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Effects of Enzyme Supplementation of Dried Cassava Peel Meal and Palm Kernel Cake Based Diets Fortified With Palm Oil on the Performance of Broiler Chickens

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***Target Audience**: Animal Scientists, Feed millers, Farmers*

Abstract
A fifty-six day (8weeks) feeding trial was conducted on 126, day-old Anak 2000 broiler chicks to evaluate the effect of enzyme supplementation of dried Cassava Peel Meal (CPM) and Palm Kernel Cake (PKC) based diets on their performance. The birds were randomly assigned six dietary treatments of 21 birds each. Thetreatments were sub-divided into three replicates containing 7 birds each in a 3x2 factorial design.There were no significant differences (P>0.05) in average initial weight and mortality. However, average final weight, average body weight, average daily weight, average daily feed intake and feed conversion ratio showed significant (P<0.05) treatment effects. In Carcass and organ weight evaluation, the live weight, dressed weight, dressing percentage and weight of breast/wings were significantly (P<0.05) different. Other parameters that showed significant treatment effects were weight of intestine,weight of liver, weight of gizzard and weight of abdominal fat. Weights of thigh/drumstick,weight of back,weight of heart and weight of kidney were not significantly (P>0.05) affected by the treatment diets. The result obtained suggest that up to 100% replacement of maize with CPM + PKC (at the ratio of 1:1) with enzyme supplementation could be achieved in rearing broiler chickens without deleterious effects.
***Key words**: Broiler chickens, performance, cassava peel, palm kernel cake, enzyme, supplementation*

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I. Introduction

Poultry production (Broiler) is one of the fastest means of bridging the animal protein gap in developing countries. Broilers are fast growing meat types birds. When compared to the beef industry, poultry enjoys a relative advantage of easy management, higher turnover and quick returns on investment[1]. A major constraint of the livestock industry in Nigeria is the inadequate and poor quality feed. Over 75 – 80 percent of the cost of poultry production is feed cost [2]. The increasing demands for maize and soya-bean which are major sources of energy and protein, respectively for Farm animal diets as human food staples and livestock feed ingredient has pushed their price to an alarming level, as a result, the use of unconventional feed stuff is gaining more the recognition in the field of animal nutrition. Maize as a conventional feedstuff contribute about 45 – 55% of most poultry diet [3], as energy source and at present, maize constitutes the bulk of the energy source used in compounding concentrate rations. This has adversely affected the cost of pigs and poultry production which depend almost entirely on concentrate feeds. It is therefore necessary to investigate locally available alternative sources of energy for commercial pig and poultry enterprises in the Country.

A cheaper and readily available alternative feedstuff is cassava peels. Cassava peels in Nigeria are always discarded as waste and are usually allowed to rot hence resulting to a waste disposal problem. This is a health hazard concern to humans [4]. Cassava peels is the outer covering of the tuber, which is usually removed manually with sharp knife, while the raw pulp is processed into the various human food such as garri, fufu, and tapioca among others. Cassava peels contains 18.81% crude fiber, 1.75% ether extract, 70.67% NFE, 5.68% Ash [5]. These peels are potential feed resource for animals if properly harnessed by a biotechnological process. Cassava peels contain hydrocyanic acid (HCN) which is toxic to monogastrics. There is need for processing of fresh cassava peels to enhance its acceptability and utilization. Several processing methods have been experimented which include grating and sun drying [6], ensiling [7], fermentation [8], freezing [9], oven drying [8],sun drying [10, 11],parboiling and sun drying [12].

Palm kernel cake (PKC) is another potential non-conventional feed which is obtained as a by-product of the oil palm processing industry. In Nigeria PKC is not consumed as food by man and about 121,520 metric tons is produced annually [13]. According to [14] palm kernel meal is aflatoxin free, palatable and has considerably potentials as carbohydrate and protein source. [15]reported that PKC is suitable for use in feed formulation for swine, poultry and horses. It is cheaper than other conventional feedstuff and it is readily available. However it is not easily digestible by poultry, due to its high fibre content which limits its use in poultry ration. Broilers can tolerate up to 20% PKC in their diets without affecting their growth performance and feed efficiency [16].

