Effect of dietary natural betaine on broiler breeder hen performance and egg quality characteristics

Nicole Heberle¹, Natasha Edwards¹, David Cadogan², Stuart Wilkinson², Robert Hughes³ and Philip Hynd¹

¹School of Animal and Veterinary Sciences, University of Adelaide, Roseworthy SA 5371 Australia
² Feedworks, PO Box 369, Romsey, Vic 3434 Australia
³ South Australian Research and Development Institute, Roseworthy, 5371, SA, Australia

Presenting author: Natasha Edwards natasha.edwards@adelaide.edu.au

Summary

The effect of dietary natural betaine supplementation on broiler breeder hen performance was evaluated. In total, 630 Cobb 500 broiler breeder hens were allocated to one of three dietary treatment groups. The control diet was a standard basal broiler breeder diet and the two treatment diets were supplemented with natural betaine at either 1000ppm or 2000ppm. Hens were fed the diets for six weeks. Hens receiving betaine-supplemented diets gained more weight (p=0.006). The average weekly egg production of the hens receiving the 1000ppm and 2000ppm betaine-supplemented diets increased by 2.4 and 5.5% respectively (p<0.0001). The eggs from hens fed 2,000ppm betaine also had greater fertility (p<0.0001). Egg characteristic differences included a decrease in albumen weight (p=0.034) and eggshell thickness (p=0.001) and an increase in yolk:albumen ratio (p=0.009) of eggs from betaine-supplemented hens. Overall, breeder hens supplemented with 2000ppm betaine performed better than control or hens supplemented with 1000ppm betaine.

Introduction

Betaine is an amino acid derivative found naturally in high quantities in both plant and animal foods (Craig, 2004). Betaine is commercially available as an animal feed supplement.

Betaine is not an essential nutrient for poultry but is beneficial when added to the diet of physiologically-challenged birds (Kidd et al., 1997). Broiler breeder hens are subjected to a number of stressors, the most significant being a restriction of feed (up to 60% of their normal daily intake) and water intake. Hens are also expected to have a high egg laying performance. The additive effect of these stressors can be poor welfare for the hen.

Incorporation of betaine in the diet may alleviate the impact of these stressors and improve performance. The two main mechanisms of action proposed for betaine are as a methyl donor and as an osmolyte. Betaine provides methyl groups to substances critical in protein and energy metabolism and accumulates in cells and cell organelles to maintain water homeostasis (Kidd et al., 1997; Craig, 2004; Eklund et al., 2005).

We tested the hypothesis that betaine in the diet of broiler breeder hens would improve the quantity and quality of eggs produced.

Materials and Methods

Birds and Housing. A total of 630 Cobb 500 broiler breeder hens (Great Grandparent, heavy meat HiChick line) were housed in 45 pens (14 hens and one cockerel per pen). Each of the three dietary treatment groups were allocated to 15 pens which were repeated in blocks of three throughout the shed. The hens were 40 weeks of age at the commencement of dietary betaine supplementation. The diet was fed for six weeks. Hens were housed on litter with five nest boxes in each pen. Feed and water were restricted with hens receiving 164g and the cockerels 131g of feed, daily. Water was provided for 4-6 hours a day. Cockerels were fed the control diet. Hens were provided with 13 hours light and temperature of the shed was maintained at 25±3°C.

Subset hens. Three pens of hens from each dietary treatment group were closely followed. These hens were weighed weekly and all eggs they laid on Mondays were collected and egg characteristics measured (Table 2).

Dietary Treatments. All hens were fed a control diet (basal broiler breeder diet) until 40 weeks of age. From week 40, control hens and cockerels continued with the control diet and the two treatment groups were fed diets containing either 1000ppm or 2000ppm betaine (Betafin® S1, 96% natural betaine, Danisco Animal Nutrition, Marlborough, UK).

Performance measurements. Egg production from all pens was recorded daily. All eggs were candled to assess fertility. Hatchability was calculated as the number of viable chicks that hatched from known fertile eggs.

Statistical Analysis. Data were analysed using SPSS Statistics Version 21(IBM) using the GLM function. When treatment was significant (p ≤ 0.05) pairwise comparisons using the LSD were made. Results in tables are presented as estimates of means ± standard errors. Breeder hen data were analysed over the entire period, for breeder hen weight and lay percentage the week prior to the betaine being added to the diet was used as a covariate. Fertility, hatchability and mortality were analysed using the chi-squared method.

Results and Discussion

Hen weight. Both betaine-supplemented groups gained more weight than the control hens (p=0.006) (Table 1). An increase in the body weight of betaine-fed hens most probably reflects improved nutrient digestibility, due to osmolytic protection of intestinal cells (Lever and Slow, 2010). It is likely that broiler breeder hens that are water restricted may be in a state of dehydration and that the osmolytic function of betaine assisted with maintaining intestinal cell integrity.

