EFFECTIVENESS OF ALTERNATIVE FEED SUPPLEMENTS TO BROILER DIETS USING A NECROTIS ENTERITIS CHALLENGE MODEL

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Summary

The effects of two alternative feed supplements (enzyme and organic acids) on mortality, growth performance and intestinal lesions of broiler chickens using a NE challenge model were investigated. The effects of these supplements were evaluated against a negative control (no additives) and a positive control (with monensin and Zn-Bacitracin). Birds fed Alternative A (enzyme) had bodyweights and FCR similar to the positive control group and had significantly higher bodyweight and improved FCR compared to the birds fed the negative control diet. There were only small numerical improvements observed compared to the negative control group when Alternatives B or C (organic acids) were added.

I. INTRODUCTION

The general fear of the development of antibiotic resistant “super-bugs” as a result of the overuse of antibiotic growth promotants (AGP) in animal production led to an increasing demand by consumers to ban AGP for use in animal feed. In 1999 the European Union (EU) restricted the use of AGPs and in late 2003 the EU announced a complete ban on all AGPs in animal feed. Although in Australia growth promotants are still registered, it has been recommended that “alternatives to antibiotics be researched and developed to control bacterial diseases and improve feed utilisation” (Grimes, 2000).

One of the most common and financially devastating bacterial diseases in modern poultry flocks is necrotic enteritis (NE). Necrotic enteritis was first described by Parish (1961) and is caused by the α-toxin of Clostridium perfringens (CP) types A and C. Damage to the intestinal mucosa through coccidial infection or a change in the normal intestinal microflora predisposes birds to the proliferation of CP (Al-Sheikhly and Al-Saieg, 1980). In its clinical form the disease results in high mortality and has to be prevented or treated immediately with antibiotics such as penicillin, virginiamycin, bacitracin, or tylosin (Watkins et al., 1997). However, in its subclinical form the disease is much more financially damaging for the producer. Symptoms such as wet litter, diarrhoea and a small increase in mortality of less than 1% are often overlooked. However damage to the intestine and the subsequent reduction in digestion and absorption can reduce weight gain by more than 200g (van der Sluis, 2000) and feed conversion ratio at 35 days of age by up to 10 conversion points (Kalbhusdal and Løvland, 2000).

It has been documented that nutritional management such as lowering the inclusion rate of fishmeal, wheat or barley in the diet may prevent NE (Ficken and Wages, 1997). Furthermore, Hofacre et al. (2003) reported that the inclusion of a lactic acid producing bacterial culture and complex carbohydrates in broiler diets can effectively reduce the severity of an NE infection and can reduce the subclinical effects of a C. perfringens infection on broiler performance and mortality. These effects are believed to be the result of selective modulation of the natural gut microflora and the inhibition of the proliferation of CP.

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There are numerous supplements commercially available which claim to be effective in altering the intestinal microflora. However, there has been little work to determine the effectiveness of alternative supplements to prevent the occurrence of subclinical NE.

The objective of the current study was to evaluate the effects of four supplements on mortality, growth performance, intestinal lesions and the occurrence of \textit{C. perfringens} in the small intestine of broiler chickens using a NE challenge model.

II. MATERIALS AND METHODS

A total of 150 male broiler chickens (Cobb) were purchased from the local hatchery, weighed in groups of 30 and placed in six floor pens in a climate controlled room. The treatment groups were: 1) negative control (no additives); 2) positive control (with monensin and \textit{Zn}-Bacitracin); 3) Alternative A (enzyme) 0.5kg/t; 4) Alternative B (acidifier A) 2.5 kg/t; and 5) Alternative C (acidifier B) 2.5kg/t. All supplements were kindly supplied by Kemin Industries, Singapore.

Birds were fed five experimental basal diets based on wheat (47%), oats (15%), peas (7.5%) and SBM (19%) from d 0 to 7. From d 8 to 14 birds received a high protein diet based on 40% fishmeal, 45% wheat and 10% oats with the full dosage of additives. On d 14 all high protein feed was removed and replaced with the experimental basal diets.

The challenge model used in this study consisted of serial oral inoculation with \textit{Clostridium perfringens} (approx. \(2 \times 10^5\text{cfu/ml}\)) on days 14, 15 and 16. All birds were wing tagged and bodyweight gain was measured individually on d8, d14, d21, d28, d35 and d42. Feed consumption and feed conversion ratio was measured on a pen basis on days 8, 14, 21, 28, 35 and 42. Necropsies of all mortalities were conducted to determine the cause of death.

On d 18 and 21 six birds from each pen were killed by cervical dislocation. Ileal digesta from two birds was pooled and the numbers of colony forming units of \textit{CP} (cfu) per g of digesta was determined. At the same time the small intestine of each bird was examined for the level of NE intestinal lesions according to the scoring table of Prescott (1979).

SAS systems (SAS Institute Inc., 2001) was used to perform the statistical analyses in this study. Data were analysed according to the GLM procedure for ANOVA. Duncan’s multiple-range test was used to separate means when significant effects (\(P<0.05\)) were detected by analysis of variance.

III. RESULTS AND DISCUSSION

Birds in the negative control group without a supplement had significantly lower (\(P<0.05\)) bodyweight and numerically increased FCR compared to birds in the positive control group with monensin and \textit{Zn}-Bacitracin (Tables 1 and 2). Furthermore, mortality as well as intestinal \textit{CP} counts and NE lesion scores were significantly higher (\(P<0.05\)) in the negative control compared to the positive control group (Table 3). These findings are consistent with data from the literature which showed that inoculation with \textit{CP} and the subsequent production of the \(\alpha\)-toxin results in reduced growth, increased feed conversion and higher mortality (Kaldhusdal and Løvland, 2000, Köhler, 2000).