According to [17] and [18], as the level of fibre in monogastric diets increases, digestibility of nitrogen and energy decreases. Research reports by [19] indicated that fibre decreases availability of nutrients by reducing the period of exposure of the food to digestive enzymes ad absorptive surfaces due to the increased rate of passage of the feed induced by its fibre content. It was reported by [20] that in broilers, endogenous enzymes cannot adequately digest non starch polysaccharides (NSPs), therefore ingestion of high levels of soluble NSP leads to increased digesta viscosity and low nutrient digestibility and adsorption. This fact implies that any technology that will breakdown fibre to small molecules that birds can digest and absorb will certainly improve the utilization of CPM and PKC by broilers. According to [21], all cereals used in poultry diets contain various levels of NSP such as β-glucans, and arabinoxylans. Common properties of the different NSP are their resistance to the animal's digestive enzymes, and their tendency to create a viscous environment within the intestinal lumen [22, 23]. NSP decreases digesta passage rate, and increased digesta retention time facilitates bacterial colonization and activity in the small intestine [24]. Research has suggested that the negative effects of NSPs can be overcome by supplementation of diets with suitable exogenous enzyme preparations [25, 26].

The use of exogenous enzymes in poultry diets has found widespread commercial acceptance as a strategy to improve nutrient utilization, performance and uniformity, and reduce feed cost and nutrient excretion. In addition the inclusion of exogenous enzymes in diets of animals also results in the reductions in pathogenic micro flora and the improvement in health and welfare of birds [27, 28].

Nutrizyme® is a commercial enzyme designed to improve the digestibility of pig and poultry diets which are rich in fibre. It is a multi-enzyme complex which contains hemicellulase, phytase, Arabinases, pectinase, amylase B-glucanases, collobiase, xylanase, pentosanase and lipase. Information on enzyme treatment of poultry diet containing CPM and PKC to facilitate the liberation of its nutrients in the diets such that they will be efficiently utilized by the birds and enhance performance is unavailable. This work evaluated the effect of enzyme supplementation of dried cassava peel meal and PKC diets on the performance of broiler chickens.

II. Materials and Methods

This study was conducted in the Animal Science unit of the Teaching and Research farm of the faculty of Agriculture and forestry, Cross River University of Technology (CRUTECH) Obubra Campus, Cross River State. The location lies along longitude 8^o – 9^oE and latitude 6^o– 7^oN of the equator, with a warm weather and ambient temperature of about 21 - 30^oC and has an annual rainfall of 500 - 1070mm [29].

Cassava Peels/PKC procurement.

Cassava peels were collected from garri producing families in Ovonum Village in Obubra Local Government Area of Cross River State, washed and sun dried for 3-5 days to reduce the toxic contents (HCN). The dried cassava peels were milled using hammer mill to produce cassava peel meal.

Palm kernel cake and nutrizyme were purchased from feed ingredients shops in Calabar and Owerri, respectively.

Experimental Bird/Design

A total of 126 day-old Anak 2000 broiler chicks for the trial were purchased from a reputable local distributor. They were randomly divided into 6 groups of 21 birds each. At the starter phase of the experiment, the groups were assigned to 6 energy level diets (2742.43 ME (kcal/kg) - 3048.12 ME (Kcal/kg) and a single protein level diet (23.0% crude protein), in a 3X2 factorial arrangement involving three levels: 0, 25 and 50% of cassava peel meal/PKC mixture (in a ratio of 1:1) and two enzyme levels (0 and 0.25%). Each treatment was replicated three times with 7 birds per replicate and housed in a separate pen. A similar arrangement was used in the finisher phase of the experiment, during these period the diets were appropriately adjusted to suit the needs finisher broilers.

