EFFECOF ASTAXANTHIN-RICH ALGAL MEAL (H. PLUVIALIS) ON GROWTH PERFORMANCE, CAECAL CAMPYLOBACTER AND CLOSTRIDIUM COUNTS AND TISSUE ASTAXANTHIN CONCENTRATION OF BROILER CHICKENS

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Summary

Supplementation of the feed of female broiler chickens with natural astaxanthin (in the form of algal meal) slightly reduced feed conversion ratio but had no effect on live weight gain. At higher levels of inclusion, the algal meal reduced the caecal Clostridium count, whereas Campylobacter counts were unaffected by inclusion level. By increasing the inclusion level of algal meal, tissue astaxanthin concentrations were increased. Adding the algal meal as an oil suspension sprayed on to the feed pellets appeared to give higher tissue astaxanthin concentrations indicating better absorption of the carotenoid than when added as a powder. Tissue astaxanthin concentrations were higher in birds inoculated with Campylobacter than in uninoculated birds.

I. INTRODUCTION

Earlier experiments with broiler chickens have shown that algal meal with a high concentration of astaxanthin improved growth performance and increased tissue astaxanthin concentration (Inbarr and Lignell, 1997). In experiments with Helicobacter pylori-infected mice, treatment with algal meal significantly reduced the bacterial count in the stomach (Wang et al., 1998). Campylobacter spp are one of the most common causes of human diarrhoeal illness, and poultry is considered a major source of such infections (Blaser, 1983).

Necrotic enteritis (NE) is an enterotoxaemic disease in poultry, caused by Clostridium perfringens. The number of these bacteria in the chicken intestine is negatively correlated to weight gain (Stutz and Lawton, 1984), and numbers are dramatically elevated in birds suffering from NE (Kaldhusdahl and Hofshagen, 1992).

The aim of the experiment was to study the effects of dietary natural astaxanthin (Haematococcus pluvialis) on broiler performance during an experimental infection with Campylobacter jejuni. Broiler performance (growth, feed intake and feed conversion) and the colonisation of Campylobacter jejuni and Clostridium perfringens in the chicken caeca was recorded. In addition, tissue astaxanthin concentrations were measured.

II. METHODS

The experiment included 960 female broiler chickens, divided into 48 pens (0.75 x 1.5 m) with initially 20 chickens per pen. The birds had free access to water and the pelleted experimental diets from day-old to slaughter at 35 days of age. Wood shavings were used as bedding.

The experimental diets were supplied with either 0, 350, 1800 and 8950 mg algal meal (NOVASTA®)/kg feed, providing 0, 7, 36, or 179 mg astaxanthin/kg feed, respectively (giving a daily intake of approximately 0, 1, 5 or 25 mg astaxanthin/day at 5 weeks of age). In addition, two different inclusion methods of the astaxanthin were studied, including

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astaxanthin mixed into the pelleted feed or the same amount mixed with oil and sprayed on top of the pellets.

At 10 days of age the birds in half of the groups were inoculated with 1.6 x 10^8 *Campylobacter jejuni* per group via the drinking water. Control and challenged birds were separated and measures were taken to avoid cross infection. Thus, the experiment included 16 treatments (2 challenge/control x 4 inclusion levels of astaxanthin x 2 algae meal inclusion methods) with three replicates each.

Chicken live weight and feed intake were recorded regularly. Prior to inoculation and once a week after challenge (in total on four occasions) one bird per group was killed and caecal samples were taken for quantitative analyses of *Clostridium perfringens* and *Campylobacter jejuni*. In uninoculated groups random samples were taken for qualitative analysis of *Campylobacter jejuni*. At slaughter, samples of liver, kidney, breast muscle, abdominal subcutaneous fat, and intestines (mid-ileum) of three birds per treatment were collected and analysed for total carotenoid and astaxanthin concentration.

