

Effects of Potassium Diformate on Growth Performance and Diarrhoea Rate in Piglets in Comparison to Antibiotics

C. Lückstädt¹, K. J. Kühlmann² and T. M. Van³

¹ADDCON Europe, Germany, ²ADDCON Asia, Thailand, ³ADDCON Asia, Vietnam

With costs of pig production under mounting pressure, efficient nutrition of piglets is of increasing interest as sustaining growth rates and optimizing feed efficiency are key requirements for economic success. Organic acids and their salts are gaining strong acceptance in the EU-export oriented Asian region in pig diets as antibiotic growth promoters (AGP) have been prohibited within the EU since 2006. In the following study potassium diformate (KDF), a double salt of formic acid and the first EU-registered non-antibiotic growth promoter for pigs was tested against some common AGP on growth performance and diarrhoea rate of weaned piglets under Asian farm conditions. Eighty 28-day old weaned piglets of equal weight (initial weight 10.1 kg), gender and breed, were allocated to 4 equal groups with 20 piglets each. Piglets were kept at an experimental farm in Southern Vietnam for 28 days, receiving a commercial diet of 19% crude protein with 2975 kcal kg⁻¹ ME. Diet 1 served as negative control, while diets 2 to 4 contained either 0.4% KDF, 300 ppm Bactrim or 120 ppm Colistin. Feed and water were available *ad libitum*. At the end of the trial, final weight, daily weight gain, feed conversion and the diarrhoea rate of piglets were obtained and analysed using ANOVA ($p < 0.05$). The final weight of piglets fed 0.4% KDF was significantly increased, whereas the inclusion of Bactrim or Colistin led only to intermediate results between the control and KDF. KDF-inclusion improved the final weight against the control by more than 11%. Furthermore, a numerical improvement of the feed conversion ratio by 16% was monitored – due to the design of the trial no statistics could be carried out. Finally, the overall days of diarrhoea per group were significantly reduced in the KDF-treatment from 49 d (control) to only 22 d. A likewise significant diarrhoea reduction has been obtained in the Colistin-group. However, not as pronounced as the KDF-fed group. The findings of the present study support the use of dietary potassium diformate as an effective and sustainable replacement for antibiotic growth promoters in post-weaned piglets under Asian conditions. Current findings suggest that KDF can be used to enhance growth and reduce post-weaning diarrhoea.

Key Words: Animal feeds, Piglets, Acidifier, Potassium diformate

INTRODUCTION

Organic acids have been used for decades in commercial compound feeds, mostly in feed preservation, where formic and propionic acids are particularly effective. In the European Union, these two organic acids and a number of others (lactic, citric, fumaric and sorbic acids) and their salts (e.g. calcium formate, calcium propionate) are used under the classification

‘feed preservatives’. Experience has shown that acidifiers are the most reliable product group of the non-antibiotic growth promoters available in Europe and can also be used safely and effectively with other additives. The main mode of action of organic acids is through their antimicrobial effects, the magnitude of which is dependent on the chemical properties of the individual acid or acid salt. This was, for instance, reviewed by Freitag (2007) and Theobald and Lückstädt (2011).

Although growth performance benefits have been shown in numerous studies over the past half-century (Cole et al., 1968); the ban on antimicrobial growth promoters in the European Union in 2006 resulted in an increased scientific focus on organic acids. Even before the ban, a double salt of formic acid – potassium diformate (FORMI) had generated sufficient data to support its approval as a ‘growth promoter’ (now called “zootechnical additive”) under Council Directive 70/524/EEC in 2001 (Øverland, 2001). Achieving this approval required that the growth promoting effects had been established under a range of practical conditions across Europe. Potassium diformate is currently the only acidifier which can legally claim performance enhancing effects in the whole pig production chain, thus covering sows, piglets and fatteners. At weaning, piglets are particularly susceptible to infection with intestinal pathogens, as well as being inadequately equipped physiologically to deal with solid feed. The buffering capacity of weaning feeds is also high, compounding the problem through a negative effect on pepsin activity in the stomach (Eidelsburger et al., 1992), a problem that is addressed through the acidification of the diet.

In diets for grower-finisher pigs, the antimicrobial effect of organic acids in the feed (hygiene), stomach and small intestine is largely responsible for their performance-enhancing benefits. This has been shown repeatedly in trials under European conditions. Effective doses have been established that can improve productivity of pigs to levels comparable with antibiotic growth promoters (Øverland et al., 2000a). However, data on a direct comparison between potassium diformate and commonly used antibiotic growth promoters under Asian conditions are scarce. This formed the impetus for the current study.

MATERIAL AND METHODS

Eighty 28-day old weaned piglets with the same initial weight of 10.1 kg, as well as same gender and breed, were allocated to 4 equal groups with 20 piglets each. Piglets were kept at an experimental farm in Southern Vietnam for 28 days, receiving a commercial diet of 19% crude protein with 2975 kcal kg⁻¹ ME (Table 1).

Table 1 Proximate composition and energy content of basic piglet feed (diet 1) used in the trial

Composition	Content (%)
Dry matter	87.0
Crude protein	19.0
Crude fat	6.0
Calcium	1.0
Phosphorus	0.8
ME (kcal/kg)	2975.0

Diet 1 served as negative control, while diets 2 to 4 contained either 0.4% KDF, 300 ppm Bactrim or 120 ppm Colistin. Feed and water were available *ad libitum*. At the end of the trial, final weight, daily weight gain, feed conversion and the diarrhoea rate of piglets were obtained and analysed using ANOVA. A significance level of 0.05 was used in all tests.

