Nigerian J. Anim. Sci. 2018, 20 (4): 402-413

Effects of xylanase enzyme supplemented palm kernel cake (PKC) diet on performance and nutrient retention of broiler chickens

Aderibigbe T.A., Atteh J.O., Alli O.I. and Okukpe K.M.*

Department of Animal Production, Faculty of Agriculture, University of Ilorin, PMB 1515, Ilorin, Kwara State, Nigeria.

***Corresponding Author:** okukpekehinde@yahoo.com; **Phone No.:** +2348066716145

Target Audience: Livestock feed producers and Poultry farmers

Abstract

The development of antibiotics-resistance pathogens in poultry, which poses threat to human health, has necessitated the search for alternative to antibiotic growth promoters (AGPs) to improve gut microflora in poultry diets. One of the alternatives to AGPs is probiotics, which are beneficial organisms. Prebiotics, are by-products of digestion of polysaccharides which poultry do not have enzymes to digest are food for probiotics. Advent of enzymes makes this digestion possible. This study was conducted to assess the effects of xylanase enzyme supplemented of palm kernel cake (PKC) on performance of broiler chickens. One thousand, nine hundred and twenty day old broiler chicks of Arbor Acre strain were used in a completely randomized design with 4 x 2 factorial combinations. Birds were fed control diet (50%) maize in which PKC was added at 10, 20 or 30% replacing maize in the control diet. Each of the diets was administered with or without 100ppm xylanase enzyme for a period of five (5) weeks. The replacement of maize with Palm Kernel Cake irrespective of levels supplemented with 100ppm xylanase enzyme caused a reduction in feed intake and an increase in weight gain and better FCR. In all these parameters, it is observed that birds fed diet with 10% PKC supplemented with xylanase enzyme out-performed birds fed diets with 10 or 30% PKC supplemented with xylanase enzyme and closer to the birds fed the control diet which was with better FCR. It can be deduced that enzyme supplementation of PKC helped in increasing and improving protein, ether extract and fibre digestibility. The haematological and serum biochemistry were within normal range for broiler chickens. The replacement of maize with PKC irrespective of the levels with supplementation of xylanase posed no threat on the health of the birds. The result of the cost benefit analysis also showed that 10% inclusion level of PKC supplemented with xylanase enzyme gave the best result of a beneficiary reduction in the cost of production with the best improved broiler performance. Enzyme supplementation of high fibre feedstuffs (HFF) could improve growth performance, nutrient retention and fibre digestibility.

Key words: prebiotics, enzymes, intestinal microflora, broiler nutrition, digestibility

Description of Problem

Palm kernel cake (PKC) is a major byproduct from the palm kernel oil industry in several tropical countries including Malaysia, Indonesia, Thailand and Colombia. Its composition contains about 15.4% crude proteins and 16.4% crude fibre out of which about 20 to 40% of the fibreis in the form of β-mannans (1; 2). This abundant by-product of palm oil industry is used as animal feed, although its use is limited to ruminant animals due to its high hemicellulose (mannan and galactomanan) and low essential amino acids (3).

Palm kernel meal is not widely used in the poultry industry because of its high fibre and low energy contents. The use of PKC in poultry diets has been reported by several researchers (4; 5; 6).It has also been reported that enzymes could break down the non-starch polysaccharides (mannans) into manno-oligosaccharides to improve its nutritional quality (7; 8; 9; 10).

The use of antibiotics in the feed to improve animal performance has been in practice for decades but this has recently been banned in the European Union since 2006. This was due to the development of antibiotics resistance by pathogens such as Salmonella, *E. coli* and *Clostridium perfringens*) and the presence of antibiotic residues in livestock/ human consumers of livestock products. This has resulted in the search for alternative growth promoters in livestock production. Prebiotics is reported as one of the alternatives to the use of antibiotics in animal feed as Mannan can be hydrolyzed into manno-oligosaccharides (MOS), a type of prebiotics (11; 12). Thus, this study was aimed at evaluating the effect of enzyme supplemented PKC on performance and nutrient retention of broiler chickens.

Materials and Methods

Sourcing and Management of birds – A total of 1920 day old broiler chicks of Arbor Acre strain purchased from Yammfy Farm hatchery at Ilemona, Kwara State were used for this experiment. The birds were housed in an electrically heated battery cage and fed the experimental diet shown in Table 1. *Xylanase* enzyme used is a bacteria xylanase feed enzyme (Nutrase, a pure endo-1, 4-beta-xylanase) produced by Bacillus subtilis to break down the arabinoxylan fraction into shorter polysaccharide (xylose monomers) with a decrease of viscosity, liberation of nutrients and improved zoo technical performances. It was supplied by Nutrex, Belgium. The study was conducted following the guidelines of the Research Policy of the University of Ilorin on Animal Welfare and Ethics.

