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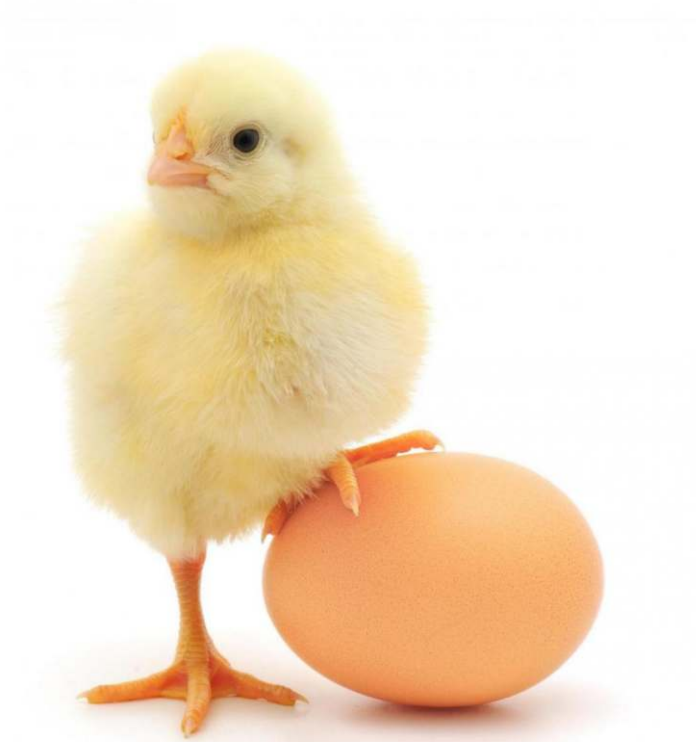

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Apparent Digestibility of Feed Nutrients, Total Tract and Ileal Amino Acids of Broiler Chicken Fed Quality Protein Maize (*Obatampa*) and Normal Maize

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Abstract: Two hundred and forty Ross Broiler chicken were used in a completely randomized design to evaluate the apparent digestibility of *Obatampa,* a quality protein maize (QPM) and normal maize (NM) nutrients with respect to crude protein, crude fibre, ether extract, ash and nitrogen free extract, as well as total tract and Ileal amino acids. There were 4 dietary treatments, each having 3 replicates with 20 birds per replicate. Two pure diets each of NM and QPM were formulated, one each without synthetic lysine supplementation (T2 and T3 for NM and QPM respectively) and one each with synthetic lysine supplementation (T2 and T4 for NM and QPM respectively). The diets were fed to the birds for two weeks before feacal collections and dissecting for Ileal sampling. Apparent Digestibility of nutrients, fecal and Ileal amino acids were higher for normal maize diets without lysine supplementation. Supplementation of diets with synthetic lysine increased nutrient and amino acids digestibility for QPM.

Key words: Quality protein maize, broiler chicken, digestibility, amino acids, ileal digesta

Introduction

All stakeholders in poultry production and business are interested in the appropriate quantity and quality of a formulated feed that results in an optimum economic return. Researchers and producers therefore study carefully the potential ingredients for feed formulation (Khieu *et al*., 2002). The goals of diet formulation are concerned with on the one hand, the prediction of the performance of livestock from a supply of nutrients and on the other hand, the aims of the formulation in creating the diet. At the interface of the two however is the process of digestion (Williams, 1995).

The assessment of amino acid digestibility of feedstuffs is important if poultry are to be fed balanced diets (Short *et al*., 1999). This is because the success of diet formulation is measured by accuracy with which nutrient requirements can be met by nutrients supply to achieve a target performance (Williams, 1995). All dietary components such as amino acids, vitamins and minerals are important when formulating feeds for poultry. However, critical attention should be given to the dietary amino acids in the form of protein as approximately 25% of the cost of practical poultry diets can be accounted for by amino acids. (Khieu *et al.,* 2002; FAO, 2004). A deficiency of an essential amino acid will result in a reduction in performance. Also, excess of amino acids in the diet above the requirements are excreted and can be a source of pollution as well as results in animals welfare problems, for example carcass defects, breast blisters and hock burn (McNab, 1994). The usual method of quantity and quality dietary feed is to conduct digestibility studies and growth performance trials with bird. Though the potential value of a feed for supplying a particular nutrient can be determined by chemical analysis, but the actual value of the food t o the animal can be arrived at only after making allowance for the inevitable losses that occur during digestion, absorption and metabolism (McDonald *et al.,* 1998).

It is therefore, necessary to estimate the level of digestion of the nutrients present in a feed material to enhance ration formulation to meet required demands for productive purposes.