RESULTS AND DISCUSSION

Piglets grew well during the 28-day trial period. No mortalities occurred during that time frame. The results are shown in Table 2. The final weight of piglets fed 0.4% KDF was significantly increased, whereas the inclusion of Bactrim or Colistin led only to intermediate results between the control and potassium diformate group. KDF-inclusion improved the final weight against the control by more than 11%. Furthermore, a numerical improvement of the feed conversion ratio by 16% was monitored – due to the design of the trial no statistics could be carried out. Finally, the overall days of diarrhoea per group were significantly reduced in the KDF-treatment from 49 d (control) to only 22 d. A likewise significant diarrhoea reduction was obtained in the Colistin-group, however this was not as pronounced as in the KDF-fed group.

Table 2 Performance parameters and diarrhoea rate of piglets fed KDF and different AGP*

	Negative control	0.4% KDF	Bactrim 300 ppm	Colistin 120 ppm
No. of piglets [n]	20	20	20	20
Final weight [kg]	23.3±2.8 ^a	26.0±2.3 ^b	24.6±3.1 ^{ab}	24.7±2.5 ^{ab}
ADG [g/d]	469	569	513	520
FCR	1.79	1.50	1.69	1.68
Days of diarrhoea [n]	49	22	33	25
Diarrhoea rate [%]	8.8 ^a	3.9 ^b	5.9 ^{ab}	4.5 ^b

*Means with different superscripts in rows are significantly different between treatments (P<0.05)

Economic analysis, based on the cost of feed, additive and medication over the course of the trial (to 56 days of age) for the weight gain reported, showed that KDF inclusion improved cost per kg weight gain by 14%, compared to the negative control. The antibiotic growth promoters Bactrin and Colistin produced an improvement in cost of only 6 and 7%, respectively.

There have been numerous previous reports of reduced pathogenic bacteria in pigs fed KDF. These reports have been associated with reductions in morbidity, including reduction in the count of coliforms in the GI-tract of pigs (e.g. Øverland et al., 2000b). Such findings are also commonly reported in conjunction with improved performance, especially weight gain and feed conversion, as reported by Eidelsburger et al. (2007). A holo-analytical model based all available trial data on acidifiers in pig diets ('Acipig' model, Rosen, 2008), showed that piglets in particular benefit from the effects of acidifiers, with improved productivity in those parameters of greatest importance to economic success. Analysis of potassium diformate data separately showed a significant improvement in performance in response to KDF inclusion into the diet, which was more pronounced than that achieved in the overall model (Lückstädt and Mellor, 2010).

The findings of the present study support the use of dietary potassium diformate as an effective and sustainable replacement for antibiotic growth promoters in post-weaned piglets under Asian conditions. Current findings suggest that KDF can be used to enhance growth and reduce post-weaning diarrhoea.

REFERENCES

- Cole, D. J. A., R. M. Beal and J. R. Luscombe. 1968. The effect on performance and bacterial flora of lactic acid, propionic acid, calcium propionate and calcium acrylate in the drinking water of weaned pigs. *Veterinary Record* 83:459-464.
- Eidelsburger, U., M. Kirchgessner and F. X. Roth. 1992. Zum Einfluss von Ameisensäure, Calciumformiat und Natriumhydrogencarbonat auf tägliche Zunahmen, Futteraufnahme, Futtermittelverwertung und Verdaulichkeit. 7. Mitteilung. Untersuchungen zur nutritiven Wirksamkeit von organischen Säuren in der Ferkelaufzucht. [Influence of formic acid, calcium formate and sodium hydrogen carbonate on dry matter content, pH value, concentration of carbonic acids and ammonia in different segments of the gastrointestinal tract. 7. Communication. Investigations about the nutritive efficacy of organic acids in the rearing of piglets]. *Journal of Animal Physiology and Animal Nutrition* 68:258-267.
- Eidelsburger, U., C. Wald and N. Portocarero-Khan. 2007. Effect of potassium diformate (Formi[®]) inclusion at two different dietary protein levels on performance and health of weaner piglets. In: *Proceedings of the 6. BOKU Symposium Tierernährung, Vienna, Austria*, pp. 248-253.

- Freitag, M. 2007. Organic acids and salts promote performance and health. In: *Acidifiers in Animal Nutrition: A guide for feed preservation and acidification to promote animal performance* (Ed. C. Lückstädt). Nottingham University Press, UK, pp. 1-11.
- Lückstädt, C. and S. Mellor. 2010. Holoanalysis – the acid test in pig diets. *Kraftfutter / Feed Magazine* 1-2:18-21.
- Øverland, M., Z. Mroz, T. Granli and S. H. Steien. 2000a. Performance and mode of action of dietary potassium diformate for weanling pigs. In: *Proceedings of the 51st Annual Meeting of the EAAP, The Hague, Netherlands, August 21-24*.
- Øverland, M., T. Granli, N. P. Kjos, O. Fjetland, S. H. Steien and M. Stokstad. 2000b. Effect of dietary formates on growth performance, carcass traits, sensory quality, intestinal microflora, and stomach alterations in growing-finishing pigs. *J. Anim. Sci.* 78:1875-1884.
- Øverland, M. 2001. A simple salt approved as a growth promoter. *Feed Mix* 9 (4/5):25-28.
- Rosen, G.D. 2008. Holo-analysis of the efficacy of acids as pronutrients in pig nutrition. In: *Proceedings of the British Society of Animal Science 2008*, p. 85.
- Theobald, P. and C. Lückstädt. 2011. Experience on the usage of organic acids in swine diets in Europe. In: *Standards for acidifiers – Principles for the use of organic acids in animal nutrition* (Ed. C. Lückstädt). Nottingham University Press, UK, pp. 39-48.