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Feeding Full Fat Palm Fruit Meal Diets with Enzymes to Broiler Chickens: 1. Growth Performance and Economics

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Abstract
In previous work, we reported no deleterious effect in feeding broiler chickens with up to 14.30% of Full Fat Palm Fruit Meal (FFPFM) with no enzymes. This particular study was aimed at evaluating the effect of feeding graded levels of FFPFM diets with fibre degrading multienzymes on the growth performance and economics of broiler chickens. A total of one hundred and forty four one-day-old broiler chicks of Arbor Acre breeds were assigned to 4 experimental diets and randomly allocated to 16 units in a completely randomized design. The birds were fed graded levels (0, 5.0, 7.50 and 10.20% at starter and 0, 7.0, 9.50 and 14.30% at the finisher) of FFPFM with one level of fibre degrading multienzymes, maxigrain (each gram containing cellulase, 10000IU; beta-glucanase, 200IU; xylanase, 10000IU and phytase, 2500FTU) at 100g/tone of feed across T2, T3 and T4. Data were recorded on feed intake and weekly weight changes. On day 56 of the experiment, eight birds per treatment were randomly selected from each of the replicates, starved overnight and slaughtered to evaluate growth performance and economics. There was no significant difference (p>0.05) at starter and finisher phases in total weight gain, daily body weight gain, feed conversion ration and feed efficiency across treatments. However, highest values were recorded for birds in T3 group on final body weight per bird at starter and finisher phases. Although there were no effects in the economic parameters across treatments, T3 group recorded the highest values for gross margin and revenue per bird. Additionally, no effect of enzymes supplementation was recorded. Thus, up to 14.30% of FFPFM with or without enzymes could be used in broiler diets without any deleterious effects on growth performance and economics.
Keywords: full fat palm fruit meal, enzymes supplementation, broiler chickens, cellulose digestion, economics

1. Introduction

The benefits of cellulose as a low cost energy source, and most abundant natural renewable resource in the world could be harnessed in order to provide economic and environmental basis for the development of nations (Zhang and Zhang, 2013). A search for alternative cheaper energy sources in order to reduce cost of feed and pressure on maize caused by competition between humans and animals is also an ongoing research priority in animal nutrition (Okeudo et al., 2005; George and Sese, 2012; Sese et al., 2014). Utilizing alternative ingredient sources would significantly reduce cost of feed which currently constitutes about 70 – 80% of total cost in poultry production (Durunna et al., 2005).

Palm fruit (*Elaeis guineensis*) is a product of palm tree and a rich source of cellulose, hemicellulose and lignin and grows in abundance in the South South rain forest zone of Nigeria. Palm fruit producing regions and nations have the potential of utilising the multiple benefits of palm products in poultry feeding (Adrizal et al., 2011). The fruit produces two types of oil namely, palm oil from fleshy mesocarp; and palm kernel oil from kernel, the endosperm which is quite different from palm oil, resembling coconut oil (Agunbiade *et al.,* 1999). It also produces phenolic acids, flavonoids, antioxidants, vitamin E (30% tocopherols, 70% tocotrienols), fat, fat soluble components including carotenoids and phytosterols (Sundram et al., 2003). When processed palm fruit yields many by-products rich in oil and oil residues such as palm kernel meal (PKM), palm oil effluent, palm oil sludge, oil-rich fibrous residue and palm kernel cake (PKC). However, full fat palm fruit meal (FFPFM) is derived from crushing the whole palm fruit, including the kernel (exocarp, mesocarp and endocarp) without oil extraction and is different from Palm fruit meal (PFM) or palm kernel cake (PKC), which are by-products of mechanically expelled palm oil or palm kernel oil extraction respectively (Okeudo et al., 2005). Previous work with up to 10.2% inclusion of FFPFM at starter and 14.30% at finisher levels showed no deleterious effect on broiler growth performance, carcass characteristics and economics of broiler chickens (Ekanem et al., 2016). However, the cellulose, hemicelluloses and lignin content of FFPFM may potentially pose some problems with utilization efficiency thereby requiring fibre degrading enzymes to help in nutrient extraction.