Experimental design – A total of 1920 day-old broiler chicks were randomly assigned to eight treatments with three replicates each made up of eighty birds per replicate. Birds were fed a control diet (50% maize) or diets in which palm kernel cake was added at 10, 20, or 30% replacing maize in the control diet. Each of these diets was given with or without 100 PPM *xylanase* enzyme in a 4 x 2 factorial combination. The experimental diets were formulated to meet NRC nutrient requirements for broiler (49), in particular the recommendations for Arbor Acre strain. Each experimental treatment was fed *ad-libitum* with its own diet for a period of 5weeks. Live weight was recorded weekly while feed intake was recorded daily in grams and excreta samples collected over a 72 hour period. Nutrient retention trial was done at the third week of the feeding trial using a total collection method. Excreta samples were oven dried at 70^{o}C, weighed and ground prior to chemical analysis. The experimental diets and excreta samples were analyzed for their chemical constituents using the procedures outlined by (13).

Table 1: Composition of experimental diet (%)

Ingredients	1	2	3	4	5	6	7	8
Maize	50	50	40	40	30	30	20	20
Palm Kernel Cake	0	0	10	10	20	20	30	30
Xylanase (ppm)	0	100	0	100	0	100	0	100
Basal ingredients	50	50	50	50	50	50	50	50
Total	100	100	100	100	100	100	100	100

Basal diets : Groundnut cake(GNC) – 26%, corn bran- 1%, soybean meal- 12%, fishmeal(72%)- 4%, palm oil- 2%, oyster shell- 2%, bone meal- 2%, salt- 0.25%, methionine- 0.25%,lysine- 0.25% and vitamin premix- 0.25%.(*Vitamin/ mineral premix contained the following: (Univit. 15 Roche) Vit A, 1500 I.U, Vit D, 3000 I.U, Vit E, 3.0g, Vit K, Vit. B_2 0.3g, Vit.B_6, 8.0mg, Vit.B_{12}, 8.0g, Nicotinic Acid, 3.0g, Ca-Pantothenate, 50mg, Fe, 10.00g, Al, 0.2g, Cu, 3.5mg, Zn, 0.15mg, I, 0.02g, CO_2, 0.01g, Se).

At the end of the experiment, blood samples were taken from 10 randomly selected birds per replicate in each treatment. 4 ml of blood was collected from the jugular vein at the neck of each bird by using sterile needle and syringe to withdraw the blood. The blood samples were put into properly labeled and sterilized tubes without anticoagulant for blood biochemistry. For blood haematology samples were placed in properly labeled and sterilized tubes already treated with EDTA (Ethylene Diamine Tetra Acetic acid). The following biochemical and haematological parameters were determined: Total protein, Albumin, Urea, Haemoglobin concentration (Hb), Red blood cell (RBC), White blood cell (WBC), and Packed cell volume (PCV). The biochemical parameters were determined as previously described by (14). The haematological parameters were determined as previously described by (15) and (14). The Mean Cell Volume (MCV), Mean Corpuscular Haemoglobin Concentration (MCHC) and Mean Corpuscular Haemoglobin (MCH) were estimated by calculation using a standard formula (16).

Cost-benefit Analysis - Cost-benefit analysis was carried out, taking into consideration the cost of maize, palm kernel cake and the enzyme (*xylanase*) as they related to the performance of birds.

Statistical analysis - All Data collected were subjected to two way analysis of variance (ANOVA) using the PRO GLM (General Linear Model) of SAS (17) at 5% level of significance. All significantly different means were separated using the Duncan's Multiple Range Test of the same software package.

Results

The effect of dietary levels of Palm Kernel Cake with or without enzyme supplementation on the performance of broilers is shown in Table 2. Increase in dietary levels of Palm Kernel Cake from 0% t0 30% had a significant effect on the feed intake, Weight gain and feed conversion ratio ($p<0.05$). Feed intake by birds fed the control was significantly lower than those of birds fed diets with dietary levels of PKC ($p<0.05$). Dietary levels of PKC had significant increased effects on the feed intake ($p<0.05$). Birds fed the control diet gained more weight than those of birds fed dietary levels of PKC ($p<0.05$). Dietary levels of PKC had significant decreased effects on the weight gain ($p<0.05$). Feed gain ratio of birds fed the control diet was significantly lower than those of birds fed diets with dietary levels of PKC

