	Acid + zinc
Blocks	39	40	40
Health			
Number of treatments for diarrhoea, days/pig			
Entire period	8.7[a]	6.9[b]	0.9[c]
0-21 days post-weaning	6.3[a]	5.7[a]	0.6[b]
22-41 days post-weaning	2.4[a]	1.2[b]	0.3[c]
Mortality, %	2.6[a]	1.9[b]	1.2[b]
Production results			
Daily feed intake, FUgp	0.82	0.80	0.80
Daily gain, g	418	410	406
Feed conversion, FUgp/kg gain	1.96	1.95	1.98
Production value			
DKK/pig	67.4	66.4	64.9
Index	100	99	96
Production value, incl. treatment for diarrhoea and mortality			
DKK/pig	52.9[a]	54.7[a]	61.2[b]
Index	100	103	116
a,b,c: Values with different letters are significantly different (P<0.05)			

Health

The number of treatments for diarrhoea was significantly reduced when acid was added to the feed (group 2) and when acid was added in combination with 2,500 ppm zinc the first 14 days post-weaning (group 3). In group 2, this resulted in a 50% reduction in treatments in the last half of the trial period. In group 3, treatments were reduced by 91% in the first half of the trial period and by 88% in the last half of the trial period compared with the control group. Mortality was furthermore significantly reduced when acid was added to the feed in combination with zinc the first 14 days post-weaning (group 3).

Figure 1 shows a general outline of treatments in the trial period. The majority of the treatments were performed in the first week post-weaning, and most pigs were treated in groups 1 and 2. Group 3 given feed including zinc had a very low number of treatments in the same period, which means that zinc must primarily have an effect on coli diarrhoea. For the remaining part of the trial period, the pigs in group 3 also had fewer treatments than groups 1 and 2, which indicates that besides preventing post-weaning diarrhoea, zinc also has a protective effect on diarrhoea in the last part of the weaner period.

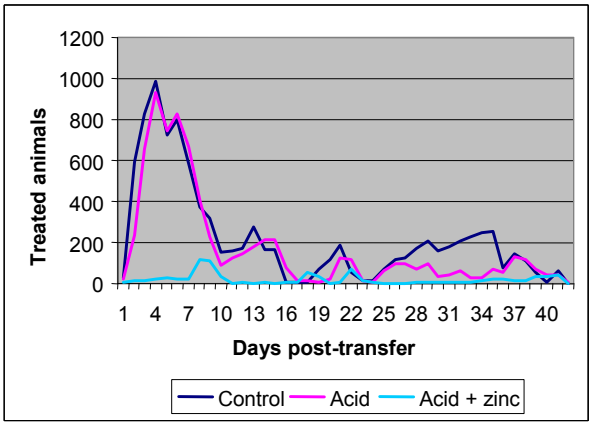

Figure 1. Effect on diarrhoea treatments of adding 2.5% organic acids or 2.5% organic acids in combination with 2,500 ppm zinc the first 14 days post-weaning.

Other investigations made with zinc confirm the results of this trial (1,2). This trial did not find a positive effect of adding organic acids to weaner feed and this does not correspond to the findings of previous trials (3,4,5,6) except one (7).

Production value incl. health

In table 2 above, an economic value is calculated that, besides an economic weighting of gain and feed conversion, also include mortality and treatments for diarrhoea (calculation formula is shown in “Materials and methods”). As can be seen, the pigs in group 3 have a significantly higher value compared with the pigs in group 1 and 2. This is caused by the lower mortality rate and fewer treatments for diarrhoea in group 3. The difference between groups 3 and 1 was approx. DKK 8 per pig. The costs for the additional

zinc amounted to approx. DKK 0.5 per pig and costs for the addition of acid amounted to approx. DKK 7-8 per pig. Overall, the gain equals the increased feed costs. On the basis of this trial it is not possible to conclude whether zinc in diet 1 alone would have the same effect as in group 3 in which it was combined with acid. However, it is known from a series of trials that 2,500 ppm zinc in diet 1 reduces the prevalence of diarrhoea significantly, so it is likely that zinc is the main reason for the effect found in group 3.

Conclusion

Overall, this trial shows that feed to which 2.5% acid is added has a less reducing effect on the prevalence of diarrhoea in the weaner period. Feed to which 2.5% acid is added in combination with 2,500 ppm zinc the first 14 days post-weaning reduced the prevalence of diarrhoea and the mortality significantly. Daily gain and feed conversion were unaffected by whether acid and zinc were added to the feed.

References

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Participants

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Appendix 1

Composition of diet 1, %

Group	1	2	3
Wheat	35.00	33.50	32.97
Wheat, coarse grinding	25.00	25.00	25.00
Barley	13.00	10.00	10.00
Soy bean meal, dehulled, toasted	8.33	9.26	9.37
Fish meal	7.00	7.00	7.00
Potato protein concentrate	2.50	2.50	2.50
Palm fat	2.34	3.00	3.13
Dried whey	2.00	2.00	2.00
Calcium carbonate	1.49	1.48	1.47
Sugar cane molasses	1.00	1.00	1.00
Mono calcium phosphate	0.83	0.86	0.86
Biolysine 65	0.60	0.57	0.57
Grisevit 183	0.40	0.40	0.40
Halite	0.28	0.28	0.28
Threonine 98	0.10	0.09	0.09
Methionine, DL	0.06	0.06	0.06
Phytase premix	0.03	0.03	0.03
Tryptophan 40%, wheat tailings 60%	0.03	0.03	0.03
Flavour additive and aromatic compounds	0.02	0.02	0.02
Acid mix (lactic acid + formic acid)		2.43	2.43
Benzoic acid		0.50	0.50
Zinc oxide Pharma 100%			0.30

