Irish Journal of Agricultural and Food Research **47:** 93–97, 2008

A note on the effect of supplementation with microbial phytase and organic acids on feed intake and growth performance of growing pigs

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This experiment was designed to investigate the effects of supplementation with phytase, either alone or in combination with organic acids, on feed intake and growth of pigs from 8 to 89 kg live weight. Some 240 pigs were used in four experimental treatments comprising: (1) control, (2) control plus phytase, (3) control plus phytase plus liquid organic acids (formic, propionic), and (4) control plus phytase plus powdered organic acids (formic, fumaric, propionic). Feed intake and growth rate in the weaner stage were increased ($P < 0.05$) by phytase supplementation, with some additional benefits from organic acid inclusion. Interval to slaughter was reduced ($P < 0.05$) by phytase supplementation.

Keywords: organic acids; phytase; pigs; weaner nutrition

Introduction

Supplementation of pig diets with microbial phytase can release plant phytate, allowing levels of dietary inorganic P to be reduced with corresponding reductions in excreta (Cromwell *et al.*, 1995). Organic acids may be included in growing pig diets as they have strong antimicrobial activities which have a positive influence on digestion (Partanen and Mroz, 1999). Activity of microbial phytase is pH dependent and is at its highest between pH 2.5 and 5.5 (Simons *et al.*, 1990). When used in conjunction with phytase, organic acids may enhance P availability though little is known about such a synergistic effect and studies in this area have yielded varying results (Jongbloed *et al.*, 2000). The aim of this experiment was to investigate the effects of dietary supplementation with

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phytase, either alone or in combination with one of two different organic acid preparations, on feed intake and growth performance of pigs managed from weaning to finishing, under commercial conditions.

Materials and Methods

Dietary treatments

The experiment was designed with four dietary treatments:

1. A conventional ration appropriate for pigs of a particular growth stage (Control; C)
2. As for C but containing 0.1 g/kg phytase (Natuphos® 5000G, BASF, providing 500 FTU phytase/per 1 kg feed) with reduced levels of inorganic Ca and P (0.001 and 0.00115 g/kg, respectively), reflecting the estimated amount of these minerals released by phytase (Phytase; PHT)
3. As for PHT but with the addition of a liquid mixture of organic acids (Luprocid®, BASF) containing 638 and 250 g/kg, respectively, of formic and propionic acids (Phytase with liquid organic acids; PLA)
4. As for PHT but with the addition of powdered organic acids (Lupromix Dry®, BASF) containing 280, 300 and 230 g/kg, respectively, of formic, fumaric and propionic acids (Phytase with powdered organic acids; PPA).

For each treatment, 5 different experimental rations were prepared corresponding to five growth stages from weaning (Day 0) to finishing as follows: i) Day 0–7; ii) Day 8–20; iii) Day 21–55; iv) Day 56–100; v) Day 101–130. For each stage, rations were formulated to provide adequate nutrients for growth and were similar across dietary treatments apart from Ca and P concentrations (adjusted in phytase treatments as described above). For stages i to v, respectively, the level of acid preparation added was 0.007, 0.006, 0.005, 0.004 and 0.003 g/kg feed for PLA, and 0.010, 0.008, 0.006, 0.005 and 0.004 g/kg feed for PPA. Feed and water were available *ad libitum* from weaning until the end of the study (89 kg live weight).

Animals and housing

Some 240 pigs, the progeny of Landrace × (Large White × Duroc) sows mated to Large White boars, were selected for the study at approximately 4 weeks of age (~8 kg live weight). Pigs were individually ear-tagged for identification and creep feed was not offered prior to weaning. They were allocated to pens in groups of five in a fully-slatted weaner building taking account of litter of origin, genotype and sex. At Day 26, three pens from the same treatment were combined and moved to a fully-slatted building for 6 weeks before transfer to another fully-slatted building for the remainder of the study. Hence there were 12 replicate pens (each 5 pigs) for stages i and ii and 4 replicate pens (each 15 pigs) for the remaining stages.

Data recording

Individual live weight was recorded at weaning, at each stage change and at the end of the study. Feed intake was estimated for each stage on a pen basis by recording feed disappearance from the trough. Animals were inspected daily for signs of ill health and any sick or injured animals were treated appropriately.

Statistical analysis

Data were subject to an analysis of variance using the general linear model command (GLM) in the statistical package Minitab (Version 14, Minitab Inc., USA). The model took account of treatment and replicate, using pen as the experimental unit. Treatment means were compared using orthogonal *a priori* single d.f. contrasts (Snedecor and Cochran, 1980) for the effects of: a) addition of phytase: C v. mean of PHT, PLA and PPA; b) addition of organic acid: PHT v. mean of PLA and PPA; c) organic acid preparation (liquid or powder): PLA v. PPA.