Table 1: Gross Composition of Experimental Broiler Starter Diet (g/100g)

Ingredients	Treatment/% Enzyme Level					
	T_1, 0.00E	T_1, 0.25E	T_2, 0.00E	$T_2$0.25E	$T_3$0.00E	$T_3$0.25E
Maize	50	50	25	25	-	-
CPM+PKC(1:1)	-	-	25	25	50	50
SBM	32.39	32.54	34.40	34.55	32.17	32.32
Wheat offal	9.17	9.31	0.70	0.30	2.93	2.55
Fish meal	3.5	3.5	3.5	3.5	3.5	3.5
Palm oil	-	-	7.0	7.0	7.0	7.0
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0
NaCl	0.3	0.3	0.3	0.3	0.3	0.3
Methionine	0.3	0.3	0.3	0.3	0.3	0.3
Lysine	0.3	0.3	0.3	0.3	0.3	0.3
Nutrizyme	-	0.25	-	0.25	-	0.25
Vit./Tm premix*	0.5	0.5	0.5	0.5	0.5	0.5
TOTAL	100	100	100	100	100	100
Calculated Chemical Composition Crude protein (%)	23.00	23.00	23.00	23.00	23.00	23.00
Crude fibre (%)	3.97	3.94	5.52	5.49	7.75	7.73
ME (Kcal/kg)	2869.78	3048.12	3048.12	3044.69	2745.86	2742.43

* To provide the following per kg of diet: Vit. A, 10,000iu; Vit D_3 2,000 iu; Vit. E, 5ui; Vit K 2mg; Nicotinic acids, 20mg; Vit. B12, 10.01mg; Panthotenic acids, 56mg; Fe, 20mg; Cu, 10mg Zn, 50mg; Co, 125mg.

Table 2: Gross Composition of Experimental Broiler Finisher Diets (g/100g)

Ingredients	Treatment/% Enzyme Level					
	$T_1$0.00E	$T_1$0.25E	$T_2$0.00E	$T_2$0.25E	$T_3$0.00E	$T_3$0.25E
Maize	54.00	54.00	27.00	27.00	-	-
CPM+PKC(1:1)	-	-	27.00	27.00	54.00	54.00
SBM	23.56	23.72	25.61	25.68	22.99	23.09
Wheat offal	14.55	14.13	5.49	5.07	8.11	7.79
Fish meal	3.50	3.50	3.50	3.50	3.50	3.50
Palm oil	-	-	7.00	7.00	7.00	7.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Na Cl	0.30	3.00	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30	0.30
Nutrizyme	-	0.25	-	0.25	0.25	-
Vit./Tm premix*	0.50	0.50	0.50	0.50	0.50	0.50
TOTAL	100	100	100	100	100	100
Calculated Chemical Composition Crude protein (%)	19.50	19.50	19.50	19.50	19.50	19.50
Crude fibre (%)	3.88	3.86	5.61	5.58	8.02	8.00
ME (Kcal/kg)	2862.67	2859.13	3016.97	3111.78	2778.78	2775.34

* To provide the following per kg of diet: Vit. A, 10,000iu; Vit D_3 2,000iu; Vit. E, 5iu; Vit. K 2mg; Riboflavin, 4.20mg; folic acid, 0.5mg; Choline, 3mg; Mg, 56mg; Fe, 20mg; Cu, 10mg; Zn, 50mg; Co, 125mg.

Management of Experimental birds

Normal brooding was carried out until the birds were three weeks old. Feed and water were provided *ad libitum*for all treatment groups throughout the experimental period. Also adequate prophylactic medications and vaccinations were carried out. The experiment lasted for a total of 8 weeks (56 days).

Data Collection

Performance characteristics

The birds were weighed at the beginning of the trial, and subsequently on a weekly basis throughout the trial period. Daily feed intake was taken by the difference between weight of feed offered and the left over the next morning. In general, data collected included: initial body weight, weekly body weight, daily feed intake, weekly weight gain, total body weight gain,morality, and feed to gain ratio.