Over the years, apparent digestibility of nutrients has been through the analysis of the total tract contents voided by the birds (Excreta). This has however been criticized because the approach fails to distinguish amino acids voided which are not of direct dietary origin (endogenous excretory losses). Fermentation occurs in the ceaca of poultry, which is likely to influence the amino acid content of excreta and thus modify results for digestibility (Short *et al*., 1999).

One of the attempts to overcome these inadequacies is the practice of sampling of ileal digesta. This hopes to eliminate endogenous excretory losses. Further advantage of the method in poultry is that it removes the effects of urinary losses as the sample used is only derived from the small intestine (Yap *et al.,* 1997; Ravindran, 2007).

The objectives of this study is to estimate the apparent digestibility of nutrients and amino acids in Quality Protein Maize (QPM) and normal maize (NM) by broiler chicken.

Materials and Methods

240 day old Ross broiler chicks were randomly distributed into four dietary treatments each with 3

replicates and 20 chicks per replicate. Four pure diets of QPM and (NM) were formulated. No source of protein was included. Treatment 1 had the pure diet of QPM while T2 had the pure diet of NM both without synthetic lysine supplementation. T3 and T4 were pure diets of QPM and NM respectively both supplemented with synthetic lysine.

The diets were fed to the chicks for two weeks each at the starter and finisher phases in a growth study.

At the end of the finisher phase, 3 birds were taken from each treatment (1 male and 2 female) and housed individually in cages. They were fed the appropriate treatment diet and allowed to adjust to the cage before the commencement of feacal collection. A twenty-four hour fast was imposed on the birds before the study during which it is expected that feces from previous feeding would be voided out by the bird. 100 g of feed was supplied daily with water *ad libitum* for 7 days during which the total fecal output for each bird was collected. Collection lasted till another 24 hours after the withdrawal of feed.

Ileal digestibility study: The birds fasted for 24 hours were then fed 100 g of feed and water for 1 hour after which feed and water were withdrawn. After 3 hours of feed withdrawal, the birds were asphyxiated before being gently bled. They were then quickly dissected to reveal the lower gastro-intestinal tract. Ileal samples were taken from the last 18 cm of the ileum from the ileo-ceacal junction. After rapid removal of the section, digesta were gently squeezed into a collection vessel.

Chemical analysis: The Excreta collected were oven dried for 24 hours at 80°C in a forced air oven and weighed for each bird. The Ileal digesta immediately after collection were transferred into the oven and dried at 80°C for 24 hours. They were then retrieved and weighed for each bird. The excreta and digesta were stored in airtight plastic containers for subsequent analysis.

The proximate composition of the dried and ground feaces, was carried out according to the methods described by AOAC (1990). The amino acid concentration of the excreta and ileal digesta were also determined using methods described by Spackman *et al.*, 1958 (AOAC, 1990).

The known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-sample Amino Acid Analyzer (TSM). The net height of chromagram peaks produced by the chart recorder of TSM (each represents an amino acid) was measured. The half-height of the peak on the chart was found and the width of the peak on the half height was accurately measured and recorded. Approximate area of each peak was then obtained by multiplying the height with the width at half-height. The norleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula:

$$NE = \frac{\text{Area of Norleucine peak}}{\text{Area of each amino acid}}$$

A constant, S was calculated for each amino acid in the standard mixture:

$$S_{std} = NE_{std} \times \text{mol. weight} \times \mu MA_{std}$$

Finally, the amount of each amino acid present in the sample was calculated in g/100 g protein using the following formula:

$$\text{Concentration (g/100g protein)} = NH \times W \ @ \ NH/2 \times S_{std} \times C$$

$$\text{Where } C = \frac{\text{Dilution x16/NH x W (nleu)}}{\text{Sample wt (g) x N\% x 10 Vol. Loaded}}$$

Where C = Dilution x16/ NH x W (nleu), Sample wt (g) x N % x 10 Vol. Loaded, NH = Net height, W = Width @ half-height, Nleu = Norleucine.

Calculations: The proximate composition of the diets and the excreta were used to calculate digestibility for crude protein, ether extract, crude fibre and Nitrogen free extract using the following formula:

Digestibility % = [Nutrient in feed - Nutrient in feaces / Nutrient in feed] x 100

The amino acid profile of the feed and the excreta were used to calculate the digestibility of each amino acid using the following formula:

Amino acid digestibility% = [Amino acid in feed- Amino acid in feces / Amino acid in feed] x 100

The amino acid profile of the feed and the ileal digesta were similarly used to calculate the digestibility of each amino acid using the following formula:

Ileal amino acid digestibility % =

$$\frac{\dfrac{\text{AA in feed}}{Fe_2O_3 \text{ in feed}} - \dfrac{\text{AA in ileum}}{Fe_2O_3 \text{ in ileum}}}{\dfrac{\text{AA in feed}}{Fe_2O_3 \text{ in feed}}}$$