($p<0.05$). The dietary levels of PKC had increased significant effects on the FCR of the birds. Thus, birds fed the control diet had a better feed gain ratio compared to dietary levels of PKC ($p<0.05$).There was significant effects by enzyme supplementation on performance of the broilers. Enzyme supplementation had significant increase effect on weight gain ($p<0.05$) but decrease effect on feed intake and feed/gain ratio ($p<0.05$). There were significant interaction between dietary levels of Palm Kernel Cake and enzyme supplementation on Feed Intake, Weight Gain and Feed Conversion Ratio parameters ($p<0.05$).Crude protein of birds fed the control diet was significantly higher than those of birds fed diets with dietary levels of PKC ($p<0.05$). Dietary levels of PKC had a significant decreased effect on the protein retention by the birds. Crude fibre by birds fed the control diet and birds fed diet with10%PKC were comparable ($p>0.05$), but significantly higher than those of birds fed diets with 20% or 30%PKC ($p<0.05$). Dietary levels of PKC had significant increase effects on the Crude Fibre ($p<0.05$). Ether extract by birds fed the control diet and birds fed diet with10%PKC were comparable ($p>0.05$), but significantly higher than those of birds fed diets with 20% or 30%PKC ($p<0.05$). Ether extract by birds fed diets with 20% and 30%PKC were comparable but significantly lower than those of birds fed diet with 10%PKC ($p<0.05$). Enzyme supplementation had significant increased effects on nutrient retention ($p<0.05$). There was significant interaction between enzyme supplementation and dietary levels of PKC on Crude Protein and Crude Fiber ($P<0.05$). The details of interactions are shown in Table 3. Thus, enzyme supplementation of the control diet resulted in decrease in crude protein retention and crude fibre retention but reverse was the case with addition of PKC irrespective of levels ($p<0.05$).

Table 2: Effects of Dietary Levels of Palm Kernel Cake (PKC) with or without *Xylanase* Supplementation on Performance of Broilers (0-5wks) and Nutrient retention

PKC (%)	Feed consumed (g/bird/day)	Weight gain (g/bird/day)	FCR	Crude protein (%)	Crude fibre (%)	Ether extract (%)
0	55.40^{d}	29.70^{a}	1.80^{d}	83.90^{a}	66.10^{a}	60.10^{a}
10	56.10^{c}	28.10^{b}	2.00^{c}	76.90^{b}	65.10^{a}	66.50^{a}
20	57.50^{b}	25.90^{c}	2.20^{b}	69.50^{c}	61.80^{b}	58.60^{b}
30	59.60^{a}	24.40^{d}	2.50^{a}	62.00^{d}	56.10^{c}	59.80^{b}
SE	0.11	0.16	0.01	0.44	0.58	1.66
Enzyme Supplementation (ES)(ppm)						
0	58.60^{a}	26.80^{b}	2.20^{a}	70.50^{b}	57.70^{b}	59.40^{b}
100	55.70^{b}	27.30^{a}	2.10^{b}	76.00^{a}	67.20^{a}	63.20^{a}
SEM±	0.08	0.12	0.01	0.31	0.41	1.17
PKC x ES	NS	NS	NS	S	S	NS

Column means with different superscripts are significantly different ($p<0.05$), *NS: not significant, S: Significant*

Table 3 shows the interaction between enzyme supplementation and dietary levels of Palm Kernel Cake. In the absence of *xylanase* supplementation, there was significant increase in feed intake (P>0.05), a decrease in weight gain (P<0.05) and a significant increase in feed conversion ratio (P>0.05). There was a respective reversal of the cases when the diet was supplemented with *xylanase*.

Table 3: Details of interaction on feed consumed, weight gain, feed conversion ratio, crude protein and crude fibre

Enzyme supplementation	Dietary Palm Kernel Cake Supplementation (%)			
ES (100ppm)	0	10	20	30
Feed **0**	56.40^{d}	58.20^{c}	59.20^{b}	60.50^{d}
Consumed **100**	54.40^{f}	54.10^{f}	55.70^{e}	58.60^{c}
Weight **0**	29.80^{a}	28.30^{b}	25.70^{c}	23.40^{d}
Gain **100**	29.70^{a}	27.90^{b}	26.10^{c}	25.50^{c}
Feed **0**	1.90^{e}	2.10^{d}	2.30^{b}	2.60^{a}
Conversion **100**	1.80^{f}	1.90^{e}	2.10^{c}	2.30^{b}
Crude **0**	86.63^{a}	76.59^{c}	66.32^{e}	56.43^{f}
Protein **100**	81.25^{b}	77.15^{c}	72.60^{d}	67.49^{e}
Crude **0**	67.81^{b}	57.81^{e}	57.20^{e}	51.34^{f}
Fibre **100**	64.45^{c}	76.59^{c}	66.32^{e}	56.43^{f}

column means with different superscripts are significantly different (p<0.05)

Table 4 shows the Cost Benefit Analysis for replacing Maize with Palm Kernel Cake with or without enzyme *xylanase* supplementation. Increase in dietary level of PKC reduced the cost of feed. Addition of *xylanase* to each level of PKC automatically increased the cost of the feed. Increase in dietary level of PKC caused an increase in the cost of producing 1kg of broiler irrespective of enzyme supplementation. Enzyme supplementation irrespective of dietary level of PKC caused a reduction in cost of raising 1kg of broiler Chickens.