Carcass and Organ Weights Evaluation

At the end of the trial, a total of six birds were selected per treatment for carcass and organ weight evaluation. These included two birds per replicate (one having the highest weight and the other with the lowest weight in the replicate). They were starved overnight of feed only, weighed and slaughtered by cervical bone dislocation. Thereafter, their jugular veins were cut and the carcass thoroughly bled. Before defeating, the carcasses werescalded in hot water of about 80^oC for about a minute, after which the feathers were manually plucked. The carcasses were then eviscerated by cutting through the vent and the viscera removed. Thereafter, the dressed carcass weights were obtained. The breast/wings, back, thigh and drumstick of dressed carcasses were sectioned out and weighted using a sensitive electronic scale, and their weights expressed as a percentage of the respective live-weights of birds used. In addition, weights of internal organs(gizzards, hearts, livers/gall bladder, kidney, intestine/crop and abdominal fat were also recorded). These and the dressed carcass weights were also expressed as percentages of the respective live weights.

Statistical Analysis

Data generated from the study on average initial weight, average final weight, average body weight gain, average daily weight gain, average daily feed intake, feed conversion ratio, and mortality were subjected to two way factorial analysis of variance (ANOVA) while treatment means were separated where significant treatment effects were detected, using the Duncan's new multiple rang test (DNMRT) as outline by [30].

III. Results

Performance

The effect of enzyme supplementation of dried cassava peel meal and palm kernel cake based diets on the performance of broiler chickens is shown on Table 3

Data obtained for average body weight gain were 2075.83g, 2042.23g, and 2010.67g, respectively for T_1, T_2,and T_3 factorial set without enzyme supplementation, while those for the factorial set with treatment diets supplemented with 0.25% exogenous enzyme were 2223.33g, 2346.67g, and 2193.33g, for T_1, T_2, and T_3, respectively. Analysis of variance indicated significant treatment effects (P<0.05) among the treatment means.

Data collected for average daily weight gain were 36.35g (T_1, 0% enzyme), 38.99g (T_1, 0.25% enzyme), 35.75g (T_2, 0% enzyme), and 41.19g (T_2, 0.25% enzyme). Others were35.19g (T_3, 0% enzyme), and 38.45g (T_3, 0.25% enzyme), respectively. The results showed significant treatment effects (P<0.05) among the treatment means.

Similarly,the average daily feed intake of experimental birdswere 92.01g (T_1, 0% enzyme), 91.79g (T_1, 0.25% enzyme), 108.33g (T_2, 0% enzyme), and 100.01g (T_2, 0.25% enzyme). Average daily feed intake value for T_3, 0% enzyme was 120.01g, whilst T_3, 0.25% enzyme recorded 97.42g. Analysis of variance on the data sets showed significant differences (P<0.05) among the treatment means.

The feed conversion ratios (g feed/g gain) of the birds were 2.53g, 3.03g, and 3.41g, respectively for the T_1, T_2, and T_3 factorial set with zero percent enzyme supplementation, whilst the factorial data set with 0.25% enzyme supplementation was 2.35g, 2.43g, and 2,53g, for T_1, T_2, and T_3, respectively. The results were significantly different (P<0.05) among the treatment means.

At the end of trial, T_1, 0%enzyme, T_1, 0.25% enzyme, and T_2, 0% enzyme recorded mortalities of 2, 1, and 2 birds, respectively, whilst others registered none. Experimental birds mortalities were not significantly (P>0.5) affected by treatments.

Carcass and organ weights evaluation

The effects of enzyme supplementation of dried cassava peel meal and palm kernel cake based diets on carcass and organ weights (% of live weights) of broiler chickens are summarized in Table 4.

Live weights of the birds were 2033.68g, 2027.46g, and 2023.41, T_1, T_2, and T_3 for factorial set with zero % enzyme supplementation, respectively. For the factorial set with 0.25% enzyme supplementation, the live weight data generated were 2185.18g, 2306.44, and 2183.18, respectively for T_1, T_2, and T_3. There were significant treatment effects (P<0.05) among the treatment means.

