THE INFLUENCE OF CARBOHYDRASE AND PROTEASE SUPPLEMENTATION ON AMINO ACID DIGESTIBILITY OF LUPIN-BASED DIETS FOR BROILER CHICKS

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Summary

An experiment was conducted to evaluate the effectiveness of xylanase, protease and cellulase on the nutritive value of lupin based diets for young broiler chicks. The lupins used were \textit{Lupinus albus} which were cultivated in the UK and incorporated as a ground mash at 400g/kg of diet. Apparent ileal digestibility coefficients for amino acids in the diet were about 0.85 for the untreated and protease treated diets but about 0.7 for the carbohydrase treated diets. The effects of enzymes on digestibility coefficients of amino acids did not reflect animal performance.

I. INTRODUCTION

Europe is not self-sufficient in protein for inclusion in animal diets and currently there is considerable consumer demand around the world, especially in the UK and Europe, to produce diets for animals that are free from animal proteins. The major leguminous component that contributes protein in poultry diets is soya bean meal. Other protein sources which are potential alternatives to soya bean meal include the seeds from legumes such as peas, beans and lupins which grow well in temperate and Mediterranean climates (Carre, 1997). They are also considered as environmentally friendly crops, fixing nitrogen. Of the three legume seeds mentioned, lupins tend to have the highest content of protein at 300-450 g/kg dry matter. They are thus of considerable interest to arable farmers in Europe as an alternative crop and also to nutritionists as a source of protein for inclusion in monogastric diets.

Of the cultivars that are grown commercially, \textit{Lupinus angustifolius} is produced in greatest quantity and primarily in Australia. \textit{Lupinus albus} tends to have a higher protein content and yield than \textit{L. angustifolius} and has been grown successfully in France and the UK. Low alkaloid cultivars of lupines have relatively few compounds that exhibit toxic or antinutritional characteristics. A limitation of legume seeds in general and lupins in particular, however, is their relatively high content (300-400g/kg) of a mixture of complex non-starch polysaccharides (NSPs). These compounds tend to have adverse effects when ingested by poultry (Carre, 1997). The major NSPs in lupins are α-galactosides and these vary in composition between lupin cultivars. They are attributed with adverse effects on intake of diets and digestibility of nutrients (Carre et al., 1985; Evans et al., 1993; Carre, 1997; Naveed et al., 1998; Ferraz de Oliveira, 1998). Other effects of increased dietary NSPs include increasing the viscosity of intestinal contents, increased litter moisture content and alteration of the profile of intestinal and litter microflora (Ferraz de Oliveira et al., 1994; Carre, 1997; Ferraz de Oliveira, 1998; Bedford and Schulze, 1998; Rubio et al., 1998).

Although the content of antinutritional and toxic proteinaceous compounds in lupins is very low the proteinaceous components of lupins tend to be somewhat refractory and thus

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tend to have relatively low digestibility coefficients (Cerletti et al., 1983; Ferraz de Oliveira and Acamovic, 1995; Carre, 1997; Ferraz de Oliveira, 1998).

The use of supplementary dietary enzymes in poultry diets to reduce the adverse dietary effects of NSPs and proteins in poultry diets is used widely with varying degrees of success (Bedford and Schulze, 1998). The success of such enzyme supplementation of lupin-based diets for poultry has had varying degrees of success in improving animal performance and nutrient utilisation and appears to be dependent on the type and quantity of lupins used in the diets as well as the enzymes used (Bryden et al., 1994; Ferraz de Oliveira and Acamovic, 1995; Annison et al., 1996; Ferraz de Oliveira, 1998; Naveed et al., 1998).

Since *Lupinus albus* has been produced in high yields in the UK, an experiment was conducted to investigate the efficacy of the use of carbohydrases and proteases in lupin-rich diets for broilers.

II. MATERIALS AND METHODS

The animal experiments were approved by the Animal Ethics Committee of SAC. Diets were formulated to meet the requirements of young broilers (NRC, 1994) and were designed to be marginally adequate in nitrogen and energy while being isonitrogenous and isoenergetic. The diets were formulated to contain 400g lupins/kg diet.

The lupins were grown in the UK and obtained from Dr. Ian Shield, IACR, Rothamstead, Herts. The enzymes used were Protease- P3X (from a selected strain of Bacillus), Xylanase-GC, Cellulase-BG (from controlled fermentation of selected Trichoderma species) and a mixture of the above three enzymes. The activity per gram of the product as determined was 100,000 protease units, 40,000 xylanase units and 4500 cellulase units respectively. The enzymes were added as supplements to the diets at 0.2, 0.05 and 0.5 g/kg respectively. One hundred and twenty 11-day-old, male broilers were randomly distributed among five treatments, using four birds per cage and six cages per treatment in such a way that the weight range was minimised within each tier.