Table 4: Cost Benefit Analysis for replacing Maize with Palm Kernel Cake with or without enzyme *xylanase* supplementation

Source of Variation	Cost of Producing/kg (N)	Percentage reduction in price of feed	Cost of Raising 1Kg of Broilers (N)	Percentage reduction to Raise 1Kg of Broilers (%)
Enzyme*Treatment				
Non- Inclusion 0	111.49	0.00	211.83	0.00
Non- Inclusion 10	106.49	4.70	218.30	-3.06
Non- Inclusion 20	101.15	10.22	233.66	-10.30
Non- Inclusion 30	96.50	15.53	249.94	-17.99
Inclusion 0	114.49	-0.03	209.52	**1.09**
Inclusion 10 Inclusion	109.49	1.82	212.41	**-0.27**
20	104.15	7.06	221.84	**-4.72**
Inclusion 30	99.50	12.05	228.85	**-8.03**

Table 5 shows the effects of dietary levels of PKC with or without enzyme supplementation on heamatological parameters of broilers. Increase in dietary levels of PKC from zero to 30% had significant effect on the PCV, Hb, RBC, Platelet, MCV, MCH, WBC and Lymphocytes ($p<0.05$), but no significant effects for MCHC and Neutrophils ($p>0.05$). The PCV for birds fed the control diet was significantly higher than those of birds fed with dietary levels of PKC ($p<0.05$). PCV for those of birds fed diets with PKC irrespective of levels were comparable ($p>0.05$). The Hb for birds fed the control diet was significantly higher than those of birds fed with dietary levels of PKC ($p<0.05$). Hb for those of birds fed diets with PKC irrespective of levels were comparable ($p>0.05$). RBC for birds fed the control diet was significantly higher than those of birds fed with dietary levels of PKC ($p<0.05$). The RBC for those of birds fed diets with PKC irrespective of levels were comparable ($p>0.05$). The platelet for birds fed the control diet was significantly higher than those of birds fed with dietary levels of PKC ($p<0.05$). Platelet for birds fed diet with 30%PKC was significantly lower than those of birds fed diets with 10% or 20%PKC($p<0.05$). MCV for birds fed the control diet was significantly higher than birds fed diet with 30%PKC ($p<0.05$), but comparable with those of birds fed diets with 10% or 20%PKC ($p>0.05$). MCV for those of birds fed diets with PKC irrespective of levels were comparable ($p>0.05$). MCH for birds fed the control diet and birds fed diet with 10%PKC were comparable($p>0.05$), but significantly lower than those of birds fed diets with 20% or 30%PKC($p<0.05$). MCH for birds fed diet with 10%PKC was significantly lower than those of birds fed diets with 20% or 30%PKC($p<0.05$). WBC for birds fed the control diet was significantly higher than those of birds fed with dietary levels of PKC ($p<0.05$). The WBC for those of birds fed diets with PKC irrespective of levels were comparable ($p>0.05$). Lym for birds fed the control diet was significantly higher than those of birds fed with dietary levels of PKC ($p<0.05$). The Lym for those of birds fed diets with PKC irrespective of levels were comparable ($p>0.05$). There was no significant effects by enzyme supplementation on PCV, Hb, MCH, MCHC, WBC and Lymphocytes of the broiler chickens ($p>0.05$). However, there were significant increased effects on RBC, Platelet, MCV and Neutrophils ($p<0.05$). There was no significant interaction between enzyme supplementation and dietary levels of PKC on all the parameters ($p>0.05$).

Table 5: Effects of dietary levels of Palm Kernel Cake with or without enzyme *xylanase* supplementation on heamatological parameters of broilers.

	PCV (%)	Hb(g/L)	RBC ($x10^{12}$/L)	Platelet ($x10^{9}$/L)	MCV	MCH	MCHC	WBC ($x10^{9}$/L)	Neut (%)	Lym (%)
PKC(%)										
0	38.30^{a}	12.80^{a}	3.60^{a}	117.00^{a}	107.00^{a}	35.90^{b}	33.30	3.50^{a}	50.80	48.30^{a}
10	29.50^{b}	9.80^{b}	2.60^{b}	108.50^{b}	103.00^{ab}	38.10^{b}	33.30	2.60^{b}	50.80	36.80^{b}
20	28.30^{b}	10.20^{b}	2.10^{b}	105.80^{b}	100.50^{ab}	41.90^{a}	33.20	2.70^{b}	45.50	38.00^{b}
30	27.80^{b}	9.80^{b}	2.10^{b}	100.00^{c}	99.00^{b}	44.70^{a}	33.30	2.70^{b}	45.00	35.30^{b}
SE	0.89	0.34	0.30	1.58	2.41	1.08	0.13	0.14	1.86	1.76
Enzyme (100ppm)	30.40	10.80	2.60^{b}	101.90^{b}	95.80^{b}	39.60	33.30	2.80	44.90^{b}	39.60
0	31.50	10.60	3.60^{a}	113.80^{a}	109.00^{a}	40.70	33.20	2.90	51.10^{a}	39.50
100	0.63	0.24	0.21	1.11	1.70	0.76	0.09	0.10	1.32	1.25
SE	0.24	0.57	0.97	0.00	0.00	0.31	0.42	0.35	0.01	0.95
PKC*ES	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*Means within column with different superscripts are significantly different ($p<0.05$);*Packed Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell Count(RBC), The Mean Cell Volume (MCV), The Mean Cell Haemoglobin (MCH), The Mean Cell Haemoglobin Concentration (MCHC), The Total White Blood Cell (WBC), the Neutrophil (Neut), the Lymphocytes (Lym) ; NS: No Significant difference ($p>0.05$).

