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Apparent ileal digestibility of crude protein and amino acids in wheat offal diets for broilers

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Abstract
Apparent ileal crude protein and amino acid digestibility of wheat offal (WO) at varying levels of inclusion (0, 10, 20, and 30%) was determined for broiler chicks in a 7 - day experiment. The feed ingredient (WO) 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 posthatch. On day 14, birds were sorted by body weight and randomly distributed into 4 dietary treatments in a completely randomized design. Each diet comprised of 4 replicates of 5 birds each from day 14 to 21 posthatch. On day 21 posthatch, birds were asphyxiated with CO_2 and digesta samples from the terminal ileum were collected. Titanium dioxide was included as the indigestible dietary marker. The concentration of crude protein increased as the level of WO increased across the diets. In general, the concentration of essential amino acids in wheat offal - based diets, was highest in diet containing 10% wheat offal and lowest in diet containing 30% WO. The digestibility of all the essential amino acids significantly ($P<0.05$) decreased as the levels of WO increased across the dietary treatments except for the control diet. Apparent ileal digestibility of crude protein and amino acids in birds on wheat offal diets were improved across the diets. The digestibility of essential amino acids improved significantly ($P<0.05$) at 10% WO inclusion level as compared with other test diets. Threonine digestibility was lowest when compared with digestibility of other essential amino acids across the diets. In conclusion, the data from the present study showed that there were considerable differences in varying levels of WO in the digestibility of their amino acids for broiler starters. Therefore, it is imperative to consider lower level of WO inclusion, as level above 10% resulted in decreased digestibility of crude protein and amino acids.

Keywords: Amino acids, broilers, crude protein, ileal digestibility, wheat offal

Introduction
The nutritive value of protein in feed ingredients is determined by the total content and availability of amino acids. The bioavailable amino acids may be defined as amino acids which can be released by digestion, absorbed and utilized by animals. While it is possible that, under some situations, an amino acid could be absorbed in a form not suitable for utilization, it is obvious that undigested amino acids (those appearing at the terminal ileum or in excreta) make no contribution to the requirements of the animal. Digestibilities of amino acids are generally considered to be good estimates of availability and digestibility assays have become the favoured technique for estimating amino acid availability, largely because the values apply directly to the animal and all amino acids can be measured in one assay (McNab, 1994). Wheat offal is a by-product of milling process and it is also a commonly used wheat by-product in poultry diets.

Wheat offal contains 14.80 - 17.60% crude protein about 10% crude fibre and 3.4 - 6.40% crude ash (Maisamari, 1986). This study was carried out to determine the apparent ileal digestibility of crude protein and amino acids in wheat offal diets for broiler chickens.

Materials and Methods

Four diets were prepared containing 0, 10, 20 and 30% of wheat offal (WO) in place of cornstarch as shown in Table 1. All other feed ingredients were included at a constant level across the diets such that changes in concentrations of crude protein from 19.48% to 24.58% were due to increasing amounts of the test ingredient. Titanium dioxide (TiO_2) was included as an indigestible dietary marker at a level of 5g/kg. The experiment was carried out at the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. Eighty broiler chicks (Arbor acre strains) were fed a commercial broiler strarter diets from day 0 to day 14 posthatch. On day 14 posthatch, birds were randomly distributed into 4 treatment diets on beddings of woodshavings in a well illuminated room. The dietary treatments consist of 4 replicates of 5 birds each in a completely randomized design. On day 21, the birds were weighed again and asphyxiated with CO_2, the terminal ileum (portion of the small intestine from Meckel's diverticulum to approximately 2cm anterior to ileo-caeco-colonic junction) was severed and ileal digesta contents were gently flushed with distilled water into containers on replicate basis. The samples were stored in a deep freezer and freeze-dried for chemical analysis.

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

Ingredient	Control (0%)	10% WO	20 % WO	30 % WO
Cornstarch	35.00	25.00	15.00	5.00
Wheat offal	0.00	10.00	20.00	30.00
Soyabean meal	15.00	15.00	15.00	15.00
Maize	10.00	10.00	10.00	10.00
Rice bran	11.50	11.50	11.50	11.50
Groundnut cake	24.00	24.00	24.00	24.00
Bone meal	2.00	2.00	2.00	2.00
Broiler premix	0.25	0.25	0.25	0.25
Oyster shell	1.50	1.50	1.50	1.50
Titanium dioxide	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculatednutrients				
Crude protein (%)	19.48	21.18	22.88	24.58
Crude fibre (%)	3.82	4.67	5.52	6.37
Energy(Kcal/gME)	2.93	2.77	2.60	2.44
Lysine (%)	0.89	0.98	1.07	1.16
Methionine (%)	0.26	0.29	0.31	0.34

WO – Wheat offal

Chemical analyses

The proximate composition of the diets and digesta samples was determined according to AOAC (2000). The concentrations of titanium dioxide in samples were estimated by photometric technique of Brandt and Allam (1987). The diet and digesta samples were analyzed for amino acids using High Performance Liquid Chromatography (HPLC), (AOAC, 2000).

Statistical analysis

Statistical analysis of data was achieved by using the GLM procedure of SAS (2006). Means were separated using Tukey's test and level of significance was set at 5%.

Results and Discussion

Table 2 shows the results of amino acid (AA) concentrations of graded levels of wheat offal. The level of essential AAs analysed for wheat offal (WO) in general, was highest in diet 2 (10% WO) except for tryptophan; least values for all the essential AAs were recorded in diet 3 containing 20% WO except for valine and isoleucine in the control diet with lower values recorded. The variations in amino acid concentrations were related largely to the protein levels in WO. Differences in cultivar, growing season, agronomic practices or processing are known to cause variations in nutrient concentrations of cereals and cereal by-products (Ravindran and Blair, 1993).