Results and Discussion

Table 1 shows the amino acid contents of the QPM and the NM used in this research. QPM was higher in 8 essential amino acids than normal maize. Importantly too, QPM is lower in Isoleucine and Leucine which are

Table 1: Amino Acid Content of Normal Maize (NM) and Quality Protein Maize (QPM)

Amino acid	NM (g/100 protein)	SQPM (g/100 Protein)
Lysine	3.02	4.03
Histidine	3.25	3.72
Arginine	4.19	4.57
Aspartic Acid	7.31	8.19
Threonine	3.23	3.78
Serine	3.74	3.50
Glutamic acid	13.93	12.88
Proline	4.07	3.31
Glycine	3.15	3.60
Alanine	5.31	5.20
Cystine	1.26	1.66
Valine	4.16	5.37
Methionine	1.09	1.75
Isoleucine	4.12	3.07
Leucine	11.37	9.83
Tyrosine	4.60	3.65
Phenylalanine	5.06	4.80
Tryptophan	1.09	1.34

Table 2: Composition of Broiler Finisher Diet

Ingredient	1	2	3	4
Maize	95.00	0.00	94.23	0.00
QPM	0.00	95.00	0.00	94.33
SBC	0.00	0.00	0.00	0.00
GNC	0.00	0.00	0.00	0.00
Bone Meal	4.00	4.00	4.00	4.00
Limestone	0.00	0.00	0.00	0.00
Common Salt	0.30	0.30	0.30	0.30
Methionine	0.40	0.40	0.40	0.40
Lysine 0.00	0.00	0.77	0.67	
Vit-min Premix [A]	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
ME Kcals/kg	3,230	3,230	3204	3207
Crude Protein%	9.03	9.03	8.95	8.96
Crude Fibre%	2.00	2.00	1.98	1.98
Ether Extract%	3.61	3.61	3.58	3.58
Calcium%	1.22	1.22	1.22	1.22
Phosphorus%	0.86	0.86	0.85	0.85
Lysine%	0.24	0.34	1.01	1.01
Methionine%	0.54	0.54	0.54	0.54

known to influence the efficiency of protein utilization. This result agrees with the findings of Prasanna *et al.*, 2001; Zhai (2002). The higher amounts of these amino acids particularly, lysine (33.4%), Methionine (60.6%) and tryptophan (22.9%) are of significant importance in nutrition. Lysine is the first limiting amino acid in maize and also the most critical amino acid for the chicks. It is needed in protein synthesis and in the cross linking process of bone collagen and in the biosynthesis of carnitine and elastine; as well as it is important in the absorption of calcium from the small intestine (Civitelli *et al.*, 1992; Flodin, 1997). Tryptophan apart from being an essential amino acid is also used in the production of the B-vitamin, Niacin in man and perhaps some animal

Table 3: Apparent Total Tract Nutrient Digestibility (%)

	Treatment			
Nutrient	1	2	3	4
Crude Protein %	70.7	61.6	71.9	65.4
Ether Extract %	87.5	83.5	88.4	74.6
Crude Fiber %	74.5	66.4	71.8	62.6
Ash %	85.6	78.1	82.4	76.6
NFE %	87.3	82.0	88.3	77.8

Table 4: Apparent Total Tract Amino Acid Digestibility (%)

	Treatment			
Amino acid	1	2	3	4
Lysine	87.8	89.0	96.2	95.8
Histidine	92.4	94.1	94.3	92.9
Arginine	95.6	95.3	94.1	93.5
Aspartic Acid	95.3	94.7	92.3	94.2
Threonine	93.2	94.2	91.1	93.8
Serine	91.6	87.4	89.8	88.2
Glutamic acid	95.8	94.9	94.3	93.8
Proline	94.7	91.9	97.7	91.9
Glycine	87.3	79.2	76.3	77.9
Alanine	90.6	90.7	91.1	89.2
Cystine	90.2	87.0	87.6	89.6
Valine	89.0	89.0	86.7	89.6
Methionine	98.4	97.8	98.2	98.1
Isoleucine	96.2	94.3	93.9	92.3
Leucine	96.2	94.6	95.3	93.7
Tyrosine	96.7	94.1	94.5	91.3
Phenylalanine	96.9	94.1	95.1	93.6
Tryptophan	91.2	89.6	88.1	88.4

species. Niacin prevents the disease pellagra in man. (NRC, 1988; Vasal, 1994; LPI, 2008). The excess Leucine in the normal maize is known to cause amino acid in balance which impairs protein synthesis and reduces the conversion of tryptophan to niacin. Thus the reduced level of Leucine in QPM is of significant importance and desirable because it makes the Leucine-Isoleucine ratio more favorable, which in turn helps to liberate more tryptophan for niacin than normal maize (NRC, 1988; Prasanna *et al.*, 2001; LPI, 2008).