Discussion

Palm Kernel Cake (PKC) is a by-product of the African palm oil industry, which can be fed to poultry because of its availability and low cost (18). World report (19) indicated Nigeria as the third largest world producer and exporter of PKC after Malaysia and Indonesia. The inclusion of PKC in the diets was less practiced in monogastric animals particularly in poultry due to its high fibre content (20). But the nutritive value of PKC may be improved through exogenous supplementation of enzymes to breakdown the non-starch polysaccharides (21; 22).

According to the findings of this study, Feed intake increased with increasing PKC levels in the diets without enzyme *xylanase* supplementation, with broilers fed the control (0%PKC) diet without *xylanase* having significantly ($p<0.05$) least feed intake which was close to feed intake of birds on10% PKC diet without *xylanase*. The feed intake was also increasing with PKC inclusion level without *xylanase* supplementation. This is in agreement with (23) who reported increase in feed intake with increase in PKC inclusion level in the diets of broilers. This increase in daily feed intake with inclusion level could be due to energy dilution of the diet by PKC leading to the broilers consuming more feed to meet their energy requirement (24; 25). However, the addition of enzyme *xylanase* reduced the feed intake. This is supported by (26) and (27) who recorded similar observation and it might be due to better feed utilization in the presence of exogenous enzymes.

Replacement of maize with PKC without enzyme supplementation caused a significant ($P<0.05$) reduction in weight gain when compared with the control. This is in agreement with (28) who reported that birds fed on diets containing 10%, 15% and 20% of PKC instead of soybean meal reduced the body weight gain when compared with control. With *xylanase* supplementation, the body weight gains were apparently improved. The moderate improvement in weight gain might be due to improved fibre digestibility by the exogenous enzyme (*xylanase*) which is in consonance with the findings of (29) and (27).

The feed/gain ratio of broilers was significantly affected with the inclusion levels of PKC without enzyme supplementation compared to control confirming the earlier report of (30) who recorded significant($P<0.05$) differences in feed efficiency due to inclusion of higher levels of PKC in the diets of broiler chickens. Birds fed PKC diets with *xylanase* showed better feed/gain ratio. It might be due to better utility of nutrients from Non-starch polysaccharides (NSP) by the effect of *xylanase* leading to better feed efficiency (feed/gain ratio). This result is in conformity with the finding of (26) who reported improvement in feed conversion ratio in birds fed biodegraded PKC. Feed to gain ratio was better among enzyme supplemented diets and the control compared with all other diets without enzyme supplementation (31). This is similar to the reports of (32) and (33) who separately observed improvements in weight gain and feed: gain ratio in birds fed enzyme supplemented diets. (33) also observed lower weight of birds fed increasing levels of PKM without enzyme supplementation.

PKC inclusion resulted in a lower cost of raising broiler chickens to 1kg live weight without detrimental effect, hence shows its economic advantage. This was as a result of an expensive high energy feedstuff source (maize) being replaced by PKC (a cheaper non-conventional feedstuff).

The reduction in CP, CF, and EE digestibility in the PKC diets without *xylanase* supplementation was attributed to the effect of replacement of highly digestible carbohydrate source, maize by PKC which was of low digestibility. The higher crude fibre content of the PKC diets may have adversely affected digestion. This is in line with (34) and (35) who reported that PKC in diets has been implicated in low digestibility of due to its high crude fibre level which is estimated at 150g/kg of PKC. Based on this trial an improved nutrient retention is observed when PKC was supplemented with *xylanase*. The enhanced nutrient digestibility was due to the breakdown of the NSPs in PKC by exogenous enzyme. Fibrous feeds decreased the digestibility of crude protein (36; 37) and the possibility that the presence of the fibre may speed up the rate of passage of feed through the simple stomach of monogastric thereby leaving little time frame for nutrient to be utilized by the birds; this was reported by (38); but enzyme supplementation helps to improve the nutrient availability in monogastric (39; 21) such that the crude protein, crude fibre and ether extract are release in a way that is more readily available for utilization by the birds . This is also in agreement with (40) and (32) who observed that the use of *xylanase* enhanced nutrient utilization. Birds fed with diets supplemented with enzymes had better crude fibre retention as compared to those fed diets without enzyme supplementation. This may also be as a result of the effect of the enzyme supplementation on the feedstuffs as exogenous enzyme supplementation has been reported to improve the digestibility of fibrous agricultural products (41; 42; 43). The effect of dietary treatments on ether extract as observed in this study may be attributed to the fact that enzyme supplementation improves ether extract availability and utilization for Monogastric animals

