The Apparent Metabolizable Energy and Amino Acid Digestibilities of Copra Meal In Broiler Diets

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ABSTRACT The world's copra meal production amounted to 1.8 million tonnes in 2002 and most of it was produced in Asia. The Philippines and Indonesia contributed approximately 65% of the world's copra meal production. The main problems of using copra meal in poultry diets are its physical properties along with its nutritional profiles. This study was conducted to determine the physical characteristics and feeding value of copra meal. Physical characteristics were determined by measuring the bulk density and water holding capacity of copra meal and a digestibility study was undertaken to investigate nutrient digestibility, jejunal digesta viscosity and apparent metabolizable energy of copra meal. A total of 28 day old male Ross chicks were given control starter and grower diets from day 1 to 35. From day 36 to 42 , the birds were fed an experimental diet. Faeces were collected for three consecutive days. Jejunal digesta was measured for viscosity and ileal digesta was used for amino acid digestibility measurements.

Data indicated that bulk density and water holding capacity of copra meal were poor, being 0.49 g/cm^3 and 4.69 g water / g feed respectively. Although the crude proteind and amino acids contents of copra meal were favourable to meet a broiler chicken's requirements, their digestibilities were low and lysine digestibility being the lowest while arginine digestibility was high. Dry matter, neutral detergent fibre digestibility and apparent metabolizable energy were also low. The low digestibilities of nutrients were not due to the jejunal digesta viscosity as jejunal digesta viscosity was low.

Key words: Copra meal, digestibility and physical characteristics

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INTRODUCTION

Formulating a diet based on chemical composition was shown to be ineffective for maximising the growth of young broilers (Sundu *et al*., 2006). Diet formulation based on metabolizable energy and amino acid digestibility has now become common practice. A data base of the metabolizable enrgy of feedstuffs has been published by NRC, (1994). However, there is very little data on the digestibility of amino acids digestibility of copra meal.

The digestibility of each fraction of the diet is an important factor in determining the quality of the diet. More importantly, digestible nutrient intake gives a more meaningful indicator of the quality of the diet. Physical characteristics are also believed to be factors affecting feed intake. Bulk density and water holding capacity (WHC) are two physical characteristics that could affect the nutritional value of feedstuffs (Kyriazakis and Emmans, 1995). This study was designed to investigate both the physical characteristics and the digestibility of copra meal by broiler chickens.

MATERIALS AND METHODS

Location and duration of study

The study was conducted for 42 days in the poultry unit. The digestibility study was done for seven days, between 36 and 42 days of age.

Birds and diet

A total of 28 day old male Ross broiler chicks were used as experimental animals and they were placed in brooder cages from days 1 to 17 and given a corn soy (CS) based starter diet. On day 18, the birds were transferred to the metabolism cages and fed the CS starter diet up to day 21. From day 21 to 35, the birds were given grower diets based mainly upon CS.

From day 36, the birds were fed the experimental diet containing 87 copra meal (Table 1). The diet was formulated by using the UFFF software and mixed by using a

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cement mixer. The diet was offered twice a day, at 09.00 and 16.00 hours. During this trial, the feed troughs were topped up twice a day and fresh water was available at all times. Cleaning of water troughs was done every three days to maintain the cleanliness of the water.

Table 1. Experimental diet (g/kg)

Ingredients	Concentration
Copra meal	870
Sunflower oil	60
Limestone	4
Dicalcium phosphate	37
Salt	5
Vitamin and mineral mix	4
Celite	20

Sample collection

Representative feed samples were collected to determine dry matter (DM), nitrogen (N), amino acids (AAs) and neutral detergent fibre (NDF). Faeces were collected daily on three consecutive days (days 40 to 42) and placed in plastic bags. Total faeces were weighed after discarding any foreign material, such as feathers and feed. About 20% of the faeces were stored in the freezer for later analyses. On day 43, four birds from each replication were randomly taken and killed by cervical dislocation. The digesta content from the Meckel's diverticulum to 1 cm before the caeca was collected and then stored in a freezer.