Results

In stage i (the first 7 days after weaning) average feed intake and daily gain were significantly greater for pigs offered phytase-supplemented diets compared to those offered the control diet (Table 1). A similar effect was observed during the next two growth stages, i.e. pigs fed the phytase-supplemented diets ate more, grew faster and were heavier at the end of the stage than those fed the control diet. Supplementation with organic acids showed further benefits to growth rate and live weight (stage ii only) and feed efficiency (stage i and ii). There were no significant effects of acid preparation on growth or feed intake. Apart from live weight at the end of stage iv, which was significantly higher for pigs on the phytase-supplemented diets, there were no significant effects of treatment on growth rate or feed intake during either of the remaining two growth stages. Average number of days to reach sale weight was significantly lower for pigs offered phytase-supplemented diets.

Discussion

In agreement with the present findings for growth stages i, ii and iii, increased feed intake and growth performance with phytase supplementation have been reported previously by Jongbloed *et al*. (2000), not only for diets supplying an inadequate level of digestible P, but even when pigs were fed levels of P above their requirements. One possible explanation for this is that a higher P supply leads to a reduced buffering capacity resulting in a lower gut pH which is beneficial to growth.

Inclusion of organic acids together with phytase tended to further increase feed intake (not significant), did increase daily gain in stage ii, and improved feed efficiency in both stages i and ii. This disagrees with the report of Jongbloed *et al.* (2000), who found that whilst organic acids (lactic or formic) were beneficial to feed intake and growth performance of pigs, there was no synergistic effect from using them in combination with phytase. This was despite a synergistic effect of feeding organic acids with phytase on ash, P and Mg digestibility.

There was no effect of dietary treatment on growth performance during stage iii or iv, although inadequate replication may mask some trends for higher feed intake and daily gain during stage iv in particular. However, it is recognised that the response of pigs to organic acids decreases with increasing age and development of gastric secretions (Easter, 1998). The significant reduction of 6 to 9 days in average time from weaning to finish weight due to supplementation with phytase and organic acids could lead to important savings in production costs for pig producers.

It is concluded that the inclusion of phytase in pig diets gave significant increases in feed intake and growth performance. These resulted in a reduction in the mean duration of finishing period which would be of benefit to pig producers in addition to reducing the risk of P pollution. The inclusion of organic acids in addition to phytase gave further significant improvements in live-weight gain and feed efficiency although these benefits were only seen in the weaner period. There were no

Table 1. Effect of dietary treatment on feed intake and growth performance of pigs offered diets supplemented with microbial phytase and organic acids

Growth stage (days; weaning = day 0)	Measurements	Dietary treatment[1]				s.e.d.	Significance of contrasts	
		Control	PHT	PLA	PPA		Phytase addition[2]	Acid addition[3]
0 to 7 (weaner)	Initial weight (kg)	8.1	8.1	8.1	8.1	0.08		
	Final weight (kg)	9.7	9.8	9.9	9.8	0.15		
	Daily gain (g)	226	245	258	244	19.2	*	
	Daily feed intake (kg)	0.24	0.26	0.26	0.25	0.013	*	
	Feed conversion ratio	1.13	1.15	1.02	1.04	0.07		**
8 to 20 (2nd weaner)	Final weight (kg)	16.1	16.7	17.2	17.0	0.34	**	*
	Daily gain (kg)	0.488	0.536	0.557	0.554	19.4	**	*
	Feed intake (kg)	0.52	0.57	0.59	0.59	0.020	**	
	Feed conversion ratio	1.08	1.07	1.05	1.07	0.016		*
21 to 55 (link)	Final weight (kg)	38.2	40.1	42.1	41.7	1.22	*	
	Daily gain (kg)	0.652	0.686	0.734	0.721	27.8	*	
	Feed intake (kg)	1.07	1.13	1.15	1.15	0.040	*	
	Feed conversion ratio	1.64	1.65	1.57	1.63	0.029		
56 to 100 (grower)	Final weight (kg)	66.5	70.5	73.2	73.4	2.55	*	
	Daily gain (kg)	0.629	0.676	0.691	0.702	37.9		
	Feed intake (kg)	1.65	1.69	1.77	1.74	0.072		
	Feed conversion ratio	2.62	2.51	2.54	2.53	0.055		
100 to finish (finisher)	Final weight (kg)	89.2	89.3	88.5	89.7	1.05		
	Daily gain (kg)	0.719	0.711	0.700	0.709	60.5		
	Feed intake (kg)	2.22	2.22	2.17	2.23	0.075		
	Feed conversion ratio	3.12	3.14	3.17	3.18	0.200		
Overall	Days to finish at 89 kg	128.5	123.0	119.8	119.8	2.35	*	

[1] Control = conventional ration only; PHT = Control supplemented with phytase (0.1 g/kg); PLA = Control supplemented with phytase + liquid organic acids; PPA = Control supplemented with phytase + powdered organic acids.
[2] Control *v* mean of PHT, PLA and PPA.
[3] PHT *v* mean of PLA and PPA.
There were no significant differences between PLA and PPA.

significant differences in growth rate or feed intake between the two organic acid preparations, so the choice of which to use will be influenced by the availability of dosing equipment for application of the liquid acid preparation.

Acknowledgements

The authors acknowledge Mr C.A. Bulman for care of animals and Dr R.S. Shiel for guidance on the use of orthogonal *a priori* contrasts.

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Received 24 January 2006