APPARENT ILEAL DIGESTIBILITY OF AMINO ACIDS IN GROUNDNUT CAKE-BASED DIETS FOR BROILERS

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Abstract
The apparent ileal amino acid digestibility of groundnut cake (GNC) at varying inclusion (0, 10, 20 and 30%) was determined for broiler chicks in a 7-day experiment. The feed ingredient used served as the sole source of amino acids, as other feed ingredients were fixed. The birds received a commercial broiler starter diets during the first 14 day post hatch. On day 14, birds were sorted by body weight and randomly distributed into 4 dietary treatments in a completely randomized design. Each diet comprised 4 replicates of 5 birds per replicate from day 14 to 21 post hatch. On day 21, all birds were asphyxiated with CO_2 and digesta samples from the terminal ileum were collected. Titanium dioxide was included as the indigestible dietary marker at a level of 5g/kg. In overall, the concentration of essential amino acids (AAs) analyzed in groundnut cake-based diets was highest in diet 4 with 30% GNC level as compared to other lower levels of GNC inclusion, least values for all the essential AAs were recorded in the control diet. The digestibility of all the essential AAs in birds on GNC diets increases as the level of GNC increased in the diets except for tryptophan which was significantly ($P<0.05$) lowered in diet 4 containing 30% GNC. In addition, digestibility of threonine was lowered compared to other essential AAs. Similar trend was observed in the digestibility of non-essential AAs in birds on the experimental diets. Digestibility of non-essential AAs increased as GNC level increases across the diets except for glycine, hydroxyproline and serine. The data from the present study showed that there were considerable differences in CP and AA digestibility of varied levels of groundnut cake in broiler starter diets.

Keywords: Ileal digestibility, amino acids, groundnut cake, broilers

Introduction

Presently, environmental pollution and the financial implications of excessive AA in poultry excreta are of great concern. The disposal of poultry excreta has become a difficult task. The effect of nitrogen on the environment cannot be overemphasized. These concerns have stimulated the use of values of digestible rather than total CP and AA contents of dietary ingredients in broiler ration formulations. However, manipulation of amino acids of undigested dietary proteins by the hind-gut microbes is of a great concern (Pertilla *et al.*, 2001). As a result of this, advances in knowledge about circumventing the intervention of these microbes in AA utilization in broilers cannot be overstressed. This has invariably led to measurement of ileal AA digestibility rather total tract excretal collection. Amino acid digestibility is not the same for all feedstuffs, with one having lower or higher digestibility than others. These differences in digestibility can be effectively used as a tool to improve the precision of feed formulation.

Groundnut cake is generally a safe feed for all classes of livestock. The use of groundnut cake has no general limitations and has been used as a protein supplement in livestock feeding. However, its low fiber and high protein contents make it an even more valuable ingredient for poultry ration. Groundnut cake usually contains 45 - 47% crude protein (Leeson and Summers, 1997). The objective of this study was to determine the apparent ileal digestibility of amino acids in broiler chickens.

Materials and Methods

Experimental diets and management of animals: The experiment was conducted in the Pullet Unit of the Teaching and Research Farm, University of Ibadan, Ibadan. Four diets were formulated consisting of 0, 10, 20 and 30% groundnut cake (GNC) respectively. Cornstarch substituted GNC while all other ingredients were included in a constant amount such that variation in the crude protein and amino acid levels in the diets was due only to the variation of the test ingredient (Table 1). Titanium dioxide was added as an indigestible dietary marker at 5g/kg of diet.

Experimental animal and layout: Eighty (80) Arbor Acre broiler chicks were used for this experiment. The birds were fed a commercial broiler starter diet in standard poultry house for 2 weeks. After which they were weighed and randomly distributed into 4 dietary treatments consisting 4 replicates of 5 birds each. They were fed the test diets and given water *ad libitum* for a further 7 days. On day 21, they were weighed again and asphyxiated with CO_2. They were immediately cut open and digesta samples obtained on pen basis from the precaecal section of the ileum by flushing with distilled water. The samples were frozen and then freeze-dried for analysis.