Analysis

Frozen faeces and feed samples were dried at 60^{o}C to measure the DM content. Frozen digesta samples were freeze dried for measurement of AAs and crude protein (CP) content. Prior to chemical analysis, feed, faeces and ileal digesta were ground (0.5 mm screen). Crude fibre (CF), lipid and ash were determined in dry samples according to the methods of AOAC, (1990). Gross energy was measured by using a bomb calorimeter. For NDF analysis, samples were defatted prior to analysis as recommended by Prosky *et al.* (1984). All analyses were performed in duplicate. Acid insoluble ash (AIA) was analyzed by a method based on Siriwan *et al.* (1993) Jejunal digesta viscosity was analysed based on the method of Perez-Maldonado *et al.* (1999) One g of digesta and 2 g of feed were dried, ashed (480^{o}C for 8 hours) and then boiled with 4 mol/L HCl for 1 hour. The residue was washed with HCl and deionized water and dried in an oven at 105^{o}C overnight. The residue was weighed as AIA. The faecal digestibility of the diet and nutrients was calculated by the formula :

$$\text{Apparent Digestibility of nutrients} = \frac{(\text{Nutrients/AIA})\text{d} - (\text{Nutrients/AIA})\text{f}}{(\text{Nutrients/AIA})\text{d}} \times 100\%$$

Where (Nutrients/AIA)d is the ratio of nutrients to acid insoluble ash in the diet and (Nutrients/AIA)f is the ratio of nutrients to acid insoluble ash in the faeces.

AA analysis was done by hydrolysis, evaporation and HPLC analysis. Samples were ground to pass through a 0.5 mm screen and weighed to contain approximately 80 mg CP. Ten ml of 8N HCl (6 g phenol in 400 ml ultra purified water and 1600 ml 32% HCl with specific gravity of 1.16) was added. The sample was then sonicated using an ultrasonic sonicator (FX-10, Unisonics Pty Ltd., Sydney, NSW) for 15 minutes and degassed by using a water suction pump for 5 minutes with care to avoid frothing. Another 30 ml of 8N HCl solution was added and flushed with N and quickly capped. Samples were hydrolysed by autoclaving at 120^{o}C and 16 psi for 16 hours. Ultra-purified water was added to the sample in a 100 ml volumetric flask to make the hydrolysate up to 100 ml. The contents were mixed thoroughly after being cooled at 4^{o}C and the volume adjusted.

To remove oxygen, an aliquot of the hydrolysate containing 8 mg CP and 1 ml of 4 mM DL-norleucine (as internal standard) were placed in a round bottom flask and then flushed with N and sealed with a glass stopper. A "Buchii" rotary evaporator under reduced pressure in a 65^{o}C water bath was used to evaporate water and HCl. The evaporated samples were immediately dissolved with 8 ml 0.2N sodium citrate diluent and transferred to a 20 ml glass vial with Teflon lined caps and the pH was adjusted to 2.20. An equal volume of chloroform to remove fat was added and the top layer was collected in a syringe and filtered through a 0.22 μm pore nylon filter membrane

(Alltech, Baulkam Hills, NSW) into injection vials. The samples were then analysed with a Shimadzu LC-10A analyser (Shim-Pack®, Shimadzu Co, Kyoto Japan)

The gross energy of diet and excreta was measured. The AME of the diet and AME of the PKM were calculated by the formula below. The AME of sunflower oil was based on the value reported by Novus (1992).

AME_{diet} = {(Food intake X GE_{diet}) – (Excreta output X $GE_{excreta}$)}/ Food intake

AME_{PKM} = {AME diet – $AME_{sunflower\ oil}$ X sunflower level)} / PKM level

RESULTS AND DISCUSSION

Results

The proximate analysis, AA content and physical characteristics of CM are shown in Tables 2 and 3 while data on nutrient digestibilities are shown in Tables 4 and 5. Crude protein and gross energy of CM were quite favourable, being 21.7% and 17.77 MJ/kg respectively. However, the digestibility of the CP was low (55%) and the AME (9.12 MJ/kg) was moderate. Amino acid content was imbalanced because lysine was very low while arginine was very high and AA digestibility was generally low. CM was also very bulky, being 0.49 g/cm^3, far below the conventional feedstuffs such as wheat (0.66 g/cm^3). The WHC of CM was high (4.14 g water/g feed).

