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NUTRITIONAL EVALUATION OF GRAIN LEGUMES FOR POULTRY

A thesis presented in partial fulfilment of the requirements for the
degree of

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At Massey University, Palmerston North,
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Catootjie Lusje Nalle

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The fear of the LORD is the beginning of knowledge: but fools despise wisdom and instruction (Proverbs 1:7)

ABSTRACT

The nutritional value of faba beans (*Vicia faba*), Australian sweet lupins (*Lupinus angustifolius*), white lupins (*Lupinus albus*) and peas (*Pisum sativum*) grown in New Zealand for broilers were evaluated in terms of their nutritional characteristics, protein quality (protein efficiency ratio), apparent metabolisable energy, apparent ileal digestibility coefficient of amino acids and the effects on bird performance. The effects of dehulling and extrusion cooking on the nutritive value of legumes were also investigated.

The first experiment discussed in Chapter 3 evaluated the effect of cultivars on the nutrient profile and protein quality of chickpeas (*Cicer arietinum*), Australian sweet lupins, peas and soybeans (*Glycine max*). With the exception of white lupins, cultivars had no effect on the proximate and fibre composition of grain legumes. Starch was the primary carbohydrate component of chickpeas and peas, whilst non-starch polysaccharides were the major carbohydrates in lupins. The legume proteins were deficient in lysine, methionine, cystine and threonine. No differences were found in protein quality between cultivars of the different grain legume species. The lowest weight gain and protein efficiency ratio, in addition to the highest relative pancreatic weight and mortality rate was found in raw soybeans, suggesting that soybeans contained high a concentration of anti-nutritional factors, such as protease inhibitors. Birds fed chickpeas, lupins and peas had a low mortality rate and relative pancreatic weight, confirming that the level of anti-nutrients in these legume seeds was low.

The apparent metabolisable energy and apparent ileal digestibility coefficient of amino acids of faba beans, Australian sweet lupins, white lupins and peas were determined in the second experiment (Chapter 4). Cultivar effect on the apparent metabolisable energy values was observed only for faba beans and white lupins. Faba beans, white lupins and peas had comparable apparent metabolisable energy values, but these values were higher than those of Australian sweet lupins, and lower than that of soybean meal. No cultivar differences were found in the apparent ileal digestibility coefficient of amino acids of grain legumes. The apparent ileal digestibility coefficient of amino acids of both lupin species was found to be comparable to that of soybean meal.

The effects of feeding diets containing 200 g/kg faba beans, lupins or peas on the performance, digestive tract development and litter quality of broilers were investigated in the third and fourth trials. In the cage trial (Chapter 5), the results showed that the weight gain of birds fed diets containing grain legumes was similar to that of control diet. Feed

intake and feed per gain of birds fed diets containing the majority of grain legume cultivars did not differ from those fed the maize-soy diet. Birds fed diets containing faba beans had more dry and friable excreta compared to other treatment diets. The performance of birds fed diets containing 200 g/kg grain legumes during the 35 d grow-out period, in the floor pen trial (Chapter 6), confirmed the results of the cage trial. In this trial, weight gain and feed per gain of birds fed diets without meat meal were superior to those with meat meal. In cage trials, the modification of some segments of digestive tract development was probably due to the dietary NSP. Whilst in floor pen trial, digestive tract development was not influenced by the inclusion of grain legumes.

The effect of methodology of determination (direct vs. difference method) on the apparent ileal digestibility coefficient of amino acids of wheat, maize, Australian sweet lupins, peas and soybean meal for broilers was evaluated in the fifth study (Chapter 7). The influence of methodology on apparent ileal digestibility coefficient of amino acids was found to vary amongst the feed ingredients. In general, the apparent ileal digestibility coefficient of amino acids of test ingredients determined by the difference method was higher than those determined by the direct method, suggesting that the use of the direct method may underestimate the apparent ileal digestibility coefficient of amino acids in low and medium protein ingredients.

Data reported in Chapter 8 shows that dehulling increased the apparent metabolisable energy values of faba beans and Australian sweet lupins, but it had no beneficial effect on peas. The increase of apparent metabolisable energy values may be attributed to the decrease in non-starch polysaccharides of these legume seeds after dehulling. The removal of hulls increased the amino acid concentrations, but it had no effect on the apparent ileal digestibility coefficient of most amino acids. These results suggest that dehulling of grain legumes would be nutritionally beneficial and, likely to be economical in view of the improved amino acid concentrations and energy values.

The final experiment (Chapter 9) demonstrated that extrusion of peas markedly influenced the content of crude protein, non-starch polysaccharides, starch, and trypsin inhibitors. The soluble non-starch polysaccharides and trypsin inhibitor contents of the majority of extruded pea samples were higher than those of raw peas, but insoluble and total non-starch polysaccharides decreased with extrusion. Extrusion had no effect on the apparent ileal protein digestibility and the apparent metabolisable energy of peas, but it increased ileal starch digestibility.

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Publications

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- Nalle, C. L., Ravindran, G. and Ravindran, V. 2007. The effect of dehulling on the apparent metabolisable energy and ileal amino acid digestibility of grain legumes for broiler chickens. Proceedings of the Massey Technical Update Conference. Vol.9:48-53.
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- Nalle, C. L., Ravindran, G. and Ravindran, V. 2008. Influence of extrusion on the nutritive value of peas. Proceedings of the Massey Technical Update Conference. Vol.10:102-107.
- Nalle, C. L., Ravindran, G. and Ravindran, V. 2008. The effect of dehulling on the apparent metabolisable energy and ileal amino acid digestibility of grain legumes for broiler chickens. Abstract. XXIII World Poultry Congress.

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List of abbreviations

AA	Amino acid
ADF	Acid detergent fibre
ANOVA	Analysis of variance
AME	Apparent metabolisable energy
AMEn	Nitrogen-corrected apparent metabolisable energy
ANF	Anti-nutritional factor
AIDC	Apparent ileal digestibility coefficient
BBI	Bowman-Birk Inhibitor
BSE	Bovine spongiform encephalopathy
BW	Body weight
Ca	Calcium
Cys	Cystein
DCP	Dicalcium phosphate
DM	Dry matter
DMSO	Dimethyl sulfoxide
FCR	Feed conversion ratio
GE	Gross energy
HU	Haemagglutinin Unit
IVPD	<i>In vitro</i> protein digestibility
IVSD	<i>In vitro</i> starch digestibility
LSD	Least significant difference
MBM	Meat and bone meal
MM	Meat meal
NDF	Neutral detergent fibre
NSP	Non starch polysaccharide
PER	Protein efficiency ratio
SCFA	Short- chain fatty acids
SD	Standard deviation
SBM	Soybean meal
SEM	Standard error of mean
Ti	Titanium

TIA

Trypsin inhibitor activity

TIU

Trypsin inhibitor unit