Table 1. Gross composition (g/100gDM) of experimental broiler diets with varying levels of groundnut cake (n = 4 replicates of 5 birds each)

Ingredient	Control (0%)	10% GNC	20% GNC	30% GNC
Cornstarch	40.00	30.00	20.00	10.00
Groundnut cake	0.00	10.00	20.00	30.00
Soyabean meal	20.00	20.00	20.00	20.00
Maize	10.00	10.00	10.00	10.00
Rice bran	13.00	13.00	13.00	13.00
Wheat offal	10.00	10.00	10.00	10.00
Fish meal (72%)	2.50	2.50	2.50	2.50
Bone meal	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50
Titanium dioxide	0.50	0.50	0.50	0.50
Broiler premix*	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrients				
Crude protein (%)	14.46	18.96	23.46	27.96
Crude fibre (%)	4.01	4.51	5.01	5.51
Energy(Kcal/gME)	2.91	2.82	2.74	2.65
Lysine (%)	0.86	1.02	1.18	1.34
Methionine (%)	0.25	0.30	0.35	0.39

GNC: Groundnut cake, *Premix s upplied the following information kg of diet Vitamin A (12,500,000 I.U), Vit D3 (2,500,000 I.U), Vit E (40,000mg) Vitamin K3 (2,000mg), Vit B, (3,000mg), Vit B2 (5,500mg), Naicin (55,000mg), calcium panthothenate (11,500mg) Vit B6 (5000mg) Vit B12 (25mg), choline chloride (500, 000mg), folic acid (1,000mg), Biotin (80mg), Mn (120,000,mg), Fe (100,000mg), Zn (80,000mg), Cu (8,500mg), I (1,500mg) Co (300mg), Se (120mg).

Digestibility calculations: Apparent ileal CP and AA digestibility were calculated using the following equation: D_{CP} or $_{AA}$ (%) = 1 – {TiO_{2diet} / $TiO_{2digesta}$} x CP or $AA_{digesta}$ / CP or AA_{diet} } x 100

Where :

D_{CP} or $_{AA}$ – percentage apparent ileal crude protein or amino acid digestibility

TiO_{2diet} – concentration of titanium dioxide in the diet (%)

$TiO_{2digesta}$ – concentration of titanium dioxide in the digesta (%)

CP or $AA_{digesta}$ – concentration of crude protein or amino acid in the digesta (%)

CP or AA_{diet} – concentration of crude protein or amino acid in the diet (%)

Chemical and statistical analyses: The proximate compositions of the diets and digesta were determined according to the methods of AOAC (2000). The concentration of titanium dioxide in samples was estimated by the photometric technique of Brandt and Allam (1987). Amino acid analysis was determined by HPLC (AOAC, 2000; Method 982.30). Data were analyzed as a completely randomized design using the GLM procedure of SAS (2006). Means were separated using Tukey HSD method.

Results and Discussion

Amino acid digestibility of broilers fed graded levels of groundnut cake-based diets

The level of essential AAs analyzed for GNC in overall, was highest in diet 4 with 30% GNC level as compared to other lower levels of inclusion, least values for all the essential AAs were recorded in the control diet (Table 2). In contrast to soybean meal, peanut meal is low in lysine but is an excellent source of arginine (NRC, 1994). However, the concentrations of essential amino acids in seventeen commercially produced, prepress, solvent-extracted peanut meals reported by Batal *et al.* (2005) are higher than those observed in this study. It could probably be as a result of differences in processing methods and varieties.

Table 2. Crude protein (g/100gDM) and amino acid (g/100gCP) profiles of graded levels of groundnut--based diets fed to broilers (n = 4 replicates of 5 birds each)

Item	Control (0%)	10% GNC	20% GNC	30% GNC
Dry Matter	89.30	90.70	89.30	90.70
Crude Protein	16.97	20.14	22.68	25.74
Essential amino acids				
Arginine	1.04	1.39	1.81	2.08
Histidine	0.41	0.46	0.54	0.56
Isoleucine	0.64	0.70	0.81	0.86
Leucine	1.29	1.45	1.63	1.70
Lysine	0.79	0.89	0.99	1.07
Methionine	0.23	0.26	0.29	0.32
Phenylalanine	0.74	0.88	1.05	1.14
Threonine	0.53	0.63	0.70	0.75
Tryptophan	0.18	0.21	0.22	0.23
Valine	0.75	0.83	0.98	1.05
Non-essential amino acids				
Alanine	0.79	0.91	1.03	1.10
Aspartic acid	1.54	1.90	2.30	2.54
Cysteine	0.22	0.25	0.29	0.32
Glutamic acid	2.55	3.03	3.56	3.86
Glycine	0.74	0.90	1.12	1.28
Hydroxyproline	0.00	0.05	0.08	0.10
Ornithine	0.02	0.01	0.02	0.03
Proline	0.84	0.95	1.06	1.20
Serine	0.59	0.80	0.88	0.76
Tyrosine	0.48	0.58	0.70	0.76