Composition of diet 2, %

Group	1	2	2
Wheat	18.33	13.70	13.70
Wheat, coarse grinding	25.00	25.00	25.00
Barley	20.00	20.00	20.00
Oats	5.00	5.00	5.00
Soy bean meal, toasted	20.71	21.83	21.83
Fish meal	2.00	2.00	2.00
Palm fat	3.65	4.16	4.16
Calcium carbonate	1.66	1.64	1.64
Sugar cane molasses	1.00	1.00	1.00
Mono calcium phosphate	0.96	0.98	0.98
Biolysine 65	0.61	0.58	0.58
Grisevit 183	0.40	0.40	0.40
Halite	0.43	0.43	0.43
Threonine 98	0.12	0.12	0.12
Methionine, DL	0.11	0.11	0.11
Phytase premix	0.03	0.03	0.03
Porzyme 8300		0.10	0.10
Acid mix (lactic acid + formic acid)		2.43	2.43
Benzoic acid		0.50	0.50

Appendix 2

Declared and analysed nutrient content, diet 1

Group	**1**		**2**		**3**	
	Analysis	Guarantee	Analysis	Guarantee	Analysis	Guarantee
Crude protein, % [1)]	19.5	19.5	19.8	19.5	19.5	19.5
Crude fat, % [1)]	5.4	5.3	4.9	5.9	6.2	6.0
Ashes, % [1)]	4.9	5.9	5.1	5.9	5.3	6.2
Water, % [1)]	12.1		12.7		12.4	
FUgp, per 100 kg [1)]	117	116	115	116	119	116
Calcium, g/kg [1)]	8.9	9.4	9.8	9.4	9.4	9.4
Phosphorus, g/kg [1)]	6.0	6.1	6.2	6.1	6.2	6.1
Lysine, g/kg [1)]	13.8	13.5	14.0	13.5	13.9	13.5
Methionine, g/kg [1)]	4.3	4.2	4.3	4.2	4.2	4.2
Cystine, g/kg [1)]	3.4		3.3		3.4	
Met+cyst, g/kg [1)]	7.6		7.6		7.6	
Threonine, g/kg [1)]	8.5		8.6		8.6	
Isoleucine, g/kg [1)]	8.7		8.7		8.5	
Leucine, g/kg [1)]	14.8		14.9		14.8	
Histidine, g/kg [1)]	4.4		4.5		4.4	
Phenylalanine, g/kg [1)]	9.2		9.1		9.2	
Tyrosine, g/kg [1)]	6.4		6.6		6.3	
Phenyl+tyrosine, g/kg [1)]	15.6		15.7		15.5	
Valine, g/kg [1)]	9.9		9.9		9.7	
Zinc, mg/kg [1)]	128		131		2597	
Lactic acid, % [1)]	0.2	0	0.8	1.0	0.8	1.0
Formic acid, % [1)]	0.11	0	0.9	1.0	1.0	1.0
Benzoic acid, % [1)]	0	0	0.5	0.5	0.5	0.5
[1] Stated on the basis of one analysis.						

Declared and analysed nutrient content, diet 2

Group	1		2		3	
	Analysis	Guarantee	Analysis	Guarantee	Analysis	Guarantee
Crude protein, % [1)]	17.8	17.7	17.1	17.7	17.2	17.7
Crude fat, % [1)]	5.8	5.9	6.1	6.4	6.5	6.4
Ashes, % [1)]	5.0	6.1	5.0	6.2	5.1	6.2
Water, % [1)]	12.2		12.7		13.2	
FUgp, per 100 kg [1)]	112	112	114	112	114	112
Calcium, g/kg [1)]	8.3	9.1	8.5	9.0	8.4	9.0
Phosphorus, g/kg [1)]	5.8	5.8	5.8	5.8	5.8	5.8
Lysine, g/kg [2)]	12.3	11.8	11.6	11.8	12.0	11.8
Methionine, g/kg [2)]	3.7	3.7	3.4	3.7	3.5	3.7
Cystine, g/kg [2)]	3.4		3.2		3.3	
Met+cyst, g/kg [2)]	7.1		6.6		6.8	
Threonine, g/kg [2)]	7.7		7.3		7.4	
Isoleucine, g/kg [2)]	7.8		7.5		7.6	
Leucine, g/kg 2)	13.1		12.6		12.8	
Histidine, g/kg [2)]	1.5		4.4		4.4	
Phenylalanine, g/kg [2)]	8.5		8.1		8.3	
Tyrosine, g/kg 2)	5.8		5.6		5.6	
Phenyl+tyrosine, g/kg [2)]	14.3		13.7		13.9	
Valine, g/kg [2)]	8.8		8.5		8.7	
Zinc, mg/kg [2)]	157		142		134	
Lactic acid, % [2)]	0	0	0.7	1.0	0.7	1.0
Formic acid, % [2)]	0	0	0.9	1.0	0.9	1.0
Benzoic acid, % [2)]	0	0	0.4	0.5	0.4	0.5

[1] Average of five analyses.
[2] Average of two analyses.