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ORIGINAL RESEARCH ARTICLE

Performance and economics of broiler chickens fed varying levels of yam peel meal with Roxazyme-G supplementation

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ABSTRACT

Two hundred and sixty day old Arbor Acre strain of broilers were used in a 56-day experiment to investigate the effect of replacing maize with varying levels of yam peel meal (YPM) with enzyme supplementation on the growth performance and economics of production of broiler chickens. Four experimental broiler starter and finisher diets were formulated to be isonitrogenous to provide 22% and 20% crude protein respectively with varying levels of enzyme supplemented YPM which replaced maize at 0, 10, 20 and 30% levels in treatments T_1, T_2, T_3 and T_4 respectively. The birds were randomly allocated to the four dietary treatments having 5 replicates of 13 birds each in a completely randomized design. The birds were raised on deep litter system. Feed and water were provided ad libitum. The results showed that means of final body weight, daily weight gain, FCR and PER of the broilers were not significantly ($p>0.05$) affected by the varying levels of enzyme supplemented YPM. Feed intake of birds significantly ($p<0.05$) increased with increasing levels of enzyme supplemented YPM. Feed cost per kilogram was within the range of ₦129.82 to ₦79.40. Feed cost consumed, feed cost per weight gain and cost of production significantly decreased ($p<0.05$) as the level of enzyme supplemented YPM in the diets increased. The revenue generated were comparable among dietary treatments whereas gross margin was significantly ($p<0.05$) higher in T_4 and T_3 compared to T_1 and T_2. It was concluded that enzyme supplemented YPM can replace maize up to 30% YPM in practical broiler diet at least cost and greater gross margin without any detrimental effect and can mitigate environmental hazards in communities where yam peels are wasted.

Keywords: Chicken, yam peel, enzyme, growth, cost benefit.

INTRODUCTION

The limitation of poultry production in Nigeria has been hinged particularly on the cost of feed production. Conventional energy source such as maize has not only served as a major ingredient in poultry ration but also as staple food for humans and as well as raw materials for industries which has made feed accounted for about 70-80% of the total cost in most livestock production in developing countries such as Nigeria (Faniyi, 2002, Ogungbesan *et al*., 2014). In poultry nutrition, energy is used for provision of body heat, maintenance, growth and production; and birds eat to satisfy their energy requirement. Maize accounts for about 45-55% of poultry feed, thus, any effort to substitute maize in poultry feed will significantly reduce the cost of production (Bamgbose *et al*., 2004). In view of this high cost of production with resultant high cost of poultry products, the use of agro-industrial by-product, that are not consumed by man, available in large quantities all year round and obtainable at the cheapest or no cost to substitute for the scarce maize in poultry diets is worthy of consideration. Yam (*Discorea rotundata*) peel is one of the numerous farm wastes that have such potentials. It is a basic waste or agricultural by product which is obtained from yam processing into food. Unlike maize, it is not edible to man and may not be useful in the industries. Yam peel is cheaply available in Nigeria and if not properly managed may constitute nuisance in our environment (Akinmutimi *et al*. 2006, Ezieshi *et al*., 2011). It is rich in mineral and amino acids (Eka, 1985). However, it usefulness in the feeding of monogastric

animals is limited by the presence of anti-nutritional factors such as trypsin inhibitors, tannin, phytate, glucosides, oxalate and saponnin (Anakebe. 2006, Akinmutimi and Onen, 2008). Besides, another major limitation is the presence of non-starch polysaccharides (NSPs) in its high fiber content, which can exert anti-nutritive activity on the animal (Ezieshi and Olomu, 2011). Studies with yam peel meal (YPM) revealed that poor performance of birds fed YPM diets were related to higher crude fiber level (Ezieshi and Olomu, 2011), which serves as an energy diluent, thereby, interfering with energy utilization (Iyayi, 2001, Ezieshi and Olomu, 2008). Poultry cannot fully utilized high fiber diet because they lack the digestive framework that can elaborately digest large amount of fibers, it become imperative to incorporate exogenous enzymes into their diet in order to enhance the breakdown of non-starch polysaccharides (NSPs) present in the fiber (Nadeem *et al*., 2005, Buchanan *et al*., 2007). Roxazymes-G enzyme is a specific blend of beta-glucanases, cellulases and xylanases which improves the efficiency of energy utilization in feeds. Information on the use of enzyme to improve the nutritive value of yam peel meal for broiler chicks and its optimum inclusion level is scarce. Therefore, this study was conducted to evaluate the performance characteristics and cost benefits of broiler chickens fed diets containing graded levels of yam peel meal with Roxazyme-G enzyme supplementation.