Dressed weight data were 1457.54g (T_1, 0% enzyme), 1584.26g (T_1, 0.25% enzyme), 1442.13g (T_2, 0% enzyme), and 1691.13g (T_2, 0.25% enzyme), respectively. Others were 1435.00 (T_3, 0% enzyme), and 1571.89g (T_3, 0.25% enzyme), respectively. There were significant treatment effects (P<0.05) among the treatment means.

The dressing percentages (% of live weights) of experimental birds were 71.67 (T_1, 0% enzyme), 72.50 (T_1, 0.25% enzyme), 71.13 (T_2, 0% enzyme), 73.33 (T_2, 0.25% enzyme), 70.92 (T_3, 0% enzyme), and 72.00 (T_3, 0.25% enzyme), respectively. Treatment means were significantly (P<0.05) affected by treatments.

Weights recorded for breast/drumstick (% of live weights) were 33.67, 33.45, and 33.53 for T_1, T_2, T_3 of the factorial set with 0% enzyme supplementation, respectively, whilst 34.17. 35.83, and 34.40 were similarly registered for the respective factorial set with 0.25% enzyme supplementation. Analysis of variance of the data indicated significant treatment effects (P<0.05).

Other carcass parameters expressed as percentages of their respective live weights that were significantly (P<0.05) affected by treatments were weights of intestine, liver/gall bladder, gizzard, and abdominal fat.

Carcass cuts that recorded no significant treatment effects (P>0.05) included the thigh/drum stick, and the back. Weights of thigh/drum stick (% of live weights) were 24.33, 24.38, and 24.12, respectively for T_1, T_2, and T_3 of the factorial set with 0% enzyme supplementation, whilst those of their counterparts supplemented with 0.25% enzyme were 24.50, 24.17 and 23.33, respectively. The weights back (% of live weights) were 13.67 (T_1, 0%, enzyme), 13.83 ($T_1$0.25% enzyme), 13.30 (T_2, 0% enzyme), 13.33 (T_2, 0.25% enzyme), 13.27 (T_3, 0% enzyme), and 14.17 (T_3, 0.25% enzyme), respectively.

Two organ weight parameters expressed as percentage of live weights were also not significantly (P>0.05) affected by treatments; they were weights of heart and kidney.

Table 3: Effect of enzyme supplementation of dried Cassava peel meal and PKC diets on the performance of broiler chickens.

Parameters	Treatment / % Enzyme level						
	T_1 0.00E	T_1 0.25E	T_2 0.00E	T_2 0.25E	T_3 0.00E	T_3 0.25E	SEM
Average initial weight (g)	40	40	40	40	40	40	0.00
Average final weight (g)	2075.83^b	2223.33^{ab}	2042.23^b	2346.67^a	2010.67^b	2193.33^{ab}	102.21
Average body weight gain (g)	2035.83^c	2183.33^b	2002.23^c	2306.67	1970.67^a	2153.33^b	102.20
Average daily weight (g)	36.35^b	38.99^a	35.75^b	41.19^a	35.19^b	38.45^a	1.84
Average daily feed intake (g)	92.01^d	91.79^d	108.33^b	100.01^{bc}	120.01^a	97.42^c	5.29
Feed conservation ratio (g)	2.53^c	2.35^{cd}	3.03^b	2.43^{cd}	3.41^a	2.53^c	0.12
Morality	2	1	2	0	0	0	0.33

[abcd]Means on the same row with different superscripts are significantly different (P<0.05).

Table4: Effect of enzyme supplementation of dried Cassava peel meal and PKC diets on carcass and organs weight evaluation of broiler chickens.