Birds were fed the diets for 21-days (from 11 to 32 days of age) after which time the birds were euthanased by an overdose of pentobarbitone and a 30cm section (immediately anterior to the ileocaecal junction) of the ileum removed. The contents were carefully washed out of the intestines with distilled water into a petri dish, frozen, lyophilised and ground prior to analyses for Cr by atomic absorption of the oxidised Cr, and amino acids after hydrolysates, by HPLC. Digestibility coefficients of the amino acids were calculated and subjected to ANOVA according to the GLM procedure (Minitab 10.5).

III. RESULTS AND DISCUSSION

All birds survived the experimental period in good health. Apparent ileal amino acid digestibility coefficients are presented in Table 1.

The apparent digestibility coefficients of lysine cystine and the dispensable, indispensable and total amino acids are relatively low but similar to those published elsewhere (Ferraz de Oliveira and Acamovic, 1995; Carre, 1997; Ferraz de Oliveira, 1998). This is likely to strongly reflect the digestibility coefficients of the amino acids in lupins since lupin protein contributed about 76% of the protein to the diets. The digestibility coefficients for methionine tended to be somewhat higher than the others, but this may reflect the fact that the diets were supplemented with synthetic methionine. Diet 2, where protease was added, had a significantly (p<0.05) higher digestibility coefficient for methionine than that for the
Table 1. Apparent ileal digestibility coefficients of some individual, dispensable (Disp) and indispensable (Indisp.) amino acids in lupin-based diets with and without treatment with protease, xylanase and cellulase.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Lysine</th>
<th>Methionine</th>
<th>Cystine</th>
<th>Disp.</th>
<th>Indisp.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.785</td>
<td>0.967</td>
<td>0.789</td>
<td>0.849</td>
<td>0.830</td>
<td>0.841</td>
</tr>
<tr>
<td>2</td>
<td>0.847</td>
<td>0.975</td>
<td>0.806</td>
<td>0.868</td>
<td>0.845</td>
<td>0.856</td>
</tr>
<tr>
<td>3</td>
<td>0.809</td>
<td>0.922</td>
<td>0.673</td>
<td>0.783</td>
<td>0.737</td>
<td>0.762</td>
</tr>
<tr>
<td>4</td>
<td>0.628</td>
<td>0.909</td>
<td>0.567</td>
<td>0.741</td>
<td>0.703</td>
<td>0.724</td>
</tr>
<tr>
<td>5</td>
<td>0.603</td>
<td>0.862</td>
<td>0.546</td>
<td>0.718</td>
<td>0.655</td>
<td>0.686</td>
</tr>
<tr>
<td>LSD²</td>
<td>0.159</td>
<td>0.039</td>
<td>0.074</td>
<td>0.102</td>
<td>0.147</td>
<td>0.125</td>
</tr>
<tr>
<td>P=</td>
<td>0.007</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.016</td>
<td>0.046</td>
<td>0.032</td>
</tr>
</tbody>
</table>

¹Treatments: diets are maize/soyabean/lupin (400g/kg) mash. 1, lupin; 2, lupin supplemented with protease; 3, lupin supplemented with xylanase; 4, lupin supplemented with cellulase; 5, lupin supplemented with protease, xylanase and cellulase.
²Least significant difference (P<0.05).

carbohydrase supplemented diets. Supplementation of the diets with the cellulase reduced the digestibility coefficients of the amino acids compared to the unsupplemented diet or the diet supplemented with protease alone.

The apparent ileal digestibility coefficients of the amino acids presented here do not reflect the growth data where growth, intake and efficiency of feed conversion were all much higher for the diets which were supplemented with xylanase and cellulase compared to the unsupplemented diet and that supplemented with protease (Naveed et al., 1998). It thus appears that the xylanase and cellulase may have improved the palatability of the diets by reducing the viscosity and water holding capacity of the diets, thus allowing increased intakes. The increased intake of diet would thus result in a large increase in the intake of digestible amino acids thereby more adequately meeting the requirements of the birds for amino acids, and energy. This increased intake, and thus throughput of diet, may encourage the proliferation of microbes in the lower gastrointestinal tract which may contribute to endogenous losses of amino acids thus reducing the apparent digestibility coefficients. Further work should assist in elucidating the apparently anomalous data.

IV CONCLUSIONS

The nutritional value of *Lupinus albus* for poultry grown in the UK is poor but can be enhanced by enzyme treatment. Treatment of lupin-based diets with proteases has a beneficial effect on the digestibility coefficients of amino acids, whereas supplementation with xylanase and cellulase appears to have a detrimental effect on the apparent ileal digestibility coefficients of amino acids, despite improving animal performance. The detailed mechanisms whereby these effects on lupin-based diets are exhibited require elucidation.

REFERENCES