MATERIALS AND METHODS

Experimental site: The study was conducted at the Poultry Unit of the Teaching and Research Farm of Federal College of Wildlife Management, New-Bussa, Niger state, Nigeria. The College is geographically located on latitude $7^{o}3^{1}$N and longitude $4^{o}33^{1}$W, which covers an area of 2.5km^2 with the vegetation described as northern guinea savanna zone of Nigeria. The average temperature is 28^{o}C to 40^{o}C with a relative humidity of 60% and mean annual rainfall of 650mm-1300mm.

Acquisition and preparation of test material: The yam peels used in this study were collected fresh from different yam processing centers in New Bussa, Niger state. They were sun-dried for 5 days until they become crispy to reduce the level of anti-nutritional factors as well as avoiding microbial reactions leading to spoilage and leaching of nutrient. The dry peel was milled in hammer mill into meals before incorporation into the experimental diets.

Experimental diets: Four isonitrogenous experimental starter and finisher diets were formulated to contain 22% and 20% CP respectively. The diets contained graded levels of yam peel meal (YPM) with Roxazyme-G supplementation to replace maize at 0, 10, 20, and 30% as T_1, T_2, T_3 and T_4 respectively. Diet T_1 which served as the control with 0% YPM and no enzyme supplementation consisted of a basal diet with maize, soybean and fish meal as major sources of energy and protein respectively. Diet 2, 3 and 4 contained 10, 20 and 30 % YPM levels respectively supplemented with Roxazyme G enzyme as shown in Table 1 and 2. Roxazyme G® is an enzyme complex derived from *Trichoderma vivida* with glucanase, cellulase and xylanase activity and the inclusion level was 200mg/kg feed as recommended by the manufacturers.

Experimental birds, design and management: A total of two hundred and sixty (260) day old *Arbor acre* broiler chicks were randomly allotted to four dietary treatments in a completely randomized design and were replicated 5 times with 13 birds each. The birds were reared on a deep litter system. Wood shavings were used as litter materials and constant management of litter through aeration and litter changing when wet were carried out. Feed and fresh clean water were provided *ad-libitum*. Circular feeders made of galvanized iron and manual drinkers made of high-impact plastic known as fountain drinkers were allocated one each per pen of 13 birds. Routine vaccination and medication schedule was properly observed. Periodic turning of the feeders to ensure feeding to appetite was also done. Records of feed intake and body weight change were taken weekly. The study lasted for 56 days.

Data collection: The response parameters taken were average body weight, measured on a weekly basis to determine body weight gain. Feed intake was recorded pen on basis daily by calculating the difference between the amount offered and the left over; feed conversion ratio (FCR) was calculated by dividing feed intake by weight gain. Protein efficiency ratio (PER) was determined as the gain in body weight to the corresponding amount of protein consumed by a bird. The prevailing price of feed ingredients was used to calculate cost of formulated feed per kilogram diet. The

feed intake per bird for 56 days experimental period was used to obtain the cost of feed consumed by a bird. The cost per kilogram weight gain was calculated using the procedure of Ukachukwu and Anugwa (1995) by taking the product of cost per kilogram feed and feed conversion ratio of birds. The cost of production was estimated as the product per kilogram weight gain and mean total weight gain, while revenue was calculated as price of meat multiple by mean total weight gain. The gross margin was estimated as the difference between revenue and cost of production.

Table 1: Gross composition of experimental starter diet containing graded levels of YPM with Roxazyme-G® enzyme

	Diets			
Ingredients	**0% YPM**	**10% YPM**	**20% YPM**	**30% YPM**
Maize	60.00	50.00	40.00	30.00
Yam Peel Meal (YPM)	-	10.00	20.00	30.00
Soybean Meal	33.00	33.00	33.00	33.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
+Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Roxazyme G	-	0.02	0.02	0.02
Total	100	100	100	100
Calculated analysis				
CP (%)	22.08	22.28	22.48	22.68
CF (%)	3.38	5.5	6.54	7.62
ME (Kcal/kg)	2956.80	2888.20	2833.64	2778.05

+ Supreme vitamin-mineral premix contains per 2.5kg the following: Vitamin A, 15,000,000 i.u; vitamin D3, 3,000,000 i.u, vitamin E,30,000 i.u, vitamin K, 2,500 mgr; Thiamine, B1, 2,000 mgr; Riboflavin, B2, 6,000 mgr; Pyridoxine B6, 4,000 mg; Niacin, 40,000 mgr; vitamin B12, 20mgr; Pantothenic Acid, 10,000 mgr; Folic Acid, 1,000mgr; Biotin, 80mgr; Choline Chloride 500mgr; Antioxidant, 125gr; Manganese 96gr; Zinc, 60gr; Iron, 24gr; Copper, 6gr, Iodine, 1.4gr; Selenium, 240mgr and Cobalt, 120gr