Comprehensive review from Asmare (2014) shows that use of enzymes in feed offers ample economic and environmental benefits given the scarcity of resources available in feeding animals. Increasing popularity on use of exogenous enzymes in poultry nutrition seems to be borne out of the economic benefits from the reduction of nutrients and energy content of feed. In other words, fibre degrading enzymes offer substantial prospects for improving utilization of ingredients and animal performance. Poultry especially are limited in their digestive ability to assimilate all essential nutrients embedded in their feed. Therefore supplementing enzymes provides prospects for increased extraction and access to nutrients due to improved digestion caused by fibre degrading enzymes in the feed. This further extraction of nutrients has led to increased efficiency in feed utilization and better performance. Asmare (2014) also noted that enzymes are much useful with feeds that have relatively higher levels of fibre in them. Some enzyme activities are known to be specific to substrates such as fibre, proteins, starch and phytate. But fundamentally, exogenous enzymes are those added to feed to complement digestive enzymes of animals and 'to breakdown anti-nutritive fractions in foods'. The increased animal performance attributed to use of enzyme provides a positive prospect when viewed against the background of increased consumer anxieties relating to the use of antibiotics and growth promoters in animal production (Beauchemin et al., 2003). However, variability in ruminant and monogastric animal's responses to enzymes use have been reported (Beauchemin et al., 2003; Asmare, 2014).

2. Materials and Methods

The study was conducted at "HatchYourOwn poultry farms", Nsukara Offot, Uyo, Akwa Ibom State, Nigeria. Uyo city is located within the tropical rainforest zone within the South South agro-ecological region of Nigeria. The city is located between latitudes 4˚59′ and 5˚04′; longitudes 7˚53′ and 8˚00′ E with 1500 mm average rainfall.

2.1 Experimental Diets

Only ripe harvested palm fruits were used in this study and sourced from palm fruit marketers in Nsukara Offot, Uyo L.G.A, Akwa Ibom State. The whole palm fruit was crushed with the hammer mill, to pass through a 2.5mm screen and added into a basal diet at the rate of 0, 5.0, 7.50 and 10.20 % at the starter level and 0, 7.0, 9.50 and 14.30 % at the finisher level. The ingredients and calculated nutrient composition of the starter and finisher diets are presented in Table 1.

2.2 Experimental Birds and Management

Sixteen (16) partitions were created in the house each measuring 3 x 3m each. All the pens were thoroughly washed and disinfected before the birds arrived. The dry concrete floor was covered with wood shavings to the thickness of about 5cm. One hundred and forty four (144) one-day-old broiler chicks of Arbor Acre breed were used. On arrival, the birds were weighed and randomly assigned to four treatment groups, with a total of 36 birds per treatment. To achieve this, the birds were further divided into 4 replicate of 9 birds each. Brooding was done by supplying heat to the chicks during their first 3 weeks to provide warmth. The birds were then cared for by using standard broiler chick management procedures, which included routine vaccinations against Newcastle disease and infectious bursal disease (gumboro), which were administered to all the birds within the first three weeks.

Table 1: Ingredients and Nutrients Composition of Experimental Starter and Finisher Broiler Diets

Ingredients	**Starter Phase**				**Finisher Phase**			
(%)	**T1**	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**
Maize	51.00	50.00	49.00	48.00	53.00	52.00	51.00	50.00
Soybean meal	30.00	31.00	32.00	33.00	26.00	27.00	28.00	29.00
PKC	10.20	5.20	2.70	0.00	14.30	7.30	4.80	0.00
Fish meal	4.00	4.00	4.00	4.00	2.00	2.00	2.00	2.00
FFPFM	0.00	5.00	7.50	10.20	0.00	7.00	9.50	14.30
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Vitamins/TM premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrient Composition								
Crude protein	22.13	21.83	21.85	21.86	20.04	19.64	19.62	19.57
Crude fibre	4.50	4.35	4.29	4.23	4.72	4.49	4.44	4.29
Ether extract	8.46	4.90	5.30	5.72	4.18	5.30	5.69	6.45
ME (Kcal/kg)	2866.00	2940.00	2973.00	3008.00	2891.00	3000.00	3032.00	3103.00

*Vitamin premix supplied (per kg diet): vitamin A = 10,000IU; vitamin D_3 = 12,000 I.U.; vitamin E = 20I.U.; vitamin K = 2.5mg; Riboflavin = 3.0mg; Thiamain = 2.0mg; Pyridoxine = 4.0mg; cobalamin = 0.05mg; vitamin B_{12} = 0.01mg; panthotenic acid = 5mg; nicotinic acid = 20mg; folic acid = 0.5mg; choline = 0.2g; manganese = 0.006g; iron = 20mg; copper = 0.006g; zinc = 0.03g; cobalt = 0.25g; iodine = 0.0014g, anti-oxidant = 0.25mg, biotin = 0.08mg; selenium = 0.24mg.

PKC = Palm kernel cake, FFPFM = Full fat palm fruit meal, ME = Metabolizable energy.

2.3 Data Collection

Data were collected daily and recorded on feed intake. Data were also collected weekly by weighing the birds and recording the weight changes. The feed intake and weight changes were used to calculate the feed: gain ratio. At the end of the feeding trial 2 birds were randomly selected from each replicate and starved overnight, weighed after the fasting, slaughtered by severing the jugular vein, scalded in warm water for about a minute, de-feathered manually, eviscerated and dressed to determine growth parameters. Dressed weight was expressed as percentage live weight (Ndelekwute *et al.,* 2013).

2.4 Proximate and Statistical Analyses

The proximate composition of the FFPFM was determined by the methods of AOAC (2002). Data collected were statistically analyzed according to the Statistical Analysis System package (SAS, 1999). Significant means were separated using Duncan's Multiple Range Test of the same package.

3. Results

Results of the research are presented in the tables 2-5 below.

Table 2: Growth performance of starter broiler chickens fed full fat palm fruit meal with enzymes

Parameters	T_1	T_2	T_3	T_4	SEM
Initial body weight (g/bird)	30.00	30.00	30.00	30.00	0.00
Daily body weight gain (g/bird)	24.42	26.81	26.70	25.12	1.32
Total weight gain (g)	664.00	751.00	753.0	703.0	44.5
Daily feed intake (g/bird)	47.84^{b}	54.10^{a}	51.70^{ab}	47.25^{b}	1.56
Final body weight (g/bird)	714.00	781.00	783.0	733.0	36.2
Feed efficiency	0.507	0.490	0.512	0.529	0.02
Feed conversion ratio (%)	1.97	2.04	1.95	1.89	0.08

SEM = standard error of means. T1= 0 % FFPFM, T2= 5.0 % FFPFM, T3= 7.50 % FFPFM, T4= 10.20 FFPFM.

Table 3: Growth performance of finisher broiler chickens fed full fat palm fruit meal with enzymes

Parameters	T_1	T_2	T_3	T_4	SEM
Initial body weight (g/bird)	714.00	781.00	783.00	733.00	36.20
Daily body weight gain (g/bird)	55.90	47.30	61.40	54.20	4.21
Daily feed intake (g/bird)	132.30^{b}	139.70^{ab}	150.20^{a}	141.40^{ab}	4.98
Final body weight (g/bird)	2278.00^{ab}	2105.00^{b}	2504.00^{a}	2251.00^{ab}	100
Feed efficiency	0.43	0.34	0.41	0.38	0.03
Feed conversion ratio (%)	2.4	2.96	2.46	2.64	0.18

SEM = standard error of means. T1= 0 % FFPFM, T2= 7.0 % FFPFM, T3= 9.50 % FFPFM, T4= 14.30 FFPFM.

