EFFECTS OF POTASSIUM DIFORMATE INCLUSION IN BROILER DIETS ON GROWTH PERFORMANCE AND NUTRIENT UTILISATION

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Summary

Potassium diformate (K-diformate) is a possible substitute for antibiotic growth promotants in broiler diets. Four dietary treatments of 0, 3, 6 and 12 g/kg K-diformate were offered to 192 caged broilers. The feed additive increased feed intake (P<0.02) and tended to increase weight gain (P<0.07) from 1-35 days post-hatch. From 16-35 days post-hatch, K-diformate increased feed intake (P<0.01) and weight gain (P<0.05). The effect was most evident at 6 g/kg with respective increases of 9.3 and 5.3%, respectively. K-diformate did not enhance feed efficiency although it increased (P<0.03) apparent metabolisable energy (AME) and nitrogen (N) retention (P<0.05). AME was increased by 0.60 MJ/kg (DM) at 3 g/kg and N retention by 5.6% at 12 g/kg K-diformate. K-diformate shows some promise and further evaluation appears justified.

I. INTRODUCTION

The inclusion of organic acids and their salts, or ‘acidifiers’, in diets with high acid binding capacities for weaner pigs to enhance growth performance is commonly practiced (Partanan and Mroz, 1999). There appears to have been less interest by the chicken meat industry in the use of organic acids for growth promotion although some investigations into their effects on bird performance and their potential to reduce carcass contamination with Salmonella have been completed (Byrd et al., 2001). With the declining use of antibiotic growth promotants, there is an ongoing need to identify effective replacements. One candidate is K-diformate (Formi®) a chemical complex, where the carbonyl group of formic acid links with the hydroxyl group of potassium formate via a hydrogen bond, which dissociates to formic acid and potassium formate in the gut. K-diformate is a crystalline powder with low corrosive properties and a K content of 288 g/kg. As K-diformate is classified as a growth promoting feed additive for pigs in Europe, the purpose of this investigation was to determine if this chemical complex has potential for poultry. With this objective, the effects of graded K-diformate inclusion levels in broiler diets on growth performance and nutrient utilisation were determined.

II. MATERIALS AND METHODS

Conventional, wheat-based, starter and finisher diets, were offered to broilers from 1-15 and 16-35 days post-hatch, respectively with K-diformate concentrations of 0, 3, 6 and 12 g/kg. Potassium levels were held constant by balancing the K content of K-diformate with potassium carbonate and adjustments to energy density and amino acid specifications were made for the diluting effect of graded levels of K-diformate, which was added mainly at the expense of wheat.

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A total of 192 day-old, male, Cobb chicks were selected on the basis of body weights and housed in electrically-heated brooders initially and then transferred to wire-floored cages in an environmentally controlled facility. Throughout the feeding period, feed and water were available ad libitum under continuous fluorescent lighting. The diets were offered in mash form and feed intakes and weight gains were recorded for the two feeding phases. Mortalities were monitored daily and dead bird weights were considered in feed conversion ratio calculations.

From 19-22 days post-hatch total excreta output was collected to determine the effects of dietary treatments on AME and N retention as described by Selle et al. (2003). Also 500g excreta samples were dried to determine treatment effects on excreta dry matter. The experimental data from eight replicates of six birds per treatment was subject to analysis of variance and regression analysis using a general linear models procedure (SPSS Inc. Chicago, IL). Where the effect of treatments met the 5% level of probability, least significant differences were calculated and, where appropriate, the significance of pair-wise comparisons between specific treatments is presented.

III. RESULTS

The results of the experiment are shown in Table 1. Growth performance of birds from 1-35 days post-hatch was satisfactory with an average weight gain of 1834 g/bird and feed efficiency of 1.58. A total of 7 birds died (3.7%), the majority of the losses occurred during the first week but the mortality rate was not related to treatment (P>0.60). Graded inclusion levels of K-diformate did not influence growth performance in the starter phase, from 1-15 days post-hatch. However, in the finisher phase, from 16-35 days post-hatch, K-diformate significantly increased feed intake (P<0.01) and weight gain (P<0.05); however, feed efficiency did not differ significantly (P>0.10) between treatments. The most pronounced effects were observed at 6 g/kg K-diformate, with a 9.3% increase in feed intake (P<0.01) and 5.3% in weight gain (P=0.01). However, at this inclusion level, K-diformate was associated with 3.7% less efficient feed conversion (P=0.16).

Over the entire feeding period K-diformate significantly increased feed intake (P<0.02) and tended to improve weight gain (P<0.07). Again, the most pronounced effects were observed at 6 g/kg K-diformate with increases in feed intake of 8.7% (P<0.01) and in weight gain of 5.8% (P=0.01). However, numerically feed efficiency was 2.5% inferior although this difference was not significant (P=0.22). K-diformate increased AME of diets (P<0.03). This was most evident at 3 g/kg, with an increase of 0.60 MJ/kg (P<0.01) and at 12 g/kg with an increase of 0.48 MJ/kg (P=0.021) on a dry matter basis. K-diformate enhanced N retention (P<0.05) with a 5.6% increase (53.8 to 56.8%) at 12 g/kg (P=0.02). K-diformate did not increase excreta moisture; in fact the feed additive tended to increase dry matter content of excreta (P=0.08).

