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ORIGINAL RESEARCH ARTICLE

Performance of finisher broilers fed diets containing orange pulp meal with or without non-starch polysaccharides enzyme supplementation

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ABSTRACT

A 28-day feeding trial was conducted to evaluate the performance of finisher broilers fed diets containing orange pulp meal (OPM) supplemented with non-starch polysaccharides multi- enzyme (Roxazyme G2). The orange pulps were gathered from fruit juice industry, sun- dried, milled and analysed for proximate composition prior to the feed formulation. Five broiler finisher diets were formulated with diet 1 serving as control. Diets 2 and 3 contained the OPM, replacing maize at 15 and 30% in the control diet. Diets 4 and 5 with similar composition as diets 2 and 3 were supplemented with 0.5g/Kg, Roxazyme enzyme G2G^R. Two hundred and twenty five (225), 28-days old broiler chicks used for the experiment were distributed into 5 groups of 45 chicks per group. The groups were randomly assigned to the five experimental diets and fed for 28 days. At the end of the feeding trial, four birds per treatment were slaughtered for carcass and internal organs evaluation. The results revealed that birds fed control and treatment diets did not vary significantly in their average daily feed intake and weight gain. Birds on diets with enzyme supplementation had superior feed conversion ratio (2.64 and 2.60 for diets 4 and 5, respectively) relative to those fed non enzyme diets. The inclusion of OPM with enzyme supplementation did not affect the carcass and internal organs of the birds adversely, except for liver and intestinal length. Dietary enzyme supplementation also did not increase the cost of feed and the cost of producing a kilogram of meat from poultry. It was concluded that OPM could replace maize at 30% in the broiler finisher diets with or without enzyme supplementation.

Keywords: Roxazyme G2G^R, Feed intake, Growth, Feed efficiency, Carcass quality.

INTRODUCTION

Shortage of feedstuff during drought and their high costs are significant limiting factors to increasing the production of livestock in the developing countries (Madhu *et al.*, 2012). The shortage, especially the major cereals like maize, guinea corn, millet, and rice often prevent any significant development in the production of poultry and pigs as they depend largely on a constant supply of these basic energy sources (Onu and Madubuike, 2006). In order to reduce the cost of feeds and thus make poultry and pig production profitable, there is need to search for cheaper, non-competitive and readily available feed ingredient to replace the costly ones (Umoren *et al.*, 2007). The increase mechanization of crop farming in the developing economics has led to rise in the tonnage of agro-industrial by-products most of which are underutilized. One of such wastes could emanate from citrus (Rice and Rice, 1987). Citrus is botanically a large family, whose dominant members include sweet orange (*Citrus sinensis*), lemon orange (*Citrus limonum*), lime (*Citrus qurantifolia)* and grape fruit (*Citrus paradsi*). Sweet orange (*Citrus sinensis*) production in Nigeria is significant, with heavy direct consumption due primarily to few and small capacity processing industries to convert the fruit to juice, concentrate and canned fruit. The orange waste product usually constitute environmental nuisance during the period of harvest, since it is not being intensively utilized. Information on the feeding potential of this agricultural waste to farm animals tend to emphasize more on its utilization as partial substitute for cereals in concentrates ration for non-ruminants (Chapman and Greenhalgh, 2002).

However, the high fibre content (non–starch polysaccharides, lignin, cellulose and hemicelluloses) render this valuable products unsuitable for monogastric. Poultry produce a number of enzymes, including amylases to digest starch, proteases to digest protein and lipases to digest fats. However, they do not produce enzymes to digest fibres in feeds. The main potential of enzymes addition appears for digestion of substances that an animal is intrinsically incapable of digesting (Cheeke, 1991). These enzymes can open up the complex feed walls, allowing the animals own enzymes to digest the enclosed nutrients (Nadeem *et al.*, 2005). Soluble high molecular weight fibre polysaccharides complexes are responsible for the high digesta viscosity. High digesta viscosity can lead to reduced feed intake, slower digesta passage rate, and

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impaired nutrient digestion (Nadeem *et al*., 2005). Recently, exogenous feed enzymes have been developed to degrade these anti-nutritive factors and ameliorate their negative effects. Non-starch polysaccharides degrading enzymes (NSPDE) have been the subject of very considerable research (Hen *et al.*, 1997; Bedford and Schulze, 1998; Bedford and Partridge, 2001 Günