OPTIMISING THE TIMING OF INCREASED CALCIUM IN THE DIET FOR LAYING HENS

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Summary

ISA Brown birds were provided with a pre-layer diet at either 16 weeks (Control) or 13 weeks (Treatment) of age. The treatment group had lower feed intake and egg weight throughout the laying life of the flock and significantly lower levels of sodium, potassium and ionised calcium in blood plasma at 60 weeks. There were no differences between the control and treatment groups in egg production, egg shell quality and faecal moisture levels. The two groups of birds responded similarly to water deprivation. There were negative effects of re-vaccination for infectious bronchitis late in lay (76 weeks of age) including an increased incidence of defective egg shells which appeared to be worse in the treatment group, and tendencies to higher faecal moisture and lower Haugh Units. Presentation of a pre-layer diet at too early an age may result in minor kidney damage that has later negative consequences if the birds are subjected to a challenge that affects the kidneys.

I. INTRODUCTION

Adequate calcium in the diet of laying hens is essential for birds to produce strong egg shells at the same time as maintaining adequate stores of calcium in their bones. The complex mechanisms of calcium metabolism in laying hens are still not completely understood (Hurwitz 1987, 1989; Etches, 1987). Medullary bone provides the most immediate source of stored calcium and the amount of medullary bone is influenced by calcium levels in the diet (Clunies et al., 1992). Mobilisation of calcium from the bones into the blood is an essential part of the process of egg shell formation. However, the overall regulation of the calcium levels in the body of the hen also involves the kidneys (Wideman, 1987).

The quantity of calcium in the grower diet is typically 10 g/kg whereas a level of 36 g/kg is normally included in a layer diet. Some producers place birds onto a prelayer (22 g calcium/kg) from several weeks prior to the arrival of the first egg until the birds have reached about 5% production. Over the past few years some Australian producers have used a combination of imported layer strains (which come into lay at 16-18 weeks of age) and Australian-bred strains which usually come into lay several weeks later. Where both types of strains occur on the same farm, sometimes all birds have been placed onto prelayer or layer diets at the same time. This has, on occasion, resulted in some birds receiving the higher level of dietary calcium up to 4-5 weeks prior to the onset of lay. Observations with broiler breeder hens have shown that providing diets with high calcium concentrations before the birds are able to utilise these larger amounts of calcium for egg production can have disastrous effects on the kidneys, resulting in kidney damage and even death. Previous studies (Leeson and Summers, 1997) have suggested that giving a prelayer ration to pullets too early prior to the onset of lay may result in subsequent persistent problems with wet droppings. It was hypothesised that these wet droppings may be due to damage to the kidneys of the birds as the result of the high levels of calcium in the diet at a time when the birds were not forming egg shells.

The present study investigated the effect of early presentation of a prelayer ration to ISA Brown laying hens on later egg production, egg shell quality, faecal moisture, and water

and electrolyte balance. It also assessed the responses of the control and treatment groups of birds to two situations of stress: water deprivation and revaccination for infectious bronchitis late in lay.

II. MATERIALS AND METHODS

Two hundred ISA Brown female chickens were received at 1-d old in May 1998. Birds were placed in brooders in an isolation laboratory and provided with commercial chick starter diet. At 6 weeks of age the birds were transferred to rearing cages in the University of New England Animal House. Birds were fed a commercial grower diet (10 g calcium/kg) from 6 to 13 weeks of age. At 13 weeks of age birds were transferred to a commercial-style layer shed and housed, individually, in California-style layer cages (used to house 3 birds in commercial situations). When birds were 13 weeks of age, the control group (100 birds) continued to receive the commercial grower diet. However, the treatment group (100 birds) received a prelayer diet containing 22 g calcium/kg. At 16 weeks of age the control group was also placed on the prelayer diet and at 19 weeks of age, when birds had reached 5% production, both groups were placed on a layer diet containing 36 g calcium/kg. At 17 weeks of age birds were exposed to a photoperiod of 12 h light and 12 h dark. Starting one week later, when birds were 18 weeks of age, the light period was increased by 30 min per week until the birds were receiving 16 h of light and 8 h of dark daily at 25 weeks of age. Birds were vaccinated at the hatchery for Marek’s disease and infectious bronchitis (IB). Vaccination for IB was repeated at 4 weeks and 12 weeks of age and vaccination for avian encephalomyelitis (AE) was given at 12 weeks of age. Beak trimming was conducted at 4 weeks of age.

Birds were housed individually and, throughout the experiments, replicates were individual birds. Egg production was monitored continuously and hen-day egg production calculated weekly. Feed intake was measured weekly and feed efficiency calculated. In addition, manure moisture was recorded for 48 birds of each group on one day each week. A sample of 48 birds from each group was weighed at 4, 6 and 12 weeks of age and then every 4 weeks for the duration of the experiment. Detailed measurements of egg and egg shell quality were made every two weeks throughout the experiment. Measurements made on the eggs were: egg weight, shell reflectivity (an indication of the colour lightness of the egg shells), egg shell breaking strength, shell weight, shell thickness, albumen height and Haugh Units, yolk colour and yolk weight. At 60 weeks of age, blood samples were collected from a sample of 20 birds from each treatment group. Haematocrit was determined and plasma analysed for osmolality and the concentrations of sodium, potassium and ionised calcium. Bone breaking strengths were measured on the humerus bones from five birds from each group at the end of the experiment using a Lloyd LRX Materials Testing Machine.

When birds were 80 weeks of age, a sample of birds from each of the groups was subjected to the challenge of water deprivation. Thirty-six birds from each of the control and treatment groups were maintained on drinking water ad libitum. An additional 36 birds from each group were deprived of water for a 48 h period. Egg production, egg shell quality and faecal moisture content were measured before, during and following the period of water deprivation. Plasma electrolytes were measured before and after the water deprivation.

