Phosphorus utilization in pigs fed *Aspergillus niger* treated wheat offal, brewers' dried grain and palm kernel cake

¹Adegbaju, S. W., ¹Akinfala, E. O., ²Babalola, G. O. and ¹Ogundeji, S. T.

¹Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife.

²Department of Microbiology, Obafemi Awolowo University, Ile-Ife.

Corresponding author: iwaleadegbaju@yahoo.com; +2348036946391

Abstract

The apparent total tract digestibility (ATTD) and standardized total tract digestibility (STTD) of Phosphorus (P) in *Aspergillus niger* treated Wheat Offal (WO), Brewers Dried Grain (BDG) and Palm Kernel Cake (PKC), were measured using growing pigs (Large White X Hampshire) of average weight 21.02 ± 0.63 kg in a 2×3 factorial arrangement. Six diets based with or without *Aspergillus niger* were formulated. A P-free diet was also formulated to measure endogenous losses of P. The results of the experiment showed that the ATTD and STTD of P in treated WO (72.22 and 83.26 %), BDG (84.61 and 88.21 %) and PKC (82.36 and 85.68 %) were greater ($P < 0.05$) than in untreated WO (53.54 and 58.08 %), BDG (67.83 and 73.92 %) and PKC (78.47 and 82.37 %) respectively. The microbial treatment also reduced ($P < 0.05$) the excretion of P in the faeces from (1.13 to 0.71 g), (0.53 to 0.43 g) and (0.56 to 0.55 g) in WO, BDG and PKC respectively. It was concluded that *Aspergillus niger* treatment of the WO, BDG and PKC significantly improved the ATTD and STTD of phosphorous and also reduced P-excretion in growing pigs fed these feedstuffs.

Keywords: Phosphorus, *Aspergillus niger*, Diets, Growing Pigs, Digestibility

Introduction

Phosphorus (P) is an essential mineral required by growing pigs for their metabolic process. It plays an important role in how the body uses carbohydrates and fats. Diets fed to pigs contain phytate phosphorus which is not readily available for utilization. Consequently, when excreted it forms an environmentally harmful component of swine manure. Phosphorus as a nutrient has posed challenges for non-ruminant nutritionists due to the inefficiency of its use in cereal-based diets, expense of P supplementation, and potential environment pollution effects of P in animal waste (Adeola *et al.*, 2004). The application of biotechnological tool such as Solid State fermentation (SSF) has been effective in improving P digestibility as well as reducing the excretion of this mineral in manure (Guggenbuhl *et al.*, 2007 and Lawal *et al.*, 2013). The use of microbial treatment to enhance digestibility and assimilation of nutrients may alleviate

the problem of manure management in swine production, at the same time reducing environmental pollution (Sharpley *et al.*, 1994) in humid tropics of Nigeria. Digestibility of P is usually expressed as the apparent total tract digestibility (ATTD) and standardized total tract digestibility (STTD) values. Relative bioavailability and apparent total tract digestibility (ATTD) of P have been measured in many feed ingredients, which is the difference between P intake and P excretion in faeces (Jongloed *et al.*, 1992; Bruce and Sandston, 1995) as reported by Ferdinando (2010). Basal EPL (Endogenous Phosphorus Loss) can be directly measured by feeding pigs a P-free diet and this value can be used to correct ATTD for EPL to calculate STTD (Standardized total tract digestibility) of P. Treatment of these test ingredients with *Aspergillus niger* due to its phytase activity could make the phosphorus in them more available for pigs in their diets. This needs to be well investigated, hence this study.

Phosphorus utilization in pigs

Materials and methods

The study was carried out at the Swine Unit of the Obafemi Awolowo University (OAU) Teaching and Research Farm, Ile-Ife (latitude 7° 28' N and longitude 4° 33' E and altitude of about 244 m above the sea level) and at laboratories of the Departments of Animal Sciences and Microbiology, OAU Ile-Ife and Central Research Laboratory, the Federal University of Technology, Akure.

Sources of test ingredients

Brewers dried grain (BDG) was obtained from International Breweries, Ilesha. Palm kernel cake (PKC) was obtained locally from small scale agro-industry using hydraulic press method of oil extraction from palm kernels in Ile-Ife. While Wheat offal (WO) was also obtained from Eagle flour Mill in Ibadan, Oyo state. The experimental pigs were also sourced locally from Desola farm Opa area, Ile Ife.