ASAP Animal Production 2016, Adelaide
The effect of supplementing broiler breeder diets with 0, 1000 and 2000ppm on breeder hen egg quality characteristics

<table>
<thead>
<tr>
<th></th>
<th>Con 1000 ppm</th>
<th>2000 ppm</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW (g)</td>
<td>4.19b</td>
<td>4.25a</td>
<td>4.27a</td>
<td>0.02</td>
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<tr>
<td>Average weekly lay rate (%)</td>
<td>49.8c</td>
<td>52.2b</td>
<td>55.3a</td>
<td>0.7</td>
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<tr>
<td>Fertility (%)</td>
<td>86.9b</td>
<td>81.9c</td>
<td>88.4a</td>
<td>-</td>
</tr>
<tr>
<td>Hatch-ability (%)</td>
<td>87.5</td>
<td>88.0</td>
<td>86.8</td>
<td>-</td>
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</table>

Different superscripts refer to significant differences within a row

Average weekly rate of lay %. There was a treatment effect of both 1,000 and 2,000ppm betaine with a significant increase of 2.4 and 5.5%, respectively. The 2000ppm betaine fed hens laid more eggs than the 1000ppm betaine fed hens (p<0.0001) (Table 2). This betaine-induced increase in egg production has been reported in laying hens raised under a physiological stress including high ammonia (Gudev et al. 2011) and elevated temperature (Hasan and Abass, 2013).

Fertility. Hens fed 2000ppm betaine laid more fertile eggs (P <0.0001) (Table 2). The combination of improved lay percentage and fertility of represents a significant impact on reproductive performance. The osmolytic function of betaine is the likely reason for these improvements. Reducing the osmotic stress of the hen would allow for more efficient cellular function and ability to consistently produce fertile eggs under stress.

The fertility of eggs was assessed at day 14 of incubation. Embryos that had died were classified as fertile. The number of deaths in proportion to fertile eggs between groups was similar (data not presented). Eggs classified as infertile were not opened to determine if early embryonic development had begun. It is possible that early embryonic death was not identified. The control and 1000ppm betaine groups may have had more early embryonic deaths. A greater amount of betaine in the egg achieved with the 2000ppm diet may be required to provide osmotic protection of early embryos.

Hatchability. There was no difference in hatchability (p=0.683) (Table 2). In previous work betaine fed to hens at 2000ppm improved hatchability (Cadogan et al., 2014), however, the improved hatchability may have been due to an improved fertility which was not quantified in that study.

Egg Characteristics. Both betaine-supplemented groups had decreased albumen weight (p=0.034) and egg shell thickness (p=0.001) and an increased yolk:albumen ratio (p=0.009) (Table 2).

These differences are likely a reflection of the increase in bodyweight of the betaine-fed hens with others reporting that heavier hens have an increased yolk:albumen ratio and a reduction in proportion of eggshell (Perez-Bonilla et al., 2012).

Table 2. The effect of supplementing broiler breeder diets with 0, 1000 and 2000ppm on breeder hen egg quality characteristics

<table>
<thead>
<tr>
<th></th>
<th>Con 1000 ppm</th>
<th>2000 ppm</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg weight (g)</td>
<td>66.7</td>
<td>66.2</td>
<td>65.8</td>
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<tr>
<td>Egg width (mm)</td>
<td>44.3</td>
<td>44.4</td>
<td>44.2</td>
<td>0.1</td>
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<tr>
<td>Egg length (mm)</td>
<td>59.3</td>
<td>58.6</td>
<td>59.0</td>
<td>0.2</td>
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<tr>
<td>Yolk weight (g)</td>
<td>19.9</td>
<td>20.2</td>
<td>20.2</td>
<td>0.2</td>
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<tr>
<td>Albumen weight (g)</td>
<td>38.7a</td>
<td>37.8b</td>
<td>37.6b</td>
<td>0.3</td>
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<td>Yolk: albumen ratio</td>
<td>0.52b</td>
<td>0.54a</td>
<td>0.54a</td>
<td>0.01</td>
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<tr>
<td>Eggshell thickness (μm)</td>
<td>272a</td>
<td>264b</td>
<td>257b</td>
<td>3</td>
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<tr>
<td>Dry shell weight(g)</td>
<td>5.5</td>
<td>5.4</td>
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Conclusion

Natural betaine inclusion at levels of 1,000 and 2,000ppm in the diets of broiler breeder hens had significant positive effects on the body weight, lay percentage and fertility.

Acknowledgements

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References