Parameters	Treatment / % Enzyme level						
	T_1, 0.00E	T_1, 0.25E	T_2, 0.00E	T_2, 0.25E	T_3, 0.00E	T_3, 0.25E	**SEM**
Live weight (LW)(g)	2033.68^b	2185.18^{ab}	2027.46^b	2306.44^a	2023.41^b	2183.18^{ab}	17.15
Dressed weight (g)	1457.54^b	1584.26^{ab}	1442.13^b	1691.31^a	1435.00^b	1571.89^{ab}	27.69
Dressing % (% of LW)	71.67^b	72.50^{ab}	71.13^b	73.33^a	70.92^b	72.00^{ab}	1.17
Weight of breast/wing (% of LW)	33.67^b	34.17^{ab}	33.45^b	35.83^a	33.53^b	34.50^{ab}	1.03
Weight of thigh/drumstick (% of LW)	24.33	24.50	24.38	24.17	24.12	23.33	0.88
Weight of back (% of LW	13.67	13.83	13.30	13.33	13.27	14.17	0.68
Weight of heart (% of LW)	0.52	0.53	0.51	0.53	0.50	0.52	0.02
Weight of kidney (% of LW)	0.25	0.30	0.17	0.17	0.22	0.25	0.00
Weight of intestine (% of LW)	5.38^c	5.00^d	5.84^b	5.42^c	6.58^a	5.42^c	0.10
Weight of liver (% of LW)	2.07^b	1.097^c	2.50^a	2.07^b	2.50^a	2.07^b	0.03
Weight of Gizzard (% of LW)	4.25^b	3.24^d	5.00^a	3.72^c	5.00^a	3.72^c	0.16
Weight of Abdominal fat (% of LW)	2.41^b	2.50^b	3.72^a	3.72^a	3.71^a	3.70^a	0.12

[abcd] Means on the same row with different superscripts are significantly different (P<0.05).

IV. Discussion

Performance characteristics

A cassava peal meal (CPM/PKC) treatment group with enzyme supplementation (T_2, 0.25% enzyme) recorded significantly (P<0.05) higher average final weight than all other treatment groups. This was followed by T_1, 0.25% enzyme and T_3, 0.25% enzyme groups which were similar in their weight profile, whilst T_1, 0% enzyme, T_2, 0% enzyme and T_3, 0% enzyme (also similar in their weight profile) registered the least final weight. A similar trend was observed in average final body weight gain result, in which T_2, 0.25% enzyme group showed significantly (P<0.05) higher value than the rest of the groups. This was followed by a similar bracket of T_1, 0.25% enzyme and T_3, 0.25% enzyme. Treatments with the least average final body weight gain were T_1, 0% enzyme, T_2, 0% enzyme and T_3, 0% enzyme, all of which were similar (P>0.05).

Average daily weight gain was significantly (P<0.05) high in T_2, 0.25% enzyme, T_1, 0.25% enzyme and T_3, 0.25% enzyme than the other treatment groups.

It was generally observed that the enzyme treated groups performed better in all the above performance parameters. This is corroborated by research reports that the inclusion of exogenous enzymes in diets could directly complement endogenous enzymes in speeding up their catalytic and hydrolytic activities for increasing the rate of digestion, absorption and metabolism of complex feed nutrients [31, 32].

According to the reports of [33], a number of researchers [34, 35, 36, 37, 38, 39] have also shown that supplementation of feeds reduce digesta viscosity, enhance digestion and absorption of nutrients, especially fat and protein; improve apparent metabolizable energy value of the diet, as well as alter population of microorganism in the tract, all of which all of which are believed to enhance weight gain. The relatively lower performance characteristics of the non-enzyme treatment groups is attributable to high dietary fiber and low metabolizable energy status of their diets. This agrees with research reports which maintain that as the level of fibre in monogastricdiets increases, digestibility of energy and nitrogen decreases [17, 18]. The findings is further corroborated by the reports of [40] which posited that fibre decreases availability of nutrients by reducing the period of exposure of the food to digestive enzymes and absorptive surfaces due to the increased rate of passage of the feed induced by its fibre content. In addition to the challenge of dietary fibre, residual anti-nutritional factors in the diets of the non-enzyme treatment groups might also limit their performance. It has been argued that dietary inclusion of enzyme reduces the anti-nutritional effect of hydrocyanic acid [41].