Table 2: Gross Composition of Finisher Experimental Diet

	Diets			
Ingredients	**0% YPM**	**10% YPM**	**20% YPM**	**30% YPM**
Maize	65.00	55.00	45.00	35.00
Y PM	0.00	10.00	20.00	30.00
Soybean	28.00	28.00	28.00	28.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Enzyme	0.00	0.02	0.02	0.02
Total	100	100	100	100
Calculated Analysis				
CP (%)	20.12	20.32	20.52	20.92
CF (%)	3.15	5.23	6.32	7.40
ME (kcal/kg)	3000.5	2939.92	2884.34	2828.75

+ Supreme vitamin-mineral premix contains per 2.5kg the following: Vitamin A, 15,000,000 i.u; vitamin D3, 3,000,000 i.u, vitamin E,30,000 i.u, vitamin K, 2,500 mgr; Thiamine, B1, 2,000 mgr; Riboflavin, B2, 6,000 mgr; Pyridoxine B6, 4,000 mg; Niacin, 40,000 mgr; vitamin B12, 20mgr; Pantothenic Acid, 10,000 mgr; Folic Acid, 1,000mgr; Biotin, 80mgr; Choline Chloride 500mgr; Antioxidant, 125gr; Manganese 96gr; Zinc, 60gr; Iron, 24gr; Copper, 6gr, Iodine, 1.4gr; Selenium, 240mgr and Cobalt, 120gr

Chemical analysis: Proximate composition of the test ingredient (YPM), starter and finisher broiler diets were determined using the procedure described by Association of Analytical Chemists (AOAC, 2006). The Metabolizable energy was calculated from the proximate composition data using the formula as described by Pauzenga (1985) as:

ME (kcal/kg) = 37 x %CP + 81.1 x % EE + 35.5 x %NFE.

Statistical analysis: Data obtained were statistically analyzed using Analysis of Variance (ANOVA) by General Linear Model (GLM) procedure of Statistical Analysis System (SAS, 2006). Means were separated using Duncan's Multiple Range Test option of the same statistical package.

Table 3: Proximate composition and energy value of yam peel meal (YPM)

Components (%)	**YPM**
Dry matter (DM)	91.10
Crude protein (CP)	11.05
Crude fiber (CF)	12.84
Ether extracts (EE)	1.50
Ash	8.45
Nitrogen free extract (NFE)	66.16
Energy kcal/kg ME	2879.18

Table 4: Proximate composition of experimental broiler starter diets (0-4 weeks)

	Diets			
Components (%)	0% YPM	10% YPM	20% YPM	30% YPM
Dry matter	90.70	90.61	90.69	90.83
Crude protein	22.45	22.58	22.67	22.80
Crude fiber	4.95	6.80	7.20	7.48
Ether extracts	3.80	3.45	3.20	3.45
Ash	6.55	7.40	7.50	7.64
Nitrogen free extract	62.25	59.77	59.43	58.63
ME (Kcal/kg)	3155.21	3037.09	3008.08	3000.76

Table 5: Proximate composition of experimental broiler finisher diet (4-8 weeks)

	Diets			
Components (%)	0% YPM	10% YPM	20% YPM	30% YPM
Dry matter	90.77	90.95	90.90	90.86
Crude protein	20.27	20.95	20.15	20.36
Crude fiber	3.65	5.80	6.67	7.88
Ether extract	3.40	3.50	3.10	3.35
Ash	6.50	7.35	7.65	7.75
NFE	66.18	62.40	62.43	60.66
ME (Kcal/kg)	3275.12	3174.20	3113.23	3074.38

