Effect of supplementing different ratios of laminarin and fucoidan in the diet of the weaning piglet on performance, nutrient digestibility, and fecal scoring

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ABSTRACT: A 3 × 2 factorial experiment was conducted to investigate the effects of different ratios of dietary laminarin (LAM) and fucoidan (FUC) on growth performance and nutrient digestibility in newly weaned piglets. At weaning, 168 piglets (24 d of age; 6.8 kg live weight) were assigned to 1 of 6 dietary treatments (n = 14/treatment): (i) basal diet, (ii) basal diet + 240 mg/kg FUC, (iii) basal diet + 150 mg/kg LAM, (iv) basal diet + 150 mg/kg LAM and 240 mg/kg FUC, (v) basal diet + 300 mg/kg LAM, and (vi) basal diet + 300 mg/kg LAM and 240 mg/kg FUC. Pigs offered 300 mg/kg LAM-supplemented diets had a higher ADG (P < 0.05) throughout the entire experimental period (days 0–35) compared with pigs offered diets with 0 and 150 mg/kg LAM supplementation. There was a significant interaction between LAM and FUC supplementation on G:F (P < 0.05) during the entire experimental period. Pigs offered the 300 mg/kg LAM-supplemented diet had a higher G:F than pigs offered the basal diet. However, there was no effect of the high level LAM on G:F when combined with FUC. There was a significant interaction between LAM and FUC supplementation on the apparent total tract digestibility (ATTD) of GE (P < 0.05). Pigs offered the 150 and 300 mg/kg LAM diet had an increased ATTD of GE compared with pigs offered the basal diet. However, there was no effect of LAM on ATTD of GE when combined with FUC. Pigs offered the 150 and 300 mg/kg LAM-supplemented diets had an improved fecal consistency (P < 0.05) from day 7 to day 14 compared to pigs offered diets without LAM supplementation. In conclusion, the inclusion of LAM improved growth performance of pigs after weaning partially due to an increased ATTD of GE.

Key words: digestibility, fucoidan, laminarin, performance, pig

INTRODUCTION

The 2006 European Union prohibition of in-feed antibiotics has prompted the search for alternatives to reduce stress-associated problems in newly weaned pigs. Seaweed and seaweed extracts have been exploited as a novel source of bioactive compounds due to their biological properties (Reilly et al., 2008). O’Doherty et al. (2010) demonstrated that the inclusion of a combination of laminarin (LAM) and fucoidan (FUC) extract increased ADG and G:F of pigs after weaning mainly through increasing nutrient digestibility and decreasing Escherichia coli in the gut. The aim of this study was to establish the optimum ratio of LAM and FUC to promote growth performance in the weaned piglet. It is hypothesized that the inclusion of both LAM and FUC will improve pig performance after weaning due to the biological properties of LAM and FUC.

MATERIALS AND METHODS

All procedures described in this experiment were conducted under experimental license from the Irish Department of Health in accordance with the Cruelty to Animals Act 1876 and the European Communities (Amendments of the Cruelty to Animals Act 1976) Regulations.

Experimental Design and Dietary Treatments

The experiment was designed as a 3 × 2 factorial arrangement. One hundred and sixty-eight piglets were selected after weaning at 24 d (6.8 kg; SD = 0.6 kg) and blocked on the basis of weaning weight and within each block assigned to 1 of 6 dietary treatments. The pigs were

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offered the following diets for 35 d: (i) basal diet, (ii) basal diet + 240 mg/kg FUC, (iii) basal + 150 mg/kg LAM, (iv) basal + 150 mg/kg LAM and 240 mg/kg FUC, (v) basal + 300 mg/kg LAM, and (vi) basal + 300 mg/kg LAM and 240 mg/kg FUC. The LAM and FUC were derived from Laminaria spp. and sourced from BioAtlantis Ltd. (Tralee, Co. Kerry, Ireland). The level of LAM and FUC used in the current study was based on previous work by Reilly et al. (2008) and McDonnell et al. (2010). The basal diet contained 380 g/kg wheat (Triticum aestivum), 233.5 g/kg barley (Hordeum vulgare), 170 g/kg soya bean (Glycine max) meal, 120 g/kg full-fat soybean, 50 g/kg whey powder, 10 g/kg soya oil, 3 g/kg vitamins and minerals, 3 g/kg salt, 12.5 g/kg CaHPO₄, 11 g/kg limestone, 4.0 g/kg lysine HCL, 1.5 g/kg DL-methionine, and 1.5 g/kg L-threonine. Pigs were housed in groups of 5. Fresh fecal samples were collected daily from all pens on days 10 to 15 for the determination of nutrient digestibility using the AIA technique (McCarthy et al., 1977). Pigs were observed for clinical signs of diarrhea and a scoring system applied to indicate the presence and severity of diarrhea as described by Pierce et al. (2005). Feces scoring began on day 0 on the experimental diets and continued until day 35. The following feces scoring system was used: 1 = hard feces, 2 = slightly soft feces, 3 = soft, partially formed feces, 4 = loose, semiliquid feces, and 5 = watery, mucous-like feces.

