Effect of betaine source on nutrient utilisation of broilers challenged with coccidia

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Introduction

Coccidiosis is an expensive disease, with an estimated cost to the world’s poultry industry of 2.3 billion € per year (DE GUSSEM, 2007). Around 80% of these costs are due to losses in performance and the rest are due to the costs of prophylaxis and treatment (VERMEULEN et al., 2001). DE GUSSEM (2007) attributed this big loss in performance to the difficulty in diagnosis of subclinical coccidiosis and therefore the possibility to control it. Coccidial infection in broilers results in diarrhoea and osmotic stress in the intestine suggesting the need for information on molecules that may have a role in osmoregulation (KETTUNEN et al., 2001).

Betaine is known to be the most effective organic osmoprotectant (RATRIYANTO et al. 2009). Consequently, betaine improves intestinal water balance and reduces performance losses of broilers exposed to coccidiosis (RATRIYANTO et al. 2009). However, most of the early studies on betaine were conducted using natural betaine and there is lack of data comparing the natural source of betaine and the synthetic sources on nutrient digestibility of broilers exposed to coccidia challenge.

Materials and methods

384 1-d-old broiler chicks (Ross 308) were randomly assigned to 6 dietary treatments (8 cages/treatment of 8 male broilers each). The dietary treatments were 1) Unchallenged control sufficient in methionine, 2) Challenged control sufficient in methionine, 3) Challenged control reduced in methionine (CC), 4) CC supplemented with natural betaine, 5) CC supplemented with betaine HCl, and 6) CC supplemented with synthetic anhydrous betaine. On day 14, birds fed treatments 2-6 were challenged with coccidia. In the challenged groups, each bird received mixed inocula of species from a recent field isolate, containing approximately 180,000 Eimeria acervulina, 6,000 E. maxima and 18,000 E. tenella oocysts. All betaine products were added to supply 960g betaine/tonne of feed. On day 21, ileal digesta was collected and analysed for indigestible marker (titanium oxide), energy and 17 amino acids (AA; Asp, Thr, Ser, Glu, Pro, Gly, Ala, Val, Ile, Leu, Tyr, Phe, His, Lys, Arg, Cys, Met) to determine digestibility. Data were analysed by one-way ANOVA using the GLM procedure of SAS (2004).

Results

The influence of dietary treatments on the nutrient digestibility is summarised in Table 1. Coccidia challenge reduced (P<0.05) the average AA digestibility and ileal digestible energy (IDE) compared to the unchallenged control. Natural betaine supplementation resulted in no effect (P>0.05) of coccidia challenge on average AA digestibility and IDE compared to the unchallenged control. In contrast, birds fed the synthetic betaine sources had lower (P<0.05)
average AA digestibility and IDE compared to the unchallenged control. No differences \((P>0.05)\) between betaine sources were observed on average AA digestibility and IDE.

Table 1. Ileal digestible energy (IDE), ileal methionine digestibility (%) and average amino acids (AA) digestibility (%) of 21 day old broilers as influenced by coccidia challenge and betaine source supplementation

<table>
<thead>
<tr>
<th></th>
<th>Unchallenged control</th>
<th>Challenged control</th>
<th>Challenged control - reduced methionine (CC)</th>
<th>Natural betaine (CC)</th>
<th>Synthetic anhydrous betaine (CC)</th>
<th>Betaine HCl (CC)</th>
<th>SEM²</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDE (MJ/kg DM)</td>
<td>13.38ᵃ</td>
<td>8.80ᶜ</td>
<td>8.91ᶜ</td>
<td>12.41ᵇ</td>
<td>11.93ᵇ</td>
<td>11.89ᵇ</td>
<td>0.34</td>
</tr>
<tr>
<td>Methionine</td>
<td>90ᵃ</td>
<td>72ᶜ</td>
<td>66ᵈ</td>
<td>79ᵇ</td>
<td>77ᵇ</td>
<td>76ᵇ³</td>
<td>1.5</td>
</tr>
<tr>
<td>Average AA</td>
<td>81ᵃ</td>
<td>58ᵈ</td>
<td>62²</td>
<td>76ᵇ³</td>
<td>74ᵇ</td>
<td>73ᵇ</td>
<td>1.7</td>
</tr>
</tbody>
</table>

ᵃᶜ Means within a row without a common superscript are significantly different \((P<0.05)\)

¹ Each value represents the mean of eight replicates (8 birds per replicate).

² Pooled standard error of mean.

**Discussion**

Coccidiosis is known to cause diarrhoea and malabsorption of AA, carbohydrates and micro nutrients (METZLER-ZEBELI et al., 2009). In agreement, the current study showed that challenging the birds with coccidia reduces AA digestibility and ileal digestible energy. During coccidia challenge, oocysts infect the cells of the intestinal lining causing tissue damage which results in changes in the morphology of the intestine such as an increase in the crypt to villus height ratio (KETTUNEN et al., 2001). This change in intestinal morphology may explain, partly, the reduction in nutrient digestibility. On the other hand, betaine decreases the crypt to villus height ratio both in healthy and challenged broilers (KETTUNEN et al., 2001) which may explain the improvement in nutrient digestibility observed in the current study. This protective effect of betaine on the intestinal mucosal structure during coccidial infection can be explained by both functions of betaine as an osmolyte and as a methyl group donor. It is believed that damaged tissues require more methyl groups than healthy tissues (CHIANG et al., 1996).

Most of the early studies on betaine were conducted using natural betaine and there is lack of data comparing the natural source of betaine and the synthetic sources. The current study showed no significant differences between the different betaine sources on nutrient digestibility under coccidia challenge. However, only the birds on the natural betaine treatment were able to fully recover the reduction in nutrient digestibility (IDE and average AA) caused by the coccidia challenge as indicated by the lack of significant differences in digestibility between the unchallenged control and the birds fed the natural betaine. The exact mechanism for the differences in degree of response between the betaine sources is not clear which warrants the need for further trials.

**Conclusions**

The results of the current study suggested that although all betaine sources were able to improve nutrient digestibility compared to the challenged control, only the birds fed the natural betaine were able to fully recover the reduction in nutrient digestibility caused by the coccidia challenge.
References