RESULTS AND DISCUSSION

Proximate composition of YPM and experimental diets: Tables 2, 4 and 5 showed the proximate composition of the YPM, experimental starter and finisher diets respectively. The YPM contained 91.10% DM, 11.05% CP, 12.84% CF, 1.5% EE, 8.45% Ash, 66.16% NFE and a considerable amount of energy (2879.18 Kcal/kg ME). The ME value obtained is slightly higher than the value (2780kcal/kg) obtained by Eka (1985) but lower than the values (3000Kcal/kg) reported by Enkeyem *et al*., (2006) and 2980 kcal/kg by Akinmutimi and Onen, (2008). The crude protein content of 10.52% was slightly higher than the value (9.14%) reported by Enkeyem *et al*. (2006) but lower than the values of 12.17% and 12.03% reported by Akinmutimi and Onen, (2008) and Ezieshi *et al*. (2011) respectively. The variation in ME and CP content of YPM may be attributed to differences in source/variety of yam peel and various factors ranges from the processing method, length of storage, or depth of peeling during processing (Ezieshi and Olumu, 2011). The proximate composition of the YPM revealed that it is a good source of carbohydrate with a fair level of crude protein (11.05%) which is higher than maize with 8.8% CP (Olomu, 1995). The CF value obtained in this study was higher than the values earlier reported (Enkeyem *et al*., 2006, Akinmutimi and Onen, 2008, Ezieshi *et al*., 2011). The value of ash content in the YPM was comparable to that reported by Ezieshi *et al*. (2011), which is an indication that it contains moderate amount of minerals for livestock performance. The nutrient compositions of the experimental diets were within the recommended range for broiler starter and finisher birds in the tropics (NRC, 1994; Olomu, 1995). However, the fiber content in the YPM diets was slightly above the recommended values of 4 - 5% CF for broiler chickens in the tropics (Oluyemi and Robert, 2000). This high level is due to the increasing inclusion level of YPM above 10% in the experimental diets.

Growth performance: The performance of broiler chicks fed diet containing graded levels of enzyme supplemented yam peel meal (YPM) is presented in Table 4. The results show that average final weight, average body weight gain, feed conversion ratio (FCR) and protein efficiency ratio were not significantly ($p<0.05$) affected with inclusion levels of enzyme supplemented YPM diets except for average feed intake. The feed intake was similar ($p>0.05$) between birds on control diet and 10% YPM diet but differs significantly ($p<0.05$) from those on 20 and 30% YPM diet groups. The similarity in feed intake observed in birds fed control diet and those fed the 10% YPM diet could be related to the fact that the energy levels of the diets were close. However, more feed were consumed by the birds with increasing levels of enzyme supplemented YPM at 30% level. This is an indication that the enzyme supplementation had possibly improved overall nutrient digestion thus making them more acceptable by degrading the NSPs into soluble metabolizable products (Bedford, 1996, Choct, 2006). Also, the lower energy level of T_4 diet (30% YPM) may have caused its highest intake by birds in their effort to optimize their energy intake. Enzyme supplementation is also believed to improve digestibility hence reducing physical bulk of the feed leading to increase in feed intake (Midau *et al*., 2011). Body weight gain of birds was comparable across the dietary treatment groups. This shows that the inclusion levels of YPM up to 30% were capable of supplying adequate nutrients for a growth rate comparable to the control diet that is without YPM. This might due to the fact that enzyme supplementation has enhanced the overall feed energy utilization thereby resulting to an improved weight gain in the birds (Midau *et al*., 2011) as well as reducing the anti-nutritional effect of soluble non-starch polysaccharides (NSP) (Buchanan *et al*., 2007). Moreover, FCR of the enzyme supplemented YPM diets compete favorably with the control diet. This may be attributed to the fact that enzyme addition has demonstrated its role in degrading the non-starch polysaccharides (NSP) to monomers, decreasing intestinal viscosity and eventually increases the digestibility and absorption of nutrients by improving gut performance (Iyayi and Okhankhuele, 2002, Nadeem *et al*., 2005, Balamurugan and Chandrasekaran, 2010). Thus, addition of Roxazyme-G used in this present study, might have enhanced the hydrolysis of fibrous components present in YPM thereby making more nutrient available for retention and utilization by the broilers. This observation is in agreement with the report of Buchanan *et al*. (2007), Ani and Nnamani (2011) and Aya *et al*. (2013) that exogenous enzyme hydrolyze NSP which might be potentially used by the animal, thereby increasing the utilization of feed energy leading to improvement in weight gain and FCR in birds fed enzyme supplemented diets. The protein efficiency ratio (PER) of the birds are comparable across the treatment groups. This shows that birds can utilize diets containing enzyme supplemented yam peel meal up to 30% substitution

level, thereby making them efficient in converting dietary protein into edible meat. Enzyme treatment is capable of solubilizing high amount of cell wall thereby producing a good quality high level of soluble carbohydrates from non-starch polysaccharides (IFRU, 2003). Thus, the considerable amount of inclusion level obtained in this study could be due to the enzyme supplementation effect on YPM, which initiated fiber breakdown and reduction in anti-nutritional activities, causing a release of locked-up nutrients that encourage good performance of broiler birds.