Microbial treatment of AIBPs by isolated fungus

The inocula of each isolate was prepared by pouring 10 mLs of sterile distilled water into spores of each agar slants and tilted. The filtrate of each isolate was subsequently diluted with more sterile distilled water to obtain a spore count of approximately 7.44×10^5 per ml using haemocytometer (Onilude and Oso, 1999). About 300 g of milled AIBPs were placed in each of three 500 mLs conical flasks corked with cotton wool and sterilized at 121 °C for 15 min. Sterile distilled water was added at the rate of 75 mLs per 300g of AIBPs to raise the moisture of the meals as described by Lawal *et al.* (2012). About 10 mLs of the spore suspension of *Aspergillus niger* was used to inoculate each of the AIBP in the three flasks under aseptic condition and then incubated for five days at room temperature (27 °C). Each of these 300 g samples were then poured into 20 kg sterilized and moistened AIBPs and mixed

Experimental pigs and management

Twenty-one growing pigs, Large White x Hampshire (21.02 ± 0.63 kg) were used for the seven treatments with three animals per treatment and each served as a replicate. The animals were adjusted for a period of five days in the metabolic cage followed by four days of faecal and urine collection. The animals were starved for 12 hours prior to experimental period to clear the gut of previous meal. The pigs were also starved for another 12 hours at the end of the feeding period to ensure total faecal collection of the faeces arising from the diet offered.

Data collection

Faeces and urine were collected separately on daily basis every morning (7.30 – 8.30 am). Samples of faeces collected were oven dried at 60 °C, weighed and were put in a plastic bag and stored in deep freezer at (-10 to -20 °C) for phosphorus analysis. Urine was collected, the record of weight and volume was taken, about 10 % of each day's collection was stored in 10 mLs of 10 % sulphuric acid to prevent nitrogen losses by evaporation of ammonia and keep the urine pH below 4.

The Apparent Total Tract Digestibility (ATTD) of P in each diet was calculated according to the following equation:

$$\text{ATTD (\%)} = [(P_i - P_f)/P_i] \times 100.$$

Where P_i is the total P intake (g) from day 6-11 and P_f is the total fecal P output (g) originating from the feed that was provided from day 6-11 days. The basal endogenous P loss (mg/kg DMI) was measured from pigs fed the P-free diet according to the following equation:

$$\text{EPL (mg/kg DMI)} = ([P_f/F_i] \times 10^6),$$

Where **DMI** is the dry matter intake, **EPL** is the endogenous P loss and F_i is the total feed

Table 1: Gross composition of experimental diets

	WO		BDG		PKC		P-free
	UT	T	UT	T	UT	T	
WO	50.00	50.00	-	-	-	-	-
BDG	-	-	50.00	50.00	-	-	-
PKC	-	-	-	-	50.00	50.00	-
Sucrose	20.00	20.00	20.00	20.00	20.00	20.00	22.00
Soy-bean Oil	-	-	-	-	-	-	6.00
Limestone	1.20	1.20	1.20	1.20	1.20	1.20	0.80
Salt	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Vitamins/Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Cassava flour	28.10	28.10	28.10	28.10	28.10	28.1	70.00
Potassium Carbonate	-	-	-	-	-	-	0.40
Magnesium Oxide	-	-	-	-	-	-	0.10
Total	100	100	100	100	100	100	100

WO = Wheat Offal, BDG = Brewer Dried Grain, PKC = Palm Kernel Cake, P – Free: Phosphorus free, TRT = Treatment, T= Treated, UT=Untreated,

*Grower premix supplied per kg diet: vitamin A 10,000,000 IU; vitamin D 32,000,000 IU; vitamin E 8,000 IU; vitamin K 2,000mg; vitamin B1 2,000 mg; vitamin B2 5,500 mg; vitamin B6 1,200 mg; vitamin B12 12 mg; biotin 30 mg; folic acid 600 mg; niacin 10,000 mg; panthethic acid 7,000 mg; choline chloride 500,000mg; vitamin C 10,000 mg; iron 60,000 mg; Mn 80,000 mg; Cu 800 mg Zn 50,000 mg; iodine 2,000 mg; cobalt 450 mg; selenium 100 mg; Mg 100,000 mg; anti-oxidant 6,000 mg.

(g DM) intake from day 6 to 9. The daily EPL loss for pigs fed P-containing diets was calculated by multiplying the calculated EPL per kg DMI of each pig.

The STTD of P was calculated using the following equation:

STTD (%) = $\frac{[P_i - \{P_f - EPL\}}{P_i} \times 100$,
Where STTD (%) is the standardized total tract digestibility of P.

Data were analyzed using the GLM (General linear Model) procedure of SAS, (2002). The UNIVARIATE procedure in SAS was used to confirm the variances if homogenous or otherwise and also to analyze for outliers. The ATTD and STTD of P in PKC, BGD and WO without and with microbial degradation was compared within each ingredient using ANOVA. The LSM statement was used to calculate mean values and the PDIFF option was used to separate mean values when significant. Alpha value of 0.05 was used to assess significance among means.