The increase in the level of some heamatological parameters might be as a result of anti-nutritional factor in the fibre source of diets. This is in consonance with the work of (44) who attributed the poor values in PCV and Hb of birds fed diets containing tiger nut meal to fibre and anti-nutrients of raw tiger nut meal such as trypsin inhibitors, tannins, phytate, among others, that inhibit proper utilization of nutrients especially protein and iron necessary for red blood formation (45). The Hb was within the standard range of 7 – 13 (46).

The platelets at 10% and 20% had similar effect, which was significantly lower than 0% and higher than 30% PKC inclusion level although that of 10% was numerically higher than that of 20% PKC inclusion level. This showed that birds fed with PKC based diets will not be able to cope with blood coagulation as effectively as birds fed diets without PKC inclusion. This may also be as a result of high fibre content in the PKC based diets. This corresponds with the report of (47) who reported a significant reduction in the platelets of birds fed raw T. catappa seed meal-based diet due to anti-nutritional factors. The result of the Lymphocytes was not in agreement with (44) who reported that lymphocyte was higher at 0% tiger nut diet as compared to other tiger nut inclusion level. This was due to the stress of anti-nutrients and high fibre diets on broiler chicks, which often cause reduction in oxygen carrying capacity of the animals blood i.e. anaemia with the resultant impairment on growth (48).

Conclusion and Applications

The results obtained from this study showed that:

1. Replacement of maize with Palm Kernel Cake irrespective of levels supplemented with 100ppm *xylanase* enzyme caused a reduction in feed intake and an increase in weight gain and better FCR.
2. Birds fed diet with 10% PKC supplemented with *xylanase* enzyme out-performed birds fed diets with 20 or 30% PKC supplemented with *xylanase* enzyme and closer to the birds fed the control diet, which was with better FCR.
3. Enzyme supplementation of PKC helped in increasing and improving protein, ether extract and fibre digestibility.
4. The haematological and serum biochemistry results in this trial were within normal range for broiler chickens. This showed that replacement of maize with PKC irrespective of the levels used in this trial with supplementation of *xylanase* posed no threat on the health of the birds.
5. The 10% inclusion level of PKC supplemented with *xylanase* enzyme gave the best result of a beneficial reduction in the cost of production with the best improved broiler performance.

References

1. Yadi, P and Yana, S. (2011). The influence of Palm Kernel Cake and Rice Bran Fermentation Product Mixture to the Broiler Carcass Quality. *International Journal of Waste Resources* 1(2): 15-17.
2. Adrizal A., Y. Yusrizal, S. Fakhri, W. Haris, E. Ali, and C. R. Angel. (2011). Feeding native laying hens diets containing palm kernel meal without enzyme suplementation: 1. Feed conversion ratio and egg production. *Applied Poultry Research* 20: 40–49. http://dx.doi.org/10.3382/japr.2010-00196
3. Sakamoto H. and Toyohara, H. (2009). A comparative study of cellulose and hemicellulase activities of brackish water clam *Corbicula japonica* with those of other marine Vineroida bivalves. *Journal of Experimental Biology* 212: 2812–2818. http://dx.doi.org/10.1242/jeb.031567.
4. Onwudike, O. C. (1986). Palm kernel as feed for poultry. 1. Composition of palm kernel meal and availability of its amino acids to chicks. *Animal Feed Science Technology* 16: 179-186.
5. Zulkifli, I., Ginsos, J. P., Liew, K. and Gilbert, J. (2003). Growth performance and Newcastle disease antibody titres of broiler chickens fed palm-based diets and their response to heat stress during fasting. *Archiv Gefugelkunde* 67: 125-130.