The economic parameters of the broiler birds fed varying levels of FFPFM with enzymes are shown in Tables 4 and 5.

Table 4: Economics of starter broiler chickens fed Full Fat Palm Fruit Meal (FFPFM) Diets with enzymes

Parameters	T_1	T_2	T_3	T_4	SEM
Cost of feed intake/bird/day (₦)	5.05	5.82	5.64	5.34	0.18
Cost of feed/kg (₦)	105.63	107.68	109.08	110.53	0.00
Cost of feed intake/bird (₦)	141.50	163.10	157.60	149.40	4.98
Cost of feed consumed/body weight gain (₦)	207.70	221.50	213.10	208.90	8.34

SEM = standard error of the means. T1= 0% FFPFM, T2= 5.0% FFPFM, T3= 7.50% FFPFM, T4= 10.20% FFPFM.

Table 5: Economics of finisher broiler chickens fed Full Fat Palm Fruit Meal (FFPFM) Diets with enzymes

Parameters	T_1	T_2	T_3	T_4	SEM
Cost of feed consumed/body weight gain (₦)	230.30	294.80	240.20	271.40	17.43
Gross margin/bird (₦)	898.00	905.00	979.00	905.00	72.00
Revenue/bird (₦)	1399.00	1470.00	1562.00	1462.00	82.40
Cost of feed/kg (₦)	97.09	99.66	101.06	103.06	0.00

[abc] means along the same row with different superscripts are significantly different ($P < 0.05$). SEM = standard error of the means. T1= 0% FFPFM, T2= 7.0% FFPFM, T3= 9.50% FFPFM, T4= 14.30 FFPFM

4. Discussions

Discussions for the results shown in tables 2 to 5 are presented below.

4.1 Effect of FFPFM with enzymes on growth performance of Broiler Chickens

At starter level, Table 2 shows no significant difference (P>0.05) in all the growth parameters (total body weight gains, daily body weight gain, final body weight per bird, feed conversion ratio and feed efficiency) except on daily feed intake where T1 showed a significant difference (P<0.05) to T2. However, feed intake was similar between T1 and T4 diet groups. At the finisher stage, table 3 shows that daily feed intake varied significantly (P<0.05) between T1 and T3. Results were similar across treatments for initial body weight, daily body weight gain, feed efficiency and feed conversion ratio. While T3 was significantly higher than T2 in final body weight, those of T1 and T4 were similar. Treatment 3 group delivered the highest values for growth parameters such as initial body weight, daily body weight gain and final body weight. Overall, these results suggest that inclusion of FFPFM with enzymes up to 14.30% has no deleterous effect on growth performance of broiler chickens. There was no recorded effect on enzymes supplementation.

4.2 Effect of FFPFM with enzymes on Economics of Broiler Chickens

As shown in table 4, daily cost of feed intake per bird at starter phase showed significant variation (P< 0.05) between T1 and T2 but not between T3 and T4. Feed cost per kg and cost of feed consumed per body weight gain were similar across treatments at starter phase. Table five shows the economic parameters of feeding FFPFM to broiler chickens at finisher phase. There was no significant variation (P>0.05) recorded for cost of feed consumed/body weight gain (₦), gross margin/bird (₦), revenue/bird (₦), cost of feed/kg (₦). However, T3 recorded the highest figures for Gross margin/bird and gross revenue per bird compared to other treatments. Overall, these results suggest that inclusion of FFPFM with enzymes up to 14.30% has no negative economic impact on broiler chicken production.

5. Conclusion

Crushed full fat palm fruit meal presents a viable alternative energy source for broiler chickens production. FFPFM with enzymes could be supplemented up to 14.30% in broilers ration for comparable performance and economics as those fed with 0% of FFPFM with no enzymes.

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