III. RESULTS

Feed conversion of birds given the highest dose of algal meal was significantly lower than that of birds of the control group and those given the lowest dose of astaxanthin. There were no differences in bird performance due to the method of algal meal mixing into the feed. However, up to 24 days of age birds inoculated with *C. jejuni* had lower live weights and feed intake than uninoculated birds. Feed conversion at 17 days was significantly higher (P<0.001) in inoculated birds. At 32 days of age there were no significant differences in performance between the treatment groups.

At 17 and 32 days of age, caecal *Clostridium* counts of birds on the two highest astaxanthin doses (5 and 25 mg/day at 35 days of age) were significantly (P<0.05) lower than that of birds fed 1 mg astaxanthin/day (Table 1).

At 32 days of age, *Clostridium* counts of birds fed 5 mg astaxanthin/day was significantly (P<0.05) lower than that of birds fed 0 and 1 mg astaxanthin/day. There were no difference in *Campylobacter* counts due to astaxanthin inclusion levels. However, spraying the algal meal mixed with oil significantly (P<0.03) reduced the caecal *Campylobacter* counts at 32 days (data not shown).

As shown in Figure 1, kidney tissue astaxanthin concentrations increased significantly with increasing levels of algal meal inclusion rates. Spraying the algal meal mixed with oil on to the pellets resulted in higher tissue astaxanthin concentrations than obtained through incorporation of the powdered algal meal into the diet. Tissue astaxanthin concentrations in the kidney (Figure 1), intestine and breast muscle were significantly (P<0.05) higher in inoculated birds.
Table 1. Effect of astaxanthin inclusion level (intake g/day), method of algal meal inclusion and *Campylobacter* inoculation on caecal *Clostridium* counts (log/g digesta).

<table>
<thead>
<tr>
<th>Age, days</th>
<th>Level of astaxanthin</th>
<th>Method of inclusion</th>
<th>Campylobac inoculation</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>1.70</td>
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<td>32</td>
<td>5.45</td>
<td>6.48</td>
<td>3.59</td>
<td>4.96</td>
</tr>
</tbody>
</table>

1 pooled values for all methods of incorporation and inoculated and non-inoculated values;
2 pooled values for inclusion levels and inoculated and non-inoculated;
3 pooled values for inclusion levels and methods of incorporation;
4 means in the same row with different superscripts are significantly (P<0.05) different.

![Graph](image)

* differs from level 0, P<0.001
# differs from inoculated, P<0.001
+ differs from powder, P<0.001

Figure 1. Astaxanthin concentration of kidney tissue for the different treatments.

**IV. DISCUSSION**

Adding algal meal to the feed did not influence broiler growth performance. Feed conversion ratio was slightly improved at higher inclusion rates. In contrast, inoculation with *Campylobacter* at 10 days of age reduced live weight gain up to 14 days after inoculation and increased FCR at day 17 but not thereafter. *Clostridium* counts appeared to be lower at higher inclusion rates of the algal meal, whereas *Campylobacter* counts were unaffected. These results are difficult to explain, and further studies are required to obtain an understanding of the mechanisms involved. As expected, tissue concentrations increased with increasing levels of inclusion of the algal meal. In general, applying the algal meal as an oil suspension by spraying it on to the pellets increased tissue astaxanthin concentrations. Since astaxanthin is a lipophilic compound, the absorption of astaxanthin in the intestine is likely to be improved by mixing it with oils and fats. Surprisingly, tissue astaxanthin concentrations appeared to be higher in inoculated birds.
V. CONCLUSIONS

The results indicate a possible Clostridium reducing effect of the algal meal, whereas Campylobacter counts were unaffected. Tissue astaxanthin and carotenoid concentrations increased with increasing levels of algal meal inclusion. Increased tissue astaxanthin levels were obtained in response to inoculation with Campylobacter jejuni and higher levels were obtained with the algal meal mixed with oil and sprayed on to the feed than added as a powder.

REFERENCES