Table 2. Crude protein (g/100gDM) and amino acid (g/100gCP) concentrations in birds fed wheat offal diets (n=4 replicates of 5 birds each)

Item	Control (0%)	10% WO	20% WO	30% WO
Dry matter	90.00	90.70	90.00	91.70
Crude protein	19.30	20.63	20.87	22.06
Essential amino acids				
Arginine	2.38	2.46	2.33	2.38
Histidine	0.68	0.71	0.68	0.70
Isoleucine	1.02	1.07	1.03	1.03
Leucine	2.00	2.02	1.94	1.97
Lysine	1.21	1.25	1.19	1.22
Methionine	0.32	0.33	0.32	0.32
Phenylalanine	1.35	1.40	1.32	1.34
Threonine	0.86	0.87	0.83	0.86
Tryptophan	0.29	0.28	0.28	0.28
Valine	1.21	1.28	1.22	1.24
Non-essential amino acids				
Alanine	1.20	1.22	1.17	1.21
Aspartic acid	2.97	3.05	2.88	2.92
Cysteine	0.32	0.33	0.32	0.34
Glutamic acid	4.43	4.55	4.37	4.48
Glycine	1.32	1.36	1.31	1.35
Hydroxyproline	0.07	0.08	0.08	0.06
Ornithine	0.02	0.02	0.02	0.02
Proline	1.30	1.32	1.27	1.34
Serine	1.22	1.21	1.13	1.18
Tyrosine	0.89	0.91	0.86	0.88

WO - wheat offal

The results on apparent ileal digestibility of dry matter, crude protein and amino acids in broilers fed diets containing graded levels of wheat offal are shown in Table 3. The digestibility of all the essential AAs in birds fed wheat offal based diets significantly (P<0.05) decreased as the levels of wheat offal increased across the dietary treatments. There were considerable variations in the non-essential AA digestibility in wheat offal-based diets. However, aspartic acid, glutamic acid and tyrosine had apparent digestibility values higher than 90%. Apparent ileal digestibility of crude protein and amino acids in birds on wheat offal diets were improved across the diets. Threonine digestibility was lowest when compared with digestibility of other essential amino acids across the diets. The low digestibility of threonine in WO found in the present study may partly due to the relatively high concentration of threonine in gut endogenous protein. Another possibility is that the peptide bond involving threonine may be less susceptible to breakdown by digestive enzymes (Kadim *et al*., 2002). A comparison of apparent ileal digestibility for essential and non-essential AAs revealed considerable variations. A part of the variation might reflect differences in amino acid composition, structure and distribution of protein in the test feedstuff.

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

Item	Control (0%)	10% WO	20% WO	30% WO	SEM	P Anova
Dry matter	71.48^{b}	73.07^{a}	70.81^{c}	70.04^{d}	0.121	<.0001
Crude protein	84.14^{b}	85.48^{a}	83.47^{c}	83.02^{d}	0.003	<.0001
Essential amino acids						
Arginine	96.24	96.14	95.12	95.12	0.507	0.4452
Histidine	90.71^{b}	91.18^{a}	89.96^{c}	89.85^{d}	0.013	<.0001
Isoleucine	90.02^{b}	90.63^{a}	89.13^{c}	88.20^{d}	0.036	<.0001
Leucine	91.23^{b}	91.54^{a}	89.94^{c}	89.43^{d}	0.008	<.0001
Lysine	91.01^{a}	90.72^{b}	88.88^{c}	88.62^{d}	0.006	<.0001
Methionine	91.22^{a}	90.63^{b}	88.52^{c}	87.44^{d}	0.007	<.0001
Phenylalanine	92.75^{a}	92.44^{a}	91.61^{b}	91.22^{b}	0.302	0.0129
Threonine	86.53^{b}	87.80^{a}	85.59^{c}	85.33^{d}	0.021	<.0001
Tryptophan	92.50^{a}	92.16^{b}	91.40^{c}	91.01^{d}	0.109	<.0001
Valine	89.32^{b}	92.33^{a}	88.67^{c}	87.85^{d}	0.057	<.0001
Non-essential amino acids						
Alanine	89.96^{a}	89.88^{b}	88.26^{c}	87.55^{d}	0.015	<.0001
Aspartic acid	91.52^{b}	91.92^{a}	90.92^{c}	90.77^{d}	0.009	<.0001
Cysteine	82.29^{d}	84.32^{a}	82.56^{c}	83.45^{b}	0.004	<.0001
Glutamic acid	93.52^{b}	93.64^{a}	92.61^{c}	92.01^{d}	0.006	<.0001
Glycine	87.58^{b}	88.24^{a}	88.93^{d}	86.03^{c}	0.025	<.0001
Hydroxyproline	60.84^{d}	71.81^{a}	69.06^{b}	62.60^{c}	0.007	<.0001
Ornithine	49.38^{c}	87.04^{a}	41.73^{d}	54.52^{b}	0.011	<.0001
Proline	88.71^{c}	90.07^{a}	88.86^{c}	89.22^{b}	0.078	<.0001
Serine	90.95^{b}	91.28^{a}	89.54^{d}	89.73^{c}	0.012	<.0001
Tyrosine	93.15^{b}	93.33^{a}	91.80^{c}	91.36^{d}	0.004	<.0001

Means on the same row with different superscripts are significantly (P<0.05) different; SEM - standard error of mean; WO – wheat offal; P Anova (p = 0.05)

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