Results and discussion

The phosphorus digestibility and retention in the growing pigs fed treated agro industrial by-products are shown in Table 2. The Phosphorus intake, fecal output, urine phosphorus output, Phosphorus retention and the apparent total tract digestibility (ATTD) were significantly ($P < 0.05$) affected by the treatments. The Phosphorus intake increased significantly ($P < 0.05$) from 2.46 to 3.65 g, 1.66 to 2.80 g, 2.62 to 3.10 g in pigs fed WO, BDG and PKC respectively when treated with *A. niger*. Phosphorus output in faeces was also reduced significantly ($P < 0.05$) from 1.13 to 0.71 g for WO, 0.56 to 0.43 g for BDG and 0.77 to 0.56 g for PKC when treated with *A. niger*. The total P intake in pigs fed untreated WO, BDG and PKC was less than that in pigs fed treated ones. When the P intake was small, the proportion of the endogenous phosphorus loss (EPL) of P in the total quantity of excreted P increases (Kim *et al.*, 2012). P retention also increased ($P < 0.05$) from 53.93 to 80.44 % for WO, 67.81 to 84.57 % for BDG and 78.46 to 82.34 % for PKC when microbially

Phosphorus utilization in pigs

treated. The ATTD of P increased ($P < 0.05$) from 53.94 to 72.22 % for WO, 67.83 to 84.61 % for BDG and 78.47 to 82.36 % for PKC when treated with *A. niger*. The basal EPL observed was not significantly ($P > 0.05$) influenced by the microbial treatment of the test ingredients. In this experiment, the basal EPL was measured by feeding a P-free diet and a value of 0.103 g/kg DMI was obtained.

The test ingredients, microbial treatment as well as the interaction between the test ingredients and the treatment significantly ($P < 0.05$) affected the values observed for the Phytic acid contents of the test ingredients. The values obtained for WO, BDG and PKC reduced from 0.019 to 0.006, 0.001 to 0.00 and 0.022 to 0.00 g/kg, respectively.

Aspergillus niger treatment increased standardized total tract digestibility (STTD) of P ($P < 0.05$) significantly in the test ingredients due to its phytase activity (Selle and Ravindran, 2008).

Standardized total tract digestibility (STTD) of Phosphorus in pigs fed the test ingredients also showed significant ($P < 0.05$) differences. The highest value of 88.21 % was observed in treated BDG, followed by 85.68 % in treated PKC, **58.08** % in untreated WO. The least value was observed in untreated WO. The values of STTD of P observed in this experiment disagreed with Ferdinando (2010), where the STTD of P in DDGS without phytase (72.9 %) was not different from the STTD of P in DDGS with phytase (75.5 %). thoroughly, then incubated in the bigger bags for seven days. The samples were then oven dried after seven days at 70 °C (Iyayi and Losel, 2001) and the dried samples were used for the preparation of diets and laboratory analysis using the method of AOAC (2005).

Experimental diets

Seven diets were formulated (Table 1), Two diets each (treated and untreated) were

based on PKC, BDG, and WO. The test ingredients served as the source of P in the diets and a P-free diet was formulated as the seventh diet. Each of the diets was fed to the pigs at daily rate of 4 % of live weight in line with the procedure of Onyimonyi *et al.* (2010). Water was provided *ad libitum* throughout the period of a period of five days in the metabolic cage followed by four days of faecal and urine collection. The animals were starved for 12 hours prior to experimental period to clear the gut of previous meal. The pigs were also starved for another 12 hours at the end of the feeding period to ensure total faecal collection of the faeces arising from the diet offered. Faeces and urine will be collected separately on daily basis every morning (7.30–8.30 am).

The significant ($P < 0.05$) improvement in the phosphorus digestibility and retention in the growing pigs fed these treated test ingredients in this study may be due to phytase enzyme released by the *A. niger* (Selle and Ravindran, 2008). The ability of microbial phytase to increase phosphorus availability in feed and enhance its digestibility has been reported in the findings of Pillai *et al.* (2006) and Brana *et al.* (2006).