Average daily feed intake was significantly ($P<0.05$) higher in T_3, 0% enzyme than all other treatment groups, whilst T_1, 0% enzyme, and T_1, 0.25% enzyme recorded the lowest. In general, birds continue to consume feed primarily until they meet their energy requirements. In a situation where fibrolytic feed stuffs or NSP somewhat dilute the energy level in a feed, it would seem that birds placed on such feed will need to consume more of it than birds on less fibrous feed to meet their energy needs. This may explain why T_3, 0% enzyme group consumed more feed than birds in other treatment groups to compensate for the low metabolizable energy in their diets. It may also account for the least feed consumption of the control treatments whose feed were formulated using conventional feed stuffs with lower fibre level and NSP contents.

The best feed conversion ratio was recorded in T_1, 0.25% enzyme and T_2, 0.25% enzyme groups. As seen in other performance parameters already reviewed, this result is attributable to effect of enzyme supplementation of the test diets. Contemporary research reports on poultry feeding, especially non-conventional feed stuffs are concerned are replete with the beneficial effects in the supplementation of poultry feeds with exogenous enzymes. These include bioavailability and utilization of energy, proteins and lipids, leading to superior growth performances and feed conversion ratio of birds [42, 43,44, 45]. Indeed, [46], reported that an evaluation of experimental results on influence of enzyme and charcoal supplementation on of cassava peel meal based diets showed that it is beneficial in its utilization for broiler chickens.

Carcass and organ weights evaluation

Observations on live weight characteristics of experimental birds in the various treatment groups is closely related to what obtained in performance characteristics. T_2, 0.25% enzyme group was significantly ($P<0.05$) higher than other treatment groups. This was followed by the other enzyme treated groups (T_1, 0.25% enzyme, and T_3, 0.25% enzyme). In the same vein, dressed carcass weight, dressing percentage, and weights of breast/wings (expressed as percentages of live weight), closely followed a similar trend. This indicates that the enzyme treated diets were superior to their non-enzyme counterparts in their feed efficiency, ability to support metabolism, growth, and weight gain that led to the production of prime carcass cuts. Worthy of note is the observation that weights of a valuable carcass cut like the thigh/drum stick was similar ($P>0.05$), across the treatment groups.The weights compared favorably with those of treatments receiving maize based diets (T_1, 0% enzyme and T_1, 0.25% enzyme). This suggests that the cassava peel meal diets did not negatively impact the prime cuts, similarly to the weights of the back.

The weights of hearts and kidneys (percentages of live weights) were not significantly ($P>0.05$) different across the treatments. Similar weight of the organs of birds fed cassava peel based diets to birds in the control treatment suggest that they were functioning normally. This indicates that the test diets contained little or no anti-nutritional factors which would exert deleterious effects on the growth, development, and normal performance of the organs.

Weight of intestine (percentage of live weight) was highest in T_3, 0% enzyme, followed by T_2, 0% enzyme. These were cassava peel meal based treatments not supplemented with exogenous enzyme. The lowest weight of the intestine was recorded in the control treatment supplemented with exogenous enzyme. There is a likelihood that cassava peel meal contains a level of NSP which according to [24] is known to cause increased digesta viscosity, decreased digesta passage rate, and nutrient digestibility and facilitates bacterial colonization and activity in the small intestine. In cassava peel meal based diets without exogenous enzyme supplementation, the foregoing is likely to trigger a physiological response to increase the size of the small intestine in order to accommodate the quantum of accumulated digesta in the organ. This analogy agrees with research reports which posited that high fibre diets generate physical distension of the walls of the GIT, increasing GIT capacity and gut fill [47, 48]. There is also a possibility that bacterial colonization of the small intestine due to digesta retention can cause inflammatory activities in the organ, leading to the thickening of its walls, with a long term effect of increase in its weight. This result apparently shows a positive linear correlation between dietary NSP and the weight of the intestine particularly with CPM/PKC based treatment diets not supplemented with exogenous enzyme.