K-diformate linearly increased N retention (r=0.389; P<0.03); however, this was the only parameter where the feed additive had a significant linear effect. The lack of linear responses to K-diformate inclusion is of interest.
Table 1: Effects of K-diformate on growth performance from 1-35 and 16-35 days post-hatch, AME, nitrogen retention and excreta dry matter.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Potassium diformate (g/kg)</th>
<th>Significance (P =)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Growth performance (1-35 days post hatch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight gain (g/bird)</td>
<td>1785</td>
<td>1808</td>
</tr>
<tr>
<td>Feed intake (g/bird)</td>
<td>2836&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2800&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>FCR (g/g)</td>
<td>1.59</td>
<td>1.55</td>
</tr>
<tr>
<td>16-35 days post hatch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight gain (g/bird)</td>
<td>1478&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1488&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Feed intake (g/bird)</td>
<td>2426&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2380&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>FCR (g/g)</td>
<td>1.64</td>
<td>1.60</td>
</tr>
<tr>
<td>AME (MJ/kg DM)</td>
<td>13.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.33&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>N retention (%)</td>
<td>53.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>55.1&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Excreta dry matter (%)</td>
<td>29.9</td>
<td>31.6</td>
</tr>
</tbody>
</table>

<sup>abc</sup> within rows, means without common superscripts are significantly different (P < 0.05)

LSD (P < 0.05): 1178, 260.9, 3159, 0.40, 52.35

IV. DISCUSSION

The use of antibiotic growth promotants (AGP) to enhance pig and poultry performance is meeting increasing opposition and it is being recommended that this practice should be discontinued. The mechanisms by which AGP improve growth performance are poorly understood although antibiotic-induced modifications of the gut microflora that are favourable to the host are thought to be involved (Anderson et al., 2000). As organic acids and their salts possess antimicrobial properties they have been given consideration as potential substitutes for AGP. For example, Byrd et al., (2001) reported that 5 g/kg formic acid in drinking water reduced the Salmonella population of the crop in broilers by 35% in association with a decline from 5.77 to 4.80 in crop pH.

It has been demonstrated that fumaric acid reduces the bacterial population in the small intestine (Vogt et al., 1981). At 1.25 g/kg fumaric acid significantly increased weight gain by 4.1% and feed intake by 5.2% of mixed-sex chicks in a 49-day feeding study under simulated commercial conditions, with birds kept on litter (Skinner et al., 1991). In a second experiment with male chicks, fumaric acid significantly increased gain and feed conversion by 4.3 and 4.4%, respectively. Pattan and Waldroup (1988) also found that fumaric acid positively influenced bird performance but since the initial investigations by Vogt et al. (1979, 1981, 1982) there have been few such reports where organic acids have been shown to enhance performance. As discussed by Waldroup et al. (1995) the unreliable effects of organic acids in poultry may be associated with the fact that they are metabolised in the foregut (crop, gizzard, proventriculus), which would limit their antimicrobial activity in the small and large intestines.

The positive influence of K-diformate on AME and N retention at 3.0 and 12.0 g/kg is noteworthy. Similar assessments may not have been previously reported in broilers but there are precedents in swine. Formic acid enhanced total tract energy digestibility at 18 and 24 g/kg (Eckel et al., 1992) and improved nitrogen balance at 13.8 g/kg (Mroz et al., 1997) in weaner and grower pigs, respectively. In the present study, however, K-diformate did not
positively influence nutrient utilisation at 6.0 g/kg, which appears to be associated with increased feed intakes and, in turn, reductions in feed efficiency. The overall lack of linear responses to graded inclusion levels of K-diformate is a curious observation and may indicate that the feed additive has more than one mode of action. The definition of appropriate K-diformate inclusion rates is an area that merits future investigations.

In the present study broilers were reared under 'clean' conditions in wire-floored cages. It is likely that broilers kept on litter, as was the case in the Skinner et al. (1991) study, would be subject to a greater microbial challenge and may be more responsive to organic acids. Thus evaluations of K-diformate may be more instructive with birds kept on litter. It is possible that K-diformate would reduce crop pH. It is interesting that Murai et al. (2001) reported that glutamic acid reduced crop pH from 6.0 to 5.4 and that this was associated with enhanced efficacy of exogenous phytase as assessed by bone mineralisation. The interaction between organic acids and exogenous phytases has been investigated in swine, although the results lack consistency. Nevertheless, parallel studies in broilers appear justified because organic acids may facilitate the hydrolysis of dietary phytate by supplementary phytase in the crop.

REFERENCES