The total endogenous phosphorus loss (EPL) observed in this study was within the range (0.070 to 0.670 g/kg) reported by Dilger and Adeola (2006) and Pettey *et al.* (2006) where the total EPL was measured using the regression method. The values for the ATTD of P in WO, BGD and PKC in this study were in agreement with values reported by Pedersen *et al.* (2007). The ATTD of P in distillers dried grains with soluble (DDGS) was previously reported with values ranging from 50 to 68 % (Pedersen *et al.*, 2007; Stein *et al.*, 2009) and the ATTD of P in BDG measured in this experiment was similar to the greatest values in this range and higher in the treated BDG, WO and PKC (84.61, 72.22 and

Table 2: Phosphorus digestibility and retention of the experimental animal

PARAMETERS	BDG				PKC				P (ANOVA)			
	WO		T		UT		T		P-Free		SEM	
	UT	T	UT	T	UT	T	UT	T	T	SRC	TRT	SRC X TRT
P Intake(g)	2.462	3.650	1.66	2.80	2.62	3.10	-	-	-	0.15	<0.0001	<0.001
Fecal output (g)	1.134	0.714	0.534	0.431	0.564	0.547	-	-	-	<0.0001	<0.0001	<0.0002
Urine P output (g)	0.0002	0.0001	0.0004	0.001	0.0004	0.005	-	-	-	<0.0001	<0.0001	<0.0001
Total P output (g)	1.134	0.714	0.534	0.431	0.564	0.547	-	-	-	<0.0001	<0.0001	<0.0001
P retention (%)	53.93	80.440	67.81	84.57	78.46	82.34	-	-	-	<0.0001	<0.0001	<0.0001
ATTD of P (%)	53.54	72.220	67.83	84.61	78.47	82.36	-	-	-	<0.0001	<0.0001	<0.0001
EPL(g/kg of DMI)	0.102	0.103	0.101	0.101	0.102	0.103	0.103	0.103	0.103	0.7100	0.1820	0.3060
FPA (g/kg)	0.019	0.006	0.001	0.00	0.022	0.00	0.00	0.00	0.00	<0.0001	<0.0001	<0.0001
STTD of P (%)	58.080	83.26	73.92	88.21	82.37	85.68	-	-	-	<0.0001	<0.0001	<0.0001

WO = Wheat Offal, BDG = Brewer Dried Grain, PKC = Palm Kernel Cake, ATTD = Apparent Total Tract Digestibility, FPA = Fecal Phytic acid, SEM = Standard Error of the Mean, SRC=Fibre source, TRT = Treatment, T= Treated, UT=Untreated, DMI =Dry Matter Intake, EPL: Endogenous Phosphorus loss, P Intake: Phosphorus intake, P- Free =Phosphorus free diet, STTD = Standardized Total Tract Digestibility.

Phosphorus utilization in pigs

82.37 %) respectively. This observation confirmed that the ATTD of P in treated BDG was much greater than in untreated WO. The result of the fecal P was similar to the results of Ferdinando (2010) that Phosphorus concentration in feces reduced ($P < 0.001$) from 1.98 to 1.15 % in pigs fed corn and from 2.84 to 1.84 % in pigs fed SBM when phytase was used.

Conclusion

Findings from this study showed that *Aspergillus niger* treatment of Wheat Offal, Brewer Dried Grains and Palm Kernel Cake significantly ($P < 0.05$) improved the Apparent total tract digestibility (ATTD) and Standardized total tract digestibility (STTD) of phosphorous. Also, *Aspergillus niger* treatment of Wheat Offal, Brewer Dried Grains and Palm Kernel Cake could reduce P-excretion in growing pigs fed these feedstuffs.

References

- A.O.A.C. 2005.** Official Methods of Analysis of the Association of official Analytical Chemist. Published by the Association of analytical chemists, Washington DC.
- Adeola, O., Sands, J. S., Simmins, P. H. and Schulze, H. 2004.** The efficacy of an *Escherichia Coli*-derived phytase preparation. <http://www.journalofanimalscience.org/content/82/9/2657>
- Brana, D. V., Ellis, M., Castaneda, E. O., Sand, J. S. and Baker, D. H. 2006.** Effect of novel phytase on growth performance, bone ash and mineral digestibility in nursery and grower-finisher pigs. *Journal of Animal Science*, 84:1839-1849.
- Bruce, J. A. M. and Sandston, F. 1995.** The effect of microbial phytase in diets for pigs on apparent ileal and fecal digestibility, pH and flow of digesta measurements in growing pigs fed a high -fibre diet. *Canadian Journal of Animal Science*, 77:121-12.
- Dilger, R. N. and Adeola, O. 2006.** Estimation of true phosphorus digestibility and endogenous phosphorus loss in growing pigs fed conventional and low-phytate soybean meals. *Journal of Animal Science*. 84: 627 – 634.
- Ferdinando, N. D. A. 2010.** Effects of microbial Phytase on the standardized total tract digestibility of phosphorus in soybean meal, corn and corn co-product. M.Sc. Thesis. Graduate College of the University of Illinois at Urbana- Champaign. 20 – 64.
- Guggenbuhl, P., Quintana, A. P. and Nunes, C. S. 2007.** Comparative effects of three phytases on phosphorus and calcium digestibility in the growing pig. *Livestock Science* 109:258-260.
- Iyayi, E. A. and Losel, D. M. 2001.** Changes in carbohydrates fractions of cassava peel following fungal solid state fermentation. *Journal of Food Technology in Africa*. 6(3): 101-103.
- Jongbloed, A.W., Mroz, Z. and Kemn, P. A. 1992.** The effect of supplement *Aspergillus niger* phytase in diet for weanling pigs on concentration and apparent digestibility of dry matter, total Phosphorus and phytic acid in different sections of the alimentary tract. *Journal of Animal Science*, 70: 1159 – 1168.