Table 2 shows the finisher diet fed to the broilers for two weeks. Table 3 shows the apparent digestibility of feed nutrients. The NM maize diets (Treatment 1 and 3) show higher digestibility values for all the nutrients than the QPM diets (Treatment 2 and 4) both with or without lysine supplementation. The result obtained in this study agrees with the findings of Klein *et al.* (1971) who reported that though QPM is highly digestible, but is slightly inferior to normal corn; and also to report of NRC (1988). Who similarly reported that the true digestibility of QPM is slightly inferior to that of normal maize though surpass normal maize in biological value and net protein utilization.

Table 4 shows the apparent digestibility of total tract (Excreta) amino acids. Digestibility of QPM amino acids were higher in the pure diet supplemented with synthetic lysine for lysine, Histidine, Alanine and Threonine,

Table 5: Apparent Ileal Amino Acid Digestibility (%)

	Treatment			
Amino acid	1	2	3	4
Lysine	82.5	80.1	99.4	94.6
Histidine	89.8	89.4	91.4	93.3
Arginine	91.5	87.7	88.8	90.9
Aspartic Acid	92.4	91.8	93.1	95.3
Threonine	93.8	92.5	93.1	96.4
Serine	93.9	89.8	92.4	84.1
Glutamic acid	92.0	87.4	93.0	92.7
Proline	96.6	93.5	95.4	95.8
Glycine	88.6	79.1	81.2	87.7
Alanine	91.1	89.7	92.3	95.2
Cystine	86.9	85.2	87.6	91.8
Valine	88.2	86.9	87.4	90.8
Methionine	97.6	96.4	97.0	98.2
Isoleucine	91.9	86.0	92.4	90.1
Leucine	95.4	92.7	94.4	95.2
Tyrosine	89.3	81.6	85.5	92.5
Phenylalanine	95.1	85.5	93.8	93.3
Tryptophan	86.9	80.3	97.0	84.7

among the essential amino acids than for the normal maize. Digestibility was however lower for other essential amino acids than in NM maize in the pure diets supplemented with lysine (Treatment 5 and 6). Digestibility were slightly higher in NM diet (Treatment 5) for lysine, Histidine, Arginine, Alanine, Methionine, Isoleucine, Leucine, phenylalanine (among the essential amino acids) than in QPM diet (Treatment 6). In a digestibility trial by Zhai (2002), NM had higher digestibility values for Valine, Methionine, Isoleucine, Leucine, phenylalanine and Histidine.

Table 5 shows the results of the apparent ileal amino acid digestibility of QPM and NM for Broiler chicken. Treatment 1 (pure diet of NM without synthetic lysine) had higher numerical values for all the amino acids than Treatment 2 (QPM pure diet without synthetic lysine).

However, for the purified diets supplemented with synthetic lysine, most of the amino acids had higher numerical values for the QPM than for NM except for lysine, serine and Glutamic acid. Additional lysine to the QPM diet appears to potentiate the digestibility of most of the amino acids. This was also the case when QPM was fed to broilers in standard ration by the author (work not yet published). The QPM standard ration had higher digestibility for most of the amino acids than the NM ration. Williams (1995) similarly reported that the stimulating effect of gut micro flora on protein synthesis was evident only in chicks fed non-purified diets and not in those fed purified diets.

The apparent differences in the presentation of digestibility for the various amino acids from the pattern presented in the total tract digestibility might be due to interferences in the gut of the bird. Fermentation occurs in the caeca of poultry, which is likely to influence the amino acid contents of excreta and thus modify results for digestibility (Williams, 1995; Short *et al.*, 1999).

In this work, it is observed that there is not much difference numerically in the digestibility values of amino acids in the excreta and in the Ileal digesta (Tables 4 and 5). This agrees with the report of Williams (1995) who stated that though there is extensive bacterial activity in the caeca of chicken, the stimulating effect of the gut micro-flora on protein synthesis was evident only in chicks fed non- purified diet. The author also stated that in another work with intact and caecectomized cockerels, it was shown that there was little difference between feacal and Ileal digestibility of amino acids for cereals but there is a slight differences for oils seed meals and significant differences for some animal meals.

Conclusion and Recommendation: Quality Protein Maize is superior to normal maize as feedstuff. The digestibility of the Obatampa nutrients are however slightly lower than that of normal maize. Crop Breeders working on QPM should continue to improve on the quality of QPM in terms of the digestibility of its nutrients to yet enhance the utilization of this feedstuff of high potential in the livestock industry.

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