There were significant differences among treatments for bodyweight gain and average daily weight gain. Birds fed Alternative A (an enzyme product) had significantly higher (\(P<0.05\)) and numerically lower FCR than the negative control and comparable to those fed monensin and \textit{Zn}-Bacitracin (positive control). It has been demonstrated that the inclusion of xylanase in wheat-based diets significantly reduced the bacterial population in the small intestine (Apajalahti and Bedford, 2000) and in particular the numbers of \textit{CP} (Choc and Sinlae, 2000). The results of this study confirm that the addition of an enzyme supplement
(Alternative A) reduced digesta viscosity in the small intestine which significantly inhibited the proliferation of CP and subsequently reduced the severity of the NE challenge (Table 3).

Table 1. Effects of supplements on bodyweight and average daily weight gain

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Bodyweight (g/bird)</th>
<th>Average daily weight gain (g/bird)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8d</td>
<td>21d</td>
</tr>
<tr>
<td>Positive Control (PC)</td>
<td>155</td>
<td>658</td>
</tr>
<tr>
<td>Negative Control (NC)</td>
<td>150</td>
<td>525</td>
</tr>
<tr>
<td>Alternative A</td>
<td>187</td>
<td>650</td>
</tr>
<tr>
<td>Alternative B</td>
<td>175</td>
<td>608</td>
</tr>
<tr>
<td>Alternative C</td>
<td>172</td>
<td>597</td>
</tr>
<tr>
<td>Means</td>
<td>166</td>
<td>602</td>
</tr>
<tr>
<td>SEM</td>
<td>3.6</td>
<td>18.4</td>
</tr>
</tbody>
</table>

Source of variance: Probability of greater F value in analysis of variance:

Diet: *** ** *** *** *** ***

a,b,c Values with unlike superscripts differ significantly (P<0.05)
2 ** P<0.01, *** P<0.001

Table 2. Effects of supplements on feed conversion ratio and mortality (measured/ pen)

<table>
<thead>
<tr>
<th></th>
<th>FCR 0-8d</th>
<th>8-21d</th>
<th>21-42d</th>
<th>0-42d</th>
<th>Mortality related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Control (PC)</td>
<td>1.379</td>
<td>1.474</td>
<td>1.827</td>
<td>1.726</td>
<td>0/30</td>
</tr>
<tr>
<td>Negative Control (NC)</td>
<td>1.434</td>
<td>1.760</td>
<td>2.141</td>
<td>2.028</td>
<td>3/30</td>
</tr>
<tr>
<td>Alternative A</td>
<td>1.377</td>
<td>1.680</td>
<td>1.838</td>
<td>1.778</td>
<td>1/30</td>
</tr>
<tr>
<td>Alternative B</td>
<td>1.372</td>
<td>1.637</td>
<td>2.066</td>
<td>1.931</td>
<td>0/30</td>
</tr>
<tr>
<td>Alternative C</td>
<td>1.361</td>
<td>1.626</td>
<td>2.047</td>
<td>1.913</td>
<td>1/30</td>
</tr>
<tr>
<td>Means</td>
<td>1.364</td>
<td>1.630</td>
<td>2.008</td>
<td>1.891</td>
<td>total 5/180</td>
</tr>
</tbody>
</table>

Birds fed Alternative B had similar bodyweight to the positive control however feed conversion was not improved. The addition of both alternatives A and B resulted in a significant reduction in the number of CP in the small intestine immediately after the challenge (18d). Alternatives C had only small numerical increases in bodyweight and FCR compared to the negative control, and these were also seen for the intestinal CP count and NE lesion score (18d).
Table 3. Effects of supplements on intestinal viscosity, intestinal count of \textit{C. perfringens} and lesion score on d18 and d21

<table>
<thead>
<tr>
<th></th>
<th>Viscosity</th>
<th>18d</th>
<th>21d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cP</td>
<td>cfu/g digesta (*10^8)</td>
<td>lesion score</td>
</tr>
</tbody>
</table>
| Positive Control (PC) | 10.6$^{abc}$ | >0.01$^c$ | 0.04$^b$ | >0.01 | 0.00$^b$
| Negative Control (NC) | 13.6$^{abc}$ | 2.03$^a$ | 1.71$^a$ | 1.23 | 0.88$^{ab}$
| Alternative A | 3.1$^c$ | 0.86$^b$ | 0.79$^{ab}$ | 1.10 | 1.46$^a$
| Alternative B | 19.5$^a$ | 0.85$^b$ | 0.96$^{ab}$ | 0.65 | 1.13$^a$
| Alternative C | 12.8$^{ab}$ | 1.86$^a$ | 1.13$^a$ | 1.87 | 1.13$^a$
| Means | 11.7 | 1.24 | 0.99 | 0.92 | 0.92 |
| SEM | 0.48 | 0.37 | 0.47 | 0.34 |

Source of variance: \*
Probability of greater $F$ value in analysis of variance: *** ** 0.06 *

$^{a,b,c}$ Values with unlike superscripts differ significantly (P<0.05)

2 * P<0.05, ** P<0.01, *** P<0.001

Based on the results of this study it appears that the reduction in broiler growth performance as a result of a sub-clinical \textit{Clostridium perfringens} infection could be partially overcome when feed enzymes (Alternative A) are added to the diet. However, NE is a complex multifactorial disease with many unknown factors and any of the alternative feed supplements will have to be combined with strict hygiene management and good husbandry practices to maintain broiler performance and control the occurrence of the disease.

REFERENCES