- Kim, B. G., Lee, J. W. And Stein, H. H. 2012. Energy concentration and phosphorus digestibility in whey powder, whey permeate, and low-ash whey permeate fed to weanling pigs. *Journal of Animal Science*, 90: 289-295.
- Lawal, T. E., Alabi, O. M., Ademola, S. A. and Adebisi, O. A. 2012. Fungal biodegradation of plantain (*Musa paradisiacal*) peel through solid state fermentation for broiler finisher feeding: *In vitro* digestibility, performance, haematological and serum parameters. *Elixir Biotechnology*. 49: 10079-10083.
- Lawal, T. E., Ademola, S. G., Owoseni, A. Atobatele, O. E. and Oriye, L. O. 2013. Use of *Aspergillus niger* for improving the feeding value of rice offal. *African Journal of Biotechnology*, 12 (20):3083-3087.
- Onilude, A. A. and Oso, O. 1999. Effect of fungi enzyme mixture supplementation of various dietary fibres contain diets fed broiler chicks on performance and characteristics. *World Journal of Microbiology and Biotechnology* 15: 17-19.
- Onyimonyi, A. E., Ugwu, S. O. C. and Machebe, N. S. 2010. Performance and Linear Measurements of Growing Pigs Fed on Basis of Their Body Weight. *Pakistan Journal of Nutrition* 9 (1): 57-59.
- Pedersen, C., Boersma, M. G. and Stein, H. H. 2007. Digestibility of energy and phosphorus in ten samples of distillers dried grains with soluble fed to growing pigs. *Journal of Animal Science* 85:1168-1176.
- Pettey, L. A., Cromwell, G. L. and Lindemann, M. D. 2006. Estimation of endogenous phosphorus loss in growing and finishing pigs fed semi purified diets. *Journal of Animal Science* 84:618–626.
- Pillai, P. B., O'Connor-Dennie, T., Owens, C. M. and Emmert, J. L. 2006. Efficacy of an *E. coli* phytase in broilers fed adequate or reduced phosphorus diets and its effect on carcass Characteristics. *Poultry Science*, 85:1737-1745.
- SAS Institute Inc., 2002. Statistical Analysis Software SAS/STAT. User Guide (Release 6.03) SAS Inst. Cary, New York USA.
- Sharpley, A. N., Chapra, S. C., Wedepohl, R., Sims, J. T., Daniel, T. C. and Reddy, K. R. 1994. Managing agricultural phosphorus for protection of surface waters: issues and options. *Journal of Environmental Quality*, 23(3):437-451.
- Selle, P. H. and Ravindran, V. 2008. Phytate-degrading enzymes in pigs Nutrition. *Livestock science*, 113: 99-122.
- Stein, H. H., Connot, S. P. and Pedersen, C. 2009. Energy and nutrient digestibility in four sources of distillers dried grains with solubles produced from corn grown within a narrow geographical area and fed to growing pigs. *Asian-Australian's Journal of Animal Science*, 22:1016–102.

Received: 28th July, 2018

Accepted: 21st December, 2018

Growth performance and haematological characteristics of starter broilers fed diets supplemented with turmeric (*Curcuma longa*) meal

¹Olabode, A. D., ¹Adetutu, I. S., ²Agu, C. I., ³Ugwuowo, L. C., ¹Ojuoloruntaye, T. J. and ⁴Okelola, O. E.

¹Federal College of Agriculture, Ishiagu, Ebonyi state.

²Enugu state polytechnic, Iwollo, Ezeagu, Enugu state.

³Nnamdi Azikiwe University Awka, Anambra state.

⁴Federal College of Fisheries and Marine Technology,
Victoria Island, Lagos state.