6. Mustafa, M. F., Alimon, A. R., Zahari, M. W., Idris, I and Hair Bejo, M. (2004). Nutrient digestibility of palm kernel cake for Muscovy ducks. *Asian-Australian Journal of Animal Science* 17: 514-517.
7. Dusterhorft, E. M., Bonte, A. W. and Voragen, A. G. J. (1993a). The role of fungal polysaccharidases in the hydrolysis of cell wall materials from sunflower and palm-kernel meals. *World Journal of Microbiology and Biotechnology* 9: 544-554.
8. Dusterhorft, E. M., Bonte, A. W. and Voragen, A. G. J. (1993b). Solubilisation of non-starch polysaccharides from oil-seed meals by polysaccharides-degrading enzymes. *Journal of Science Agriculture* 63: 211-220.
9. Dusterhorft, E. M., Engels, F. M. and Voragen, A. G. J. (1993c). Parameters affecting the enzymic hydrolysis of oil seed meals, lignocellulosic by-products of the food industry. *Bioresource Technology* 44: 39-46.
10. Daud, M., Sama, J. N. d. and Rasool, S. (1997). Specific commercial enzymes for nutritive value improvement of palm kernel cake for poultry diets. In: Proceedings of the 19th MSAP annual Conference. Johor Bahru, Johor, Malaysia. pp. 137-138.
11. Reid, G. and Robert, F. (2002). Alternatives to antibiotic use: Probiotics for the gut. *Animal Biotechnology* 13: 97 – 112. http://dx.doi.org/10.1081/ABIO-120005773
12. Samadi. (2002). Probiotik pengganti antibiotik dalam pakan ternak. [terhubung berkala]. http://www.ppi-goettingen.de/mimbar/kliping/probiotik. html
13. A.O.A.C, (2008). Official Methods of Analysis: Association of Analytical and Applied Chemists (18th edition) Washington D.C. USA.
14. Aderolu, A.Z., Iyayi, E.A and Onilude, A.A. (2007). Performance, Organ Relative Weight, Serum and Haematology Parameters in Broiler Finisher Fed Biodegraded Brewers Dried Grain. *Pakistan Journal of Nutrition* 6 (3): 204-208.
15. Swenson, M.J, (1970). Physiological properties, cellular and chemical constituents of blood. In: Duke's physiology of Domestic Animals. 8th Edn. (M. J. Swenson Edition). Con-stock publishing associates. Cornell University press. Thaca and London.
16. Jang, I.S., Ko, Y.H., Kang, S.Y. and Lee, C.Y. (2007). Effect of a commercial essential oil on growth performance, digestive enzyme activity and intestinal microflora population in broiler chickens. *Animal Feed Science and Technology* 134: 304-315.
17. SAS (2008). SAS Institute Inc. 2008. ASA/STAT Users Guide version 9.2 for windows. Carry, North Carolina, USA. SAS Institute Inc.
18. Perez, J.F., Garnet, A.G. and Murillo, J.G. (2000). Effect of different levels of palm kernel meal in layers diets. *Poultry Science* 79: 77-79
19. World Report (2003). Palm kernel meal: World supply and distribution. In Foreign Agricultural Services. Official USDA Report on estimates for March 2004.
20. Ander, K.O. (1992). Some Physical characteristics of diets containing graded levels of Palm kernel and Corn offal and dressing characteristics of broilers fed these diets. M.sc Thesis, Department of Animal science; University of Ibadan, Nigeria.
21. Hosamani, S. V., Shivakumar, M. C., Kulkkarni, V. S. and Harapanahailli, M. D. (2001). Effect of supplementing dietary enzymes on the performance of broilers. *Karnataka Journal of Agricultural sciences14:1046-1048.*

22. Ohimain, E. I. and Ofongo, R. T. S. (2013). Effect of enzyme supplemented diet on gut microflora, digesta ph and performance of Broiler chickens. *Journal of Microbiology, Biotechnology and Food Sciences.* 3(2): 127-131.
23. Sundu, B., Kumar, A. and Dingle, J. (2005). Palm kernel meal in broilers diets, effect on chicken performance and health. *World Poultry Science Journal* 62: 316-325.
24. Jorgensen, H.Z., XinQuan, K.E., Krudse, B.O. and Zhao, X.Q. (1996). The influence of dietary fibre source and level on development of the gastrointestinal tract digestibility and energy metabolism in broiler chickens. *British Journal of Nutrition* 75: 379-395.
25. Onifade A. A. and Babatunde, G. M. (1998). Comparison of the utilization of palm kernel meal, brewer´s dried grains and maize offal by broiler chicks. *British Poultry Science* 39: 245-250.
26. Lawal, T. E., Iyayi, E. A., Adeniyi, B. A. and Adaramoye, O.A. (2010). Biodegradation of palm kernel cake with multi enzyme complexes from fungi and its feeding value for broilers. *International Journal of Poultry Science* 9: 695-701.
27. Soltan, M. A. (2009). Growth performance, immune response and carcass traits of broiler chicks fed on graded levels of palm kernel cake with out or with enzyme supplementation. *Livestock research for rural Development* 21: 1-15.
28. Ojewola, G. S and Ozuo, U. K. (2006). Evaluation of palm kernel meal as substitute for soybean meal in the diet of growing cockerels. *International Journal of Poultry Science* 5(5): 401-403.
29. Ojewola, G. S., Oguike, M. A., Akomas, S. C., Likita, T., Onyiro, O. M. and Wokocha, C. (2003). Comparison of the supplemental effects of Roxazyme -G enzyme in palm kernel meal and brewers dried grain based diets fed to male turkey poults. *Nigeria Agricultural Journal* 34: 116-124
30. Panigrahi, S. and Powell, C. J. (1991). Effect of high inclusion of palm kernel meal in broiler chick diets. *Animal Feed Science and Technology* 34: 37-47
31. Iyayi, E. A., Ogunsola, O and Iyayi, R. (2005). Effect of three sources of fibre and period of feeding on the performance, carcasses measure, organ relative weight and meat quality in broilers. *International Journal of Poultry Science* 4(9): 695-700.
32. Atteh J.O. (2000). Use of enzyme to improve the nutrient value of wheat inclusion. A paper presented on 2-day seminar on array of tailor made biotechnical improver for flour milling and baking industry. Sheraton Hotel Lagos, Nigeria. May 2-3.
33. Esuga, P. M., Sekoni, A. A., Omage, J. I and Bawa, G. S (2008). Evaluation of enzyme (Maxigrain®) supplementation of graded levels of palm kernel meal (PKM) on the performance of broiler chickens. *Pakistan Journal of Nutrition*, 7(4): 607-613.
34. McDonald, P., Edwards, R.A. and Greenhalgh, J.F.D. (1983). Animal Nutrition, Longman group Limited. 3rd edition, pp. 393 - 409.
35. Ezieshi, E. V and Olomu, J. M (2004). Comparative performance of broiler chickens fed varying levels of palm kernel meal and maize offal. *Pakistan Journal of Nutrition* 3(4): 254-257.
36. Koong, L.J., Ferrell, C.L. and Nienaber, J.A. (1985). Assessment of interrelationships among levels of intake and production, organ size and fasting heat production in growing animals. *Journal of Nutrition* 115: 1383-1390.
37. Iyayi, E. A and Davies, B. I. (2005). Effect of enzyme supplementation of palm kernel meal and brewer's dried