Thirty-six ISA Brown laying hens of 76 weeks of age were taken from each of the control and treatment groups. Birds were then allocated to one of six groups, each of 12 birds: Group 1 (control group + sham vaccination); Group 2 (control + Steggles Strain IB No. 1 vaccine); Group 3 (control + Websters Vic S strain vaccine); Group 4 (treatment group + sham vaccination); Group 5 (treatment + Steggles vaccine); Group 6 (treatment + Vic S vaccine). Vaccines and sham (distilled water) were administered by eye drop.
III. RESULTS

Egg production over the laying life of the flock was similar for both groups. However, both feed intake and egg weight were consistently higher for the control group of birds (Figures 1 and 2). Interestingly, the higher egg weight of the control group in the present study resulted largely from a greater volume of albumen as neither yolk weight nor egg shell weight was higher in the control group. Body weight and faecal moisture content were the same for both groups throughout the laying life of the flock. Also, there were no differences in egg shell quality. For the blood samples taken at 60 weeks of age, the osmolality and concentrations of sodium, potassium and ionised calcium were all significantly higher in the control group (Table 1). Bone breaking strengths measured on the humerus bones resulted in a higher mean result for the treatment birds, although this was not statistically significant (P=0.08).

![Figure 1: Egg Weight](image1)

Control Group: Solid Line
Treatment Group: Dotted Line

![Figure 2: Feed Intake](image2)

Control Group: Solid Line
Treatment Group: Dotted Line

Table 1. Plasma osmolality and electrolyte concentrations at 60 weeks of age.

<table>
<thead>
<tr>
<th>Group</th>
<th>Plasma osmolality (mOsm/kg)</th>
<th>Plasma sodium (mmol/L)</th>
<th>Plasma potassium (mmol/L)</th>
<th>Plasma ionised calcium (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>322.6 ± 5.0a</td>
<td>149.3 ± 0.7a</td>
<td>5.44 ± 0.08a</td>
<td>1.59 ± 0.03a</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>301.5 ± 3.0b</td>
<td>136.7 ± 1.8b</td>
<td>4.90 ± 0.08b</td>
<td>1.29 ± 0.04b</td>
</tr>
</tbody>
</table>

*ab*Means within columns with different superscripts differ significantly (P<0.05).

Birds that were subjected to water deprivation had lower feed intake, egg production and faecal moisture levels during the period of water deprivation. Egg shell quality (percentage shell, shell thickness and breaking strength) was reduced and Haugh Units and yolk colour were increased. Haematocrit and plasma osmolality, sodium and chloride were elevated. However, these changes were similar for both control and treatment groups of birds.

Revaccination for IB resulted in more defective egg shells (cracked, wrinkled and soft-shelled) than were found in the birds which were not revaccinated and the incidence was greater for the treatment group, particularly with the Stegges vaccine (Table 2). There was also a tendency for lower Haugh Units and increased faecal moisture in the revaccinated birds.
Table 2. Percentage good and defective egg shells following re-vaccination for infectious bronchitis.

<table>
<thead>
<tr>
<th>Group</th>
<th>Good</th>
<th>Cracked</th>
<th>Soft Shelled</th>
<th>Wrinkled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control + sham</td>
<td>96.2±1.5×</td>
<td>3.8±1.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Control + Steggles</td>
<td>83.3±4.8×</td>
<td>4.0±1.7</td>
<td>3.6±2.9</td>
<td>9.1±3.4×</td>
</tr>
<tr>
<td>Control + Vic S</td>
<td>78.7±6.7×</td>
<td>6.6±2.0</td>
<td>5.1±3.4</td>
<td>9.6±6.7×</td>
</tr>
<tr>
<td>Treat + sham</td>
<td>94.8±1.4×</td>
<td>2.7±1.2</td>
<td>1.0±0.7</td>
<td>1.4±0.6×</td>
</tr>
<tr>
<td>Treat + Steggles</td>
<td>69.4±6.9×</td>
<td>7.7±3.4</td>
<td>4.6±3.2</td>
<td>18.4±5.4×</td>
</tr>
<tr>
<td>Treat + Vic S</td>
<td>81.6±3.2×</td>
<td>7.5±1.4</td>
<td>4.5±1.9</td>
<td>6.3±3.5×</td>
</tr>
</tbody>
</table>

×c Means within columns with different superscripts differ significantly (P<0.05).

IV. DISCUSSION

The results of the present study indicate that early presentation of a pre-layer diet had some long lasting effects on the performance of the flock, including consistently lower feed intake and egg weight. A similar effect on egg size was recorded by Leeson et al. (1986). In addition, there were significantly lower concentrations of sodium, potassium, ionised calcium and osmolality in the blood of the birds at 60 weeks of age.

However, egg production, egg shell quality and faecal moisture were not significantly affected. The water deprivation challenge tested the hypothesis that early presentation of pre-layer diet results in minor kidney damage which leaves the birds more susceptible to later challenges that involve the kidneys. However, the response to water deprivation was similar for both groups. The revaccination of birds that had not been vaccinated since they were 12 weeks of age increased the incidence of defective egg shells in both groups but to a greater extent in the treatment group, and had some negative effects on Haugh Units and faecal moisture. These negative effects support the observation that, if the titre levels of birds are allowed to fall, revaccination can negatively affect the kidneys and oviducts of birds. In conclusion, the provision of additional calcium to laying hens prior to the onset of lay needs to take into consideration the potential negative effects of providing additional calcium too early.

REFERENCES