Table 6: Performance of broiler chickens fed graded levels of yam peel meal with Roxazyme G enzyme supplementation (n =56days)

	Diets				
Parameters	0% YPM	10% YPM	20% YPM	30% YPM	**SEM**
Initial weight g/bird	51.50	51.55	51.38	51.40	1.04
Final weight g/bird	2122.25	2115.10	2118.05	2110.75	9.31
Feed intake g	3145.61[a]	3140.72[a]	3182.83[b]	3196.81[b]	17.17
Daily feed intake g/bird	64.20	64.10	64.96	65.24	0.87
Weight gain g	2070.75	2063.55	2066.67	2059.35	5.17
Daily weight gain g/bird	42.26	42.11	42.18	42.03	2.43
FCR	1.51	1.52	1.54	1.55	0.28
PER	1.50	1.56	1.52	1.54	0.22

[a,b,c] Means with different superscripts are significantly different (P<0.05).

Economics of production: Table 7 summarizes the results obtained on the economics of production of broiler chickens using YPM with enzyme supplementation. Cost per kg feed and revenue were showed no significant difference (p>0.05) while other parameters evaluated were significantly (p<0.05) affected by the inclusion levels of YPM with enzyme supplementation. Feed cost per kilogram ranged between ₦129.82 to ₦79.40, showing a decreased with increasing inclusion level of YPM in the diets. This is due to comparable lower cost per unit of yam peel to that of maize (Akinmutimi and Onen, 2008). The result revealed that there was a significant (p<0.05) reduction in the cost of feed consumed (₦253.83) and cost of feed per kilogram weight gain (₦123.07) as the level of YPM in the diets increased and was lowest in birds fed diet 4 (30% YPM) but highest in control group as ₦408.36 and ₦196.03 respectively. Similarly, the cost of production reduced (p<0.05) when enzyme supplemented YPM increased in the diets. Diet 4 (₦253.44) and 3 (₦284.60) were the cheapest followed by diet 2 (₦385.26). The control diet 1 (₦405.93) was the most expensive. It is very obvious because cost of production decreased with increasing level of enzyme supplemented YPM. This could be attributed to the partial replacement of the more expensive maize with YPM that has a minimal cost impact. This shows that it is more economical and profitable to supplement YPM diets with Roxazyme-G enzyme. Though revenue generated was not significantly (p>0.05) affected by enzyme supplementation, it was numerical higher in T_1 (₦1242.45) and T_3 (₦1240.00) compared to the other treatments. This could be due to higher body weight gain and better FCR observed in birds fed control diet and T_3 diet (20% YPM) compared to other diets. It is very obvious from the result that gross margin increased with increasing level of enzyme supplemented YPM. The gross margin was highest in birds fed diet 4 compared to those fed control diet which had the lowest gross margin. These findings pointed out the inclusion of YPM with enzyme supplementation in broiler diet would yield better economic returns for farmers as well as help address the cost concerns usually attached to high demand of conventional ingredients like maize. Increased nutrient availability and metabolizable energy due to NSP degradation as well as reduction in digesta viscosity by the enzyme could be the reason for the observed results (Odetallah *et al*., 2005, Midau *et al*., 2011, Aya *et al*., 2013).

Table 7: Economics of production of broiler chickens fed graded levels of yam peel meal with Roxazyme G enzyme supplementation (n=56 days)

	Diets				
Parameters	0% YPM	10% YPM	20% YPM	30% YPM	**SEM**
Feed cost/kg (₦/kg)	129.82	122.83	89.42	79.40	-
Feed cost consumed (₦/kg)	408.36[b]	385.77[b]	284.61[a]	253.83[a]	19.82
Feed cost/weight gain (₦/kg)	196.03[b]	186.70[b]	137.71[a]	123.07[a]	18.78
Cost of production (₦)	405.93[a]	385.26[a]	284.60[b]	253.44[c]	12.08
Revenue (₦)	1242.45	1238.13	1240.00	1235.61	8.07
Gross margin (₦)	836.52[b]	852.87[b]	955.40[a]	982.17[a]	25.97

[a,b,c] Means with different superscripts are significantly different (P<0.05).

CONCLUSION

The study demonstrated that yam peel meal can be utilized as a source of energy in poultry diets with enzyme supplementation. The results of this study have revealed that the nutritive value of yam peel meal can be improved by supplementing with an enzyme. The use of Roxazyme-G enzyme supplemented YPM in place of maize up to 30% level elicited a good performance in broiler chickens without any adverse effect at the lowest cost of production with higher gross margin and is hereby recommended for poultry farmers. This will mitigate environmental hazards in communities where yam peels are wasted.

CONFLICT OF INTEREST

Authors have declared that there were total absences of conflict of interest that could be perceived to influence their research work.

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