The highest significant ($P<0.05$) gizzard weights were recorded in treatments receiving cassava peel meal (CPM/PKC) based diets not supplemented with exogenous enzyme (T_2, 0% enzyme and T_3, 0% enzyme), whilst the lowest was found in maize based diet treatment supplemented with exogenous enzyme (T_1, 0.25% enzyme). Increased gizzard weight is attributable to the challenge of high insoluble fibre contents of the

CPM/PKC based diets. Research reports by [49] indicated that enzyme supplementation of broiler diets reduced gizzard weight. According to [50], higher dietary fibre would promote thickening of muscles which would lead to increased gizzard weight. This position is further corroborated by [51]. According to the researcher, higher gizzard weight in broilers may be related to higher dietary fibre content. The thickening response of gizzard to dietary fibre however has a beneficial effect on its development and function [52].

Weight of the liver was significantly ($P<0.05$) higher in treatments fed CPM/PKC based diets not supplemented with exogenous enzyme (T_2, 0% enzyme and T_3, 0% enzyme), than all other treatments, whilst the lowest liver weight was recorded in maize based treatment group whose diet was supplemented with exogenous enzyme (T_1, 0.25% enzyme). On the other hand, weight of abdominal fat was highest in all CPM/PKC based diets (T_2, 0% enzyme, T_2, 0.25% enzyme, T_3, 0% enzyme, and T_3, 0.25% enzyme), and lower in maize based treatments (T_1, 0% enzyme, and T_1, 0.25% enzyme). Increased weight of the liver in CPM/PKC based diets might imply nutritional imbalance associated with protein and energy, which condition usually result in fat infiltration of the liver and deposition of excessive amounts of fat in the abdomen. It will be recalled that in an effort to meet the energy needs of birds in CPM/PKC based diets, it was necessary to augment the same with palm oil. As beneficial as it could be as an energy source, the use of palm oil in poultry diets should be done with caution because if its dietary inclusion disorganizes the energy/protein ratio of the diet, it result in metabolic disorders that might negatively affect the liver in the long run. It would seem that the inclusion of exogenous enzyme in CPM/PKC based diets liberated more energy molecules bound in cassava peel, which in addition to that provided by palm oil could be in excess of requirement in the diets. Since energy in excess of requirement in the system is usually converted to fat and stored in adipose tissues and visceral organs, this may account for the apparent fat infiltration of the liver of the birds on test diets and the weight increase of the organ. On the other hand, the increased liver weight might also be a physiological challenge arising from the presence of certain toxic factors in the diets of the birds, with a deleterious effect on the performance of the organ.

Increased weight of abdominal fat of experimental birds placed on CPM/PKC based diets may likely be a function of metabolic disorder arising from energy/protein imbalance as suggested in the case of the liver. In avian species, most fatty acid are synthesized in the liver and transported via low-density lipoproteins or chylomicrons for storage in adipose tissues as triglycerides [53]. According to [54], abdominal fat tissues is crucial in poultry because it grows faster compared to other fat tissues. More so, research has shown that abdominal fat pad is a reliable parameter for judging total body fat content because it is directly linked to total body fat content [55, 56]. There is therefore a need to pay attention to protein/energy ratio when using palm oil to balance dietary energy requirement in poultry diets supplemented with exogenous enzyme.

V. Conclusion

The results of this study suggest that the combination of dried cassava peel meal and palm kernel cake in a ratio of 1:1 to formulate broiler chickens diets supplemented with 0.25% of exogenous enzyme (Nutrizyme), can be harnessed in total replacement of maize as energy source in broiler chicken production with no significant deleterious effects. It is however recommended that this study be carried out with varying enzyme levels, to establish its optimum for growth performance of the birds.

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