Discussion

The proximate analysis of copra meal (see Table 2) indicated that protein content and ether extract were relatively high, being about 21 and 7% respectively. These two nutrients benefit CM as gross energy is likely to be higher. However, the dietary fibre of CM expressed as either 14.1% CF or 61.7% NDF, indicates that this feedstuff contains a high quantity of indigestible materials. This would impair the nutritional value. Low bulk density and high water holding capacity may also impair the nutritional value of a feedstuff. The association of bulk density and water holding capacity with feed intake has been long understood (Mratz *et al.*, 1957; Kyriazakis and Emmans, 1995).

Data on DM digestibility (44.7%) and NDF digestibility (39.8%) may indicate that most of the dietary fibre in CM could not be digested. It has been reported that most of the dietary fibre in CM is in the form of mannan (either pure mannan or galactomannan) (Balasubramaniam, 1976; Saittagaroon *et al*., 1983). Which is indigestible by monogastric animals. The AME of CM was moderate, being 9.12 MJ/kg. Protein digestibility was also low (55.0%). It can be speculated that protein may be trapped in the cell wall of the dietary fibre of CM (Knudsen, 1997). or drying and oil extraction processes may impair its digestibility. However, ileal digestibility of protein was a bit higher, being 63.1%. Since the protein in the faeces is not entirely from the diet, but quite a large amount is from the microbes in the large intestine, along with the endogenous protein, the faecal protein digestibility may underestimate the true digestibility. It can be assumed that a considerable amount of protein in the faeces which decreases the faecal protein digestibility may be from micro-organisms leaving the large intestine.

Table 2. Chemical analysis of copra meal

Fractions	Concentrations (%)
DM	90.3
Crude protein	21.7
Gross energy (MJ/kg)	17.77
Crude fibre	14.1
Neutral detergent fibre	61.7
Lipid	6.9
Ash	5.6
Bulk density; unmodified (g/cm^3)	0.56
Bulk density 0.5 mm (g/cm^3)	0.49
Water holding capacity; 0.5 mm (g feed/g water)	4.14
Water holding capacity 1 mm (g feed/g water)	4.69

CM has been reported to be deficient in most AAs, particularly lysine and methionine. Lysine, for instance, was present as 5.5 mg/g which is equivalent to only 50% of the chick's requirement of lysine (see Table 3). The. digestibilities of AAs varied widely from 51% for lysine to 85% for arginine. This indicates that lysine is the most limiting AA in CM due to its low content and low digestibility. Methionine digestibility was also low, being about 71%. High content and digestibility of arginine in CM indicated that CM can be a good source of arginine. Since the production of CM involves two heating processes, drying and oil extraction, it is possible to speculate that heat damage to AAs may have occured in the CM used in this current study. Furthermore, this may be the

Table 3. Amino acid content of copra meal

Amino Acids	CM (mg/g)	Young chicks requirement (NRC, 1994) (mg/g)	The ability of 100 % CM to meet amino acids requirements of young chickens (%)
Arginine	30. 5	12.5	244
Histidine	5.7	3.5	163
Lysine	5.5	11.0	50
Isoleucine	8.1	8.0	101
Leucine	15.9	12.0	133
Methionine	3.3	(Cys + Meth) 9.0	Cys was not analysed
Phenylalanine	10.3	(Phenyl + Tyrosine) 13.4	110
Threonine	8.4	8.0	105
Valine	10.2	9.0	113
Tyrosine	4.5	(Phenyl + Tyrosine) 13.4	110
Glycine	9.3	(Glycine + Serine) 12.5	170
Serine	12.0	(Glycine + Serine) 12.5	170

Cys: Cystine; Phenyl: Phenylalanine; Meth: Methionine

reason for the low digestibility of amino acids (Nwokolo *et al.*, 1976). in addition to its high fibre content (Knudsen, 1997). The wide range of AA digestibilities is hard to explain. Speculation can be raised that each single amino acid may have a different temperature limit to form Maillard products. It is suggested that lysine may have the lowest temperature tolerance as this AA had the lowest digestibility. Further studies are needed to clarify this speculation

CONCULISION

The feeding value of copra meal is likely to be poor due to low digestibility, imbalanced amino acids and low bulk density and high water holding capacity.

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