Corresponding author: adeoladavid2005@yahoo.com; 08063379970

Abstract

Turmeric (Curcuma longa) is an extensively used spice, food preservative and coloring material that has biological actions and medicinal applications. Turmeric, when used as an additive could enhance the performance of broiler chickens in Nigeria. The aim of the present study was to assess the growth performance and haematological characteristics of starter broiler chicken fed diets supplemented with processed turmeric meal (TM). Ninety-six, two weeks old unsexed "Agri-tech" broiler birds were randomly distributed in a completely randomized design (CRD) into four treatments, comprising of twenty four birds each, with three replicates per treatment (having 8 birds per replicate). The processed turmeric was included at the rate of 0%, 0.5%, 1.0% and 1.5% respectively. Feed and water were given without restriction. Supplementation of processed turmeric meal in the diet of starter broilers significantly ($p < 0.05$) influenced the final body weight, average daily feed intake, average daily weight gain and feed conversion ratio. The treatment groups containing processed turmeric meal had poor performance in all parameters studied when compared to that of the control. Mean values of all haematological parameters evaluated namely; packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC) and white blood cell (WBC) differed significantly ($p < 0.05$) between the control and the turmeric treated groups, however all the values obtained were within the recommended standard range of values for broiler. It was concluded that processed turmeric meal can be added to the diets of starter broilers up to the level of 1.5% and also can be safely used as a phyto-additive in starter broiler chickens, preferably in their feed.

Keywords: Growth performance, supplemented, starter broiler, turmeric meal, haematology

Introduction

The low level of animal protein consumption by Africans in general and Nigerians specifically is a reflection of the state of deterioration of the Nigerian livestock sector, especially poultry which has continued to show a discouraging slow rate of growth (Martins, 2001). Thus a realistic step towards enhancing animal protein supply and intake in Nigeria is the development and expansion of the poultry industry (Onyimonyi *et al.*, 2009; Olabode

et al., 2013). Despite the privileged role accorded the poultry industry, its future development depends to a large extent on the supply of appropriate, safe and cost effective feeds. The interest in feed additives grew over the last decade as the usage continues to increase across the country. These feed additives have received a high attention as feed supplements for various purposes in poultry production during the recent years (Zhang *et al.*, 2009). Some of the beneficial effects of bioactive

Broilers fed diets supplemented with tumeric (*Curcuma longa*) meal

plant substance in animal nutrition may include the stimulation of appetite and feed intake.

Turmeric (*Curcuma longa*) is an extensively used spice, food preservative and coloring material that has biological actions and medicinal applications (Akpbarian *et al.*, 2012). The significant biological properties of turmeric make it a potential substitute for use as a feed additive in livestock diets. The active and main ingredient found in turmeric plants is the *curcumin*, which has been found to have antioxidant and antibacterial activities (Kerami *et al.*, 2011). Over the years turmeric has proved to have a protective effect as a feed additive on aflatoxin-induced mutagenicity and hepatocarcinogenicity in livestock production. The aim of the present study is to assess the growth performance and hematological assay of broiler chickens at starter phase given diets supplemented with processed turmeric (*Curcuma longa*).

Materials and methods

The experiment was carried out at the poultry unit of the Federal College of Agriculture, Ishiagu, Ebonyi state. The experiment lasted for a period of five weeks. The test ingredient, which is turmeric was sourced at the Research Institute, Umudike and also locally at the Ogbete main market, Enugu state. The fresh turmeric was peeled, cleaned and washed, and later sundried before been crushed into powder form at the college feed mill.

A total of 96 day old Agri-tech broiler chicks were used for the experiment. The birds were randomly distributed into four treatments namely, T1, T2, T3 and T4. Each treatment was replicated three times, with eight birds per replicate and twenty-four birds per treatment. The birds were raised on a deep litter system with wood shavings serving as a source of litter. All chicks were raised in a well ventilated and sanitized deep

litter broiler poultry house using wood shavings as litter materials. Similar routine management practices were maintained for all the treatment groups. The birds were vaccinated on schedule against Newcastle, gumboro and fowl pox disease.

Determination of daily feed intake was done by obtaining the difference between the quantity of feed offered and the left over the following morning. All chicks were weighed at the beginning and at the end of the study, the weight was taken weekly. The body weight gain was calculated by subtracting the initial body weight from the final body weight. The body weight change (daily body weight gain) was obtained by dividing the body weight gain by the number of days the experiment lasted. Data generated was used to calculate the feed conversion ratio. The quantity of feed consumed compared with the unit gain as a measure of the efficiency of the feed given. This was expressed as the ratio of daily feed intake to daily weight gain. At the end of the feeding trial, blood samples (2 mLs bird⁻¹) were randomly collected from one bird per replicate (three birds per treatment) from the wing vein with a sterile needle into well-labeled sterilized bottles containing EDTA as an anticoagulant. These were used for the hematological analysis to estimate the Packed Cell Volume (PCV), Hemoglobin count (Hb), Red Blood Cell (RBC) and White Blood Cell (WBC). Data obtained were subjected to analysis of variance (ANOVA) according to A.O.A.C (2005).