Analyses

The proximate analysis of diets and feces for N and GE were carried out according to AOAC Int. (1995). Following collection of the feces, they were dried at 100°C for 48 h. The concentrates and dried feces were milled through a 3-mm hammer mill. The N content of both feed and feces was determined using the Leco FP 528 instrument (Leco, UK Ltd., Stockport, Cheshire, UK). The GE was determined using a Parr 1201 oxygen bomb calorimeter (Parr, Moline, IL). The data were analyzed as a 3 × 2 factorial using the GLM procedure of the Statistical Analysis Institute (SAS Inst. Inc., Cary, NC). The model used included the main effects of LAM and FUC supplementation and the associated interaction between LAM and FUC. The initial pig BW was included as a covariate for the performance analysis. The data are presented as least square means ± SEM.

RESULTS

Growth Performance

The effects of dietary treatment on pig performance are shown in Table 1. Pigs offered the 300 mg/kg LAM-supplemented diets had a higher ADG ($P < 0.05$) during the entire experimental period (days 0 to 35) compared with pigs offered diets with 0 and 150 mg/kg LAM supplementation. There was an interaction between LAM and FUC supplementation on G:F ($P < 0.05$) during the entire experimental period. Pigs offered the 300 mg/kg LAM supplemented diet had a higher G:F than pigs offered the basal diet. However, there was no effect of the 300 mg/kg LAM on G:F when combined to FUC.

Apparent Total Tract Digestibility and Fecal Scoring

The effects of dietary treatment on apparent total tract digestibility (ATTD) and fecal scoring are shown in Table 1. There was an interaction between LAM and FUC supplementation on the ATTD of GE ($P < 0.05$). Pigs offered the 150 and 300 mg/kg LAM diet had an increased ATTD of GE compared to pigs offered the control diet. However, there was no effect of the 300 mg/kg LAM on G:F when combined to FUC.

Table 1. Effect of dietary treatment on pig growth performance, digestibility coefficient, and fecal scoring after weaning

<table>
<thead>
<tr>
<th>Treatment</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAM, mg/kg</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FUC, mg/kg</td>
<td>0</td>
<td>240</td>
</tr>
<tr>
<td>Performance, days 0–35</td>
<td>0</td>
<td>0.340</td>
</tr>
<tr>
<td>ADG, kg/d</td>
<td>0.591</td>
<td>0.584</td>
</tr>
<tr>
<td>ADFI, kg/d</td>
<td>0.574</td>
<td>0.605</td>
</tr>
<tr>
<td>G:F, kg/kg</td>
<td>0.768</td>
<td>0.790</td>
</tr>
<tr>
<td>Digestibility coefficient</td>
<td>0.770</td>
<td>0.782</td>
</tr>
<tr>
<td>GE</td>
<td>3.67</td>
<td>3.35</td>
</tr>
<tr>
<td>N</td>
<td>3.79</td>
<td>3.19</td>
</tr>
<tr>
<td>Days 0–7</td>
<td>3.46</td>
<td>2.74</td>
</tr>
<tr>
<td>Days 14–21</td>
<td>2.77</td>
<td>2.30</td>
</tr>
<tr>
<td>Overall score</td>
<td>3.32</td>
<td>2.79</td>
</tr>
</tbody>
</table>

1Values are least square means.
2LAM = laminarin; FUC = fucoidan.
combined with FUC. Pigs offered the 150 and 300 mg/kg LAM-supplemented diets had increased the ATTD of N ($P < 0.05$) compared to pigs offered diets without LAM supplementation. Pigs offered the 150 and 300 mg/kg LAM-supplemented diets had a significantly lower fecal score ($P < 0.01$) from day 7 to day 14 compared to pigs offered diets without LAM supplementation. There was a significant interaction between LAM and FUC supplementation on fecal score from day 14 to day 21 ($P < 0.05$), day 21 to day 35 ($P < 0.05$), and during the overall experimental period ($P < 0.05$). Pigs offered the FUC diet had a reduced fecal score compared with pigs offered the basal diet. However, there was no further effect of FUC on fecal score when combined with 150 or 300 mg/kg LAM.

**DISCUSSION**

The inclusion of 300 mg/kg LAM increased both ADG and G:F of the pigs throughout the duration of the experiment. This improved performance may be partially attributable to the improved nutrient digestibility of the diets. In a study by O’Doherty et al. (2010), the supplementation of a seaweed extract containing LAM and FUC improved growth performance in weaned pigs. This improved performance concomitantly occurred with increased total tract nutrient digestibility. There was no positive effect of FUC supplementation on overall pig performance, which may be due to the pigs inability to completely hydrolysis FUC in the gut (Lynch et al., 2010).

In the current study, fecal scores were decreased in pigs fed the LAM-supplemented diets in the critical 7- to 14-d period after weaning. The pigs fed the diets supplemented with LAM and FUC had a lower fecal score, which may support the improvement in daily gain and G:F ratio achieved during the experimental period. Fecal scoring has routinely been considered an indicator of gut health with a lower fecal score considered beneficial for gut health (Pierce et al., 2005). Similarly, McDonnell et al. (2010) demonstrated that weaning pigs offered diets supplemented with LAM had reduced fecal *E. coli* counts. The interaction between LAM and FUC observed for some parameters in the present study suggests that their effects were not additive, and this may be due to different modes of action for each of the bioactives. In conclusion, the supplementation of 300 mg/kg LAM singularly seems the optimal inclusion level to increase growth performance partially through enhancing the nutrient digestibility of diets.

**LITERATURE CITED**


