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Effects of dietary potassium diformate on growth and gastrointestinal health in weaned piglets in Vietnam

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Abstract

Organic acids have been used for decades in commercial compound feeds, mostly in feed preservation. Potassium diformate (KDF) is currently the only acidifier which can legally claim performance enhancing effects in the whole pig production chain, thus covering sows, piglets and fatteners. The current study tested the efficacy of KDF under tropical conditions. Seventy eight 28-day old weaned piglets with an initial weight of ~8 kg, of the same sex and breed, were allocated to 3 equal groups with 26 piglets each. Piglets were kept for 28 days, receiving a commercial diet from 28 to 50 days of age with 19% crude protein (CP) and 3100 kcal/kg metabolisable energy (ME), while from day 50 onwards till the end of the trial (56 days of age), a diet containing 20.8% CP (3000 ME kcal/kg) was fed. Diet 1 contained no additive and served as negative control, while diets 2 and 3 contained 0.4% and 0.5% KDF respectively. 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, as well as pH-data from the gastro-intestinal tract were measured. The final weight of the piglets fed 0.4% and 0.5% KDF was significantly increased compared to the control ($P<0.05$). The lowest KDF inclusion improved the final weight compared to the control by more than 11%. Furthermore, a numerical improvement of the feed conversion ratio of at least 15% was monitored. Finally, the overall days of diarrhoea per group were significantly reduced with the KDF treatments from 40 days (control) to only 25 and 21 days, respectively. The findings of the present study support the use of dietary KDF as an effective and sustainable growth-promoter in post-weaned piglets.

Introduction

The use of organic acids in commercial compound feed has been common practice - at least in Europe - for several decades, 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 (e.g. 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. PAPATSIROS AND BILLINIS (2012) stated in this regard "…Dietary acidifiers can actually become the most common and efficacious alternative solution to antibiotics, in order to improve health status and performance in pigs." 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®, KDF) 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. During that stage, as reported by GABERT AND SAUER (1994), the nutritive effect of organic acids is most pronounced. The available data on the use of KDF in weaned piglets are mainly from Europe. The current study tested therefore the efficacy of KDF in post-weaning piglets under tropical conditions in Vietnam.

Material and Methods

Seventy eight 28-day old weaned piglets with an initial weight ranging from 8.0 to 8.3 kg, of the same sex and breed, were allocated to 3 equal groups with 26 piglets each. Piglets were kept at an experimental farm in Southern Vietnam for 28 days, receiving a commercial diet from 28 to 50 days of age with 19% crude protein (CP) and 3100 kcal/kg metabolisable energy (ME), while from day 50 onwards till the end of the trial (56 days of age), a diet containing 20.8% CP (3000 ME kcal/kg) was fed (Table 1).

Table 1: Proximate composition of experimental diets in %

	Basal-Diet I (28-50 days of age)	**Basal-Diet II (51-56 days of age)**
Moisture	14.0	14.0
Crude protein	19.0	20.8
Crude lipid	3.0	3.8
Calcium	0.8-1.25	1.0
Phosphorus	0.65	0.73
Metabolisable energy [kcal/kg]	3100	3000

The basal diets were fed to the 3 groups of pigs. The basal diets contained no additive and served as negative controls for the two age groups, while diets for the experimental groups contained, in addition, 0.4% or 0.5% KDF. 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, as well as pH-data from the gastro-intestinal tract were obtained and analysed statistically using ANOVA. Furthermore, an economic efficiency analysis was carried out.

Results and Discussion

The inclusion of potassium diformate led to significant changes in pH in the stomach and duodenum of piglets, while from the jejunum onwards only numerical differences could be monitored (Table 2). The 0.5% KDF dosage resulted in a significant reduction in stomach and duodenal pH by almost 0.6 units ($P<0.05$). This is in line with measurements on the postprandial flow rates of potassium and formic acids in duodenal digesta of weaned piglets after the ingestion

of KDF (MROZ ET AL., 2000). Furthermore, the fluctuation in the gastrointestinal pH of the piglets in the control group was greatly reduced in the KDF-treated piglets, thus providing stable conditions for the gastric-digestive processes.

Table 2: pH-values in the gastrointestinal tract of piglets fed with or without increasing levels of KDF

	Control	**0.4% KDF**	**0.5% KDF**
Stomach	4.74 ± 0.48^{a}	4.32 ± 0.13^{ab}	4.16 ± 0.18^{b}
Duodenum	6.23 ± 0.37^{a}	5.86 ± 0.11^{ab}	5.66 ± 0.15^{b}
Jejunum	6.66±0.59	6.58±0.08	6.25±0.13
Ileum	6.60±0.23	6.54±0.33	6.52±0.46
Colon	6.32±0.14	6.16±0.11	6.08±0.04

Means with a different superscript differ significantly at P<0.05

Mortality remained constant throughout the trial within the groups. In each group, 1 case was monitored (mortality rate 3.8%). The final weight of the piglets fed 0.4% and 0.5% KDF was significantly increased compared to the control (P<0.05) – Table 3. The lowest KDF inclusion improved the final weight by more than 11% compared to the control. Furthermore, a numerical improvement of the feed conversion ratio of at least 15% was monitored; the group with 0.5% dietary KDF had an improvement in FCR of almost 21%. These data are supported by a holo-analysis; an analytical model based on all available trial data on acidifiers, including KDF. The analysis of potassium diformate data separately showed a significant improvement in performance in response to KDF inclusion into the diet, (Rosen 2008, reported by LÜCKSTÄDT AND MELLOR, 2010).

Table 3: Performance parameters and diarrhoea measurements of post-weaning piglets fed with or without dietary KDF

	Control	**0.4% KDF**	**0.5% KDF**
Piglet [n]	26	26	26
Initial weight [kg]	8.04±0.73	8.26±0.75	8.08±0.67
Final weight [kg]	17.04 ± 1.81^{a}	18.96 ± 1.57^{b}	19.96 ± 2.83^{c}
Avg. daily weight gain [g d^{-1}]	321	381	411
FCR	1.84	1.56	1.46
Total days of diarrhoea [d]	40	25	21
Diarrhoea rate [%]	5.5^{a}	3.4^{a}	2.9^{b}
Cost (USD) / kg gain	0.47	0.41	0.37

Means with a different superscript differ significantly at P<0.05

The overall days of diarrhoea per group were significantly (P<0.05) reduced with the KDF treatments from 40 days (control) to only 25 and 21 days, respectively. As such the diarrhoea rate declined from 5.5% to only 2.9% – an improvement of 47%. Similar effects have been reported by DAZA ET AL. (2001). Finally, the reduced diarrhoea rate and the improved FCR led to lower veterinary costs and relatively reduced feed costs – thus the overall costs per kg-gain were consequently reduced by up to 21% or 10 USD cents.

Conclusions and Outlook

The findings of the present study support the use of dietary KDF as an effective and sustainable growth promoter in post-weaned piglets. Current findings suggest that KDF can be used to enhance growth and reduce post-weaning diarrhoea, as well as improve the overall economic productivity on-farm under tropical conditions.

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