Results and discussion

The growth performance traits of birds given the experimental diets are presented in Table 3. Supplementation of processed turmeric meal in the diets of starter broiler birds significantly ($p < 0.05$) influenced the final live weight, daily feed intake, daily body weight gain and feed conversion ratio. The result for the final body weight showed

Table 1: Composition of starter broiler diet

Parameters	Treatments			
	T1(0%tm)	T2(0.5%tm)	T3(1.0%tm)	T4(1.5%tm)
Maize	52.25	51.75	51.75	51.75
Wheat offal	9.50	9.50	9.00	9.00
Groundnut cake	22.15	22.15	22.15	21.65
Total	100	100	100	100

Other feed ingredient had the same value across the treatment group. Soybean meal -5.00; Fishmeal -3.00; Bloodmeal -3.00; Bonemeal -2.50; Limestone-1.50; Salt-0.25; Starter premix-0.30; Lysine-0.25; Methionine-0.30.

Table 2: Proximate composition of turmeric meal (on dry matter basis)

Component	% Composition
Crude protein	10.32
Crude fiber	4.78
Ether extract	7.40
Ash content	3.98
Nitrogen free extract	3.52

that birds in treatment 1 (control) had the highest value of 1385 g which was similar ($p>0.05$) to those of birds in treatment 2 (1357 g), but different ($p<0.05$) from those in treatment 3 (1244 g) and 4 (1159 g) respectively. The significant decrease in value for final body weight across the treatment group may be due to the inability of the birds' enzymatic system to stimulate protein synthesis and also optimized the antioxidant activities of turmeric. This present research work is in contrast with the work of Samarasinghe *et al.* (2003) who found out that inclusion of turmeric meal in the diet increased their body weight. Average daily feed intake showed significant ($p<0.05$) effect among treatment group. Values for birds in treatment 1 (98.37 g) was similar ($p>0.05$)

to those on treatment 2 (97.20 g), but was significantly ($p<0.05$) different from those obtained for birds on treatment 3 (90.18 g) and 4 (88.66 g). The result obtained in this study was in agreement with the work carried out by Rajput *et al.* (2013) that reported a significant difference in feed consumption when dried processed turmeric meal was offered to broiler birds, but disagreed with the observation of Nouzarian *et al.* (2011) who observed no significant ($p>0.05$) differences when turmeric meal was fed to starter broiler chicks. Thus, the low level of feed intake observed in treatments containing turmeric meal could be due to the inability of the birds' gut to maximize the turmeric meal due to its colour and taste imparted on the diets.

Table 3. Growth performance characteristics of starter broilers fed diet supplemented with processed turmeric meal

Parameters	Treatments				SEM
	T1	T2	T3	T4	
Initial body Weight (g)	259	253	259	257	-
Final body weight (g)	1385 ^a	1357 ^a	1244 ^b	1159 ^c	35.33
Av. Daily weight gain (g)	53.62 ^a	52.57 ^a	46.91 ^b	42.95 ^c	1.70
Av. Daily feed intake (g)	98.37 ^a	97.10 ^a	90.18 ^b	88.66 ^c	1.39
Feed conversion ratio	1.84 ^c	1.85 ^c	1.92 ^b	2.06 ^a	0.05

^{abc} Means on the same row with different superscripts are significantly ($p < 0.05$) different.
SEM = Standard error of mean.

Broilers fed diets supplemented with tumeric (Curcuma longa) meal

The result of the haematological indices of starter broilers fed diets supplemented with processed turmeric meal is presented in Table 4. Haematological parameters are good indicators of the physiological status of the animal (Esonu *et al.*, 2006). The blood parameters for hematology were significantly ($p < 0.05$) affected by the *Curcuma longa* across the treatment group, even though they did not follow a particular pattern. All values obtained for packed cell volume (PCV), hemoglobin (Hb), red blood cell (RBC) and white blood cell

(WBC) studied falls within the normal ranges for broiler as reported by The Merck Veterinary Manual (2015). The results obtained in the present study contradicts the findings of Abou-Elkhair *et al.* (2014) who reported that inclusion of turmeric meal in the diet of starter broilers had no effect on PCV, Hb, RBC and WBC respectively. The improvement in the haematological constituents observed in the present study is an indication that the inclusion of turmeric meal did not show any pathological effect on the bird thus did not cause or create any haematological disorder.

Table 4. Haematological characteristics of starter broilers fed diet supplemented with processed turmeric meal

Parameters	Treatments				SEM
	T1	T2	T3	T4	
Packed cell volume (%)	22 ^a	22 ^a	15 ^b	21 ^a	0.87
Haemoglobin (g/d)	7.3 ^a	7.4 ^a	5.0 ^b	7.0 ^a	0.30
Red blood cell ($\times 10^{12/l}$)	2.3 ^a	2.6 ^a	1.6 ^b	2.6 ^a	0.13
White blood cell ($\times 10^9/l$)	5.4 ^c	6.2 ^b	4.5 ^d	7.5 ^a	0.34

^{abcd} Means on the same row with different superscripts are significantly ($p < 0.05$) different.
SEM = Standard error of mean.