GNC-groundnut cake

The results of apparent ileal digestibility of dry matter, crude protein and amino acids in birds fed GNC diets are presented in Table 3. The digestibility of all the essential AAs in birds on GNC diets increases as the level of GNC increased in the diets except for tryptophan which was significantly ($P<0.05$) lowered in diet 4 containing 30% GNC. Dry matter digestibility in birds fed groundnut cake (GNC) based diets reduced greatly across the diets. Amino acids digestibility varies considerably across the dietary treatments. The variability could be due to the presence of high levels of anti-nutritional factor of grain legumes which can cause substantial reductions in protein and amino acid digestibilities (up to 23%) in rats, poultry and pigs (Gilani *et al.*, 2005). The apparent digestibility of arginine and tryptophan in groundnut cake-based diets varies across the diets and had digestibility relatively greater than 90%. The results agreed fairly well with what might be expected from the kinetic characteristics of transport and absorption of amino acid mixtures. It was reported that when AAs are absorbed from a mixture, the absorption of those AAs whose transport is strongly inhibited by others is retarded until the concentration of the powerful inhibitors has fallen (Milne, 1971). Arginine was reported to be absorbed more rapidly than expected from its behavior when alone, probably its transport was stimulated by other AAs (Holdsworth, 1972). This was in line with what was observed in this present study as related to apparent digestibility of arginine.

Table 3. Apparent ileal digestibility (%) of crude protein and amino acids in birds fed groundnut - based diets (n = 4 replicates of 5 birds each)

Item	Control (0%)	10% GNC	20% GNC	30% GNC	SEM	P Anova
Dry matter	77.16^{a}	77.53^{a}	76.91^{a}	71.95^{b}	1.300	<.0001
Crude protein	87.30^{d}	88.10^{b}	88.33^{a}	87.55^{c}	0.020	<.0001
Essential amino acids						
Arginine	93.31^{d}	93.83^{c}	95.14^{b}	95.38^{a}	0.003	<.0001
Histidine	90.13^{c}	88.22^{d}	90.35^{b}	90.85^{a}	0.013	<.0001
Isoleucine	88.81^{c}	87.43^{d}	89.27^{b}	90.16^{a}	0.004	<.0001
Leucine	90.08^{c}	89.05^{d}	90.75^{b}	90.91^{a}	0.003	<.0001
Lysine	90.32^{c}	89.95^{d}	91.12^{b}	91.55^{a}	0.004	<.0001
Methionine	90.78^{b}	89.68^{d}	90.46^{c}	91.05^{a}	0.005	<.0001
Phenylalanine	90.02^{c}	89.63^{c}	91.38^{b}	92.16^{a}	0.101	<.0001
Threonine	84.33^{d}	84.43^{c}	86.45^{b}	87.15^{a}	0.004	<.0001
Tryptophan	90.32^{d}	90.65^{c}	91.71^{a}	91.13^{b}	0.015	<.0001
Valine	87.97^{c}	86.41^{d}	88.71^{b}	90.18^{a}	0.004	<.0001
Non-essential amino acids						
Alanine	89.02^{c}	88.53^{d}	89.82^{b}	90.37^{a}	0.004	<.0001
Aspartic acid	88.07^{d}	88.68^{c}	90.75^{b}	91.53^{a}	0.004	<.0001
Cystine	81.24^{c}	79.71^{d}	82.66^{b}	84.47^{a}	0.004	<.0001
Glutamic acid	91.34^{c}	91.23^{d}	92.48^{b}	93.14^{a}	0.004	<.0001
Glycine	86.03^{a}	84.03^{d}	85.57^{b}	85.02^{c}	0.004	<.0001
Hydroxyproline	0.00^{d}	69.03^{c}	74.92^{a}	72.59^{b}	0.003	<.0001
Ornithine	71.23^{b}	32.23^{d}	66.18^{c}	81.04^{a}	0.013	<.0001
Proline	87.54^{c}	86.17^{d}	88.32^{b}	90.43^{a}	0.004	<.0001
Serine	87.86^{d}	88.65^{c}	89.44^{a}	88.97^{b}	0.021	<.0001
Tyrosine	90.14^{c}	89.79^{d}	91.72^{b}	92.31^{a}	0.004	<.0001

Means on the same row with different superscripts are significantly (P<0.05) different; SEM- standard error of mean; GNC – groundnut cake; P Anova (P = 0.05).

Conclusion: The data from the present study showed that there were considerable differences in CP and AA digestibility of varied levels of groundnut cake in broiler starter diets.

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