grains on the performance of broilers. *International Journal of Poultry Science* 4(2): 76-80.
38. Yunusa, Y., Doma, U.D., Zahraddeen, D., Umar, A and Abubakar, S.B. (2014). Carcass and Gut Characteristics of Broiler Chicken Fed Different Energy Source. *International Journal of Poultry Science* 13 (9): 525-529.
39. Schingoethe, D.J., Stegeman, G.A. and Treacher, R.J. (1999). Response of lactating dairy cows to a cellulase and xylanase enzyme mixture applied to forages at the time of feeding. *Journal of Dairy Science* 82: 996–1003.
40. Adams, E.A. (1993). Non-starch polysaccharides and their digestion in poultry. *Feed compounder* 13: 19 -21.
41. Tuleun, C.D., Njoku, P.C and Yaakugh, I.D.I. (1998). The performance of pullet chicks fed Roxazyme®. 3rd ASAN Conference, Lagos, 74-76.
42. Rotter, B. A., Friesen, O. D., Guenter, W. and Marquardt, R. R. (1990). Influence of enzyme supplementation on the bioavailability energy of barley. *Poultry Science* 69: 1174-1181.
43. Viveros, A., Centeno, C., Brenes, A., Canales, R. and Lozana, A. (2000). Phytase and phosphatase activities in plant feedstuffs. *Journal of Agricultural and Food Chemistry* 48: 4009–4013.
44. Agbabiaka, L. A, F.N. Madubuike , B.U. Ekenyem and B.O Esonu. (2013). Effect of tigernut based diets on haematology and serum biochemistry of broiler finisher. *Agriculture Biology Journal of North America*, 2013, 4(3): 186-191.
45. Ayuk, E.A and Essien, A (2009). Growth and haematological response of broiler chicks fed graded levels of sweet potato (*Ipomea batata*) meal as replacement for maize. *International Journal of Poultry Science*. 8 (5):485-488.
46. Mitruka, B.J. and Rawsley, H.M. (1981). Clinical Biochemical and Hematological Reference values in Normal experimental Animals, 2nd ed. Masson Publishing U.S.A. Inc; 1977: 186-187.
47. Muhammad, N.O and Oloyede, O.B. (2009). Haematological Parameters of Broiler Chicks Fed *Aspergillus niger* - Fermented *Terminalia catappa* Seed Meal-Based Diet. *Global Journal of Biotechnology and Biochemistry* 4 (2): 179-183.
48. Okukpe K.M., Adeyemo A.D., Adua M., Omotayo O.O., Yusuf O.A., Aderibigbe T.A., Opowoye I.O., Ogunsola F.O. and Osho B. (2016). Stress modulating effect of crude leaf extract of *Vernonia amygdalina* in captive grasscutter (*Thryonomys swinderianus*). *Wayamba Journal of Animal Science* 2012-578X: P1445-P1459.
49. National Research Council (1994). Nutrient requirements of Poultry, 9th Rev. Ed. National Academy Press, Washington, DC.