Conclusion

The study indicated that the use of turmeric meal in the diets of broiler chickens does not have any adverse effect on them. Thus, the addition of turmeric meal up to 1.5% can be tolerated by the broiler birds at their starter stage without any negative effect. In conclusion, turmeric meal could be safely used as a phyto-additive for broiler chickens.

References

Abou-Elkhair, R., Ahmed, H. A. and Selim, S. 2014. Effect of black pepper (*Piper nigrum*), turmeric powder (*Curcuma longa*) and coriander seeds (*Coriandrum sativum*) and their combinations as feed additives on growth performance, carcass traits, some blood parameters and humoral immune response of

broiler chickens. *Asian-Australas. J. Anim. Sci.*, 27(6):847-854.

Akbarian, A., Abolghasem, G., Ahmadi, S. and Hossein, M. 2012. Effect of ginger root (*Zingiber officinale*) on the egg yolk cholesterol, antioxidant status and performance of laying hens. *Journal of Applied Animal Science*, 39: 19-21.

AOAC. 2005. Association of Official Analytical Chemists. Official methods of Analysis. 18th edition. AOAC Inc. Arlington, Virginia, USA.

Esonu, B. O., Opara, M. N., Okoli, I. C., Obikaonu, H. O., Udedibie, C. and Iheshiulor, O. M. 2006. Physiological response of laying birds to neemleaf meal based diets; body weight, organ

- characteristics and hematology. *Online Journal of Health and Allied Science*, 5: 26-30.
- Kerami, M., Alimon, A. R., Sazili, A. Q., Goh, Y. M. and Ivan, M. 2011.** Effect of dietary antioxidants on the quality, fatty acid profile and lipid oxidation of longissimus muscle in Kacang goat with aging time. *Meat Sci.*, 88: 102-108.
- Kumara, P. M. K., Gupta, R., Ranjan, K. K., Singh, R. and Yadava, R. 2007** *Curcuma longa* as feed additive in broiler birds and its pathophysiological effects. *Indian Poultry Science*, 40: 137-141.
- Martins, A. M. 2001.** The future of the world food system. *Outlook on Agriculture*, 30: 11-19.
- Nouzarian, R., Tabeidian, S. A., Toghyani, M., Ghalamkari, G. and Toghyani, M. 2011.** Effect of turmeric powder on performance, carcass traits, humoral immune responses and serum metabolites in broiler chickens. *J. Anim. and Feed Sci.*, 20: 389-400.
- Olabode, A. D., Onyimonyi, A. E., Ezekwe, A. G. and Okelola, O. E. 2013.** Performance characteristics and economic evaluation of laying birds fed graded levels of neem leaf meal. *Inter. J. Agric. BioSci*, 2(5):213-216
- Olabode, A. D., Ojuoloruntaye, T. J., Agu, C. I. and Okelola, O. E. 2018.** Performance and haematological characteristics of starter broilers fed diet supplemented with turmeric (*Curcuma longa*) meal. *Proceeding of the Nigerian Society for Animal Production*, 43: 180-182.
- Onyimonyi, A. E., Olabode, A. D and Okeke, G. C 2009.** Performance and economic characteristics of broilers fed varying levels of neem leaf meal. *International Journal of Poultry Science*, 8(3): 256-259.
- Raghdad, A. and Al-Jaleel, A. 2012.** Use of turmeric (*Curcuma longa*) on the performance and some physiological traits of broiler birds. *The Iraqi Journal of Veterinary Medicine*, 36(1):51-57.
- Rajput, N., Muhammed, N., Yaan, R., Zhang, X. and Wang, T. 2013.** Effect of dietary supplementation of *curcumin* on growth performance, intestinal morphology and nutrients utilization of broiler chicks. *J. Poult. Sci.*, 50: 44-52.
- Samarasinghe, K., WenkSilvak, K. and Gunasekera, J. 2003.** Turmeric (*Curcuma longa*) root powder and mannan-oligosaccharides as alternatives to antibiotics in broiler chicken diets. *Asian-Australas. J. Anim. Sci.*, 16(10): 1495-1500.
- The Merck Veterinary Manual 2015.** Recommended nutrient level for pullet chicken. A subsidiary of Merck and Co. Inc., Kenilworth, N.J., U.S.A
- Zhang, G. F., Yang, Z. B., Wang, Y., Yang, W. R., Jiang, S. Z. and Gai, G. S. 2009.** Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens. *Poultry Science*, 88:2159-2166.

Received: 26th July, 2018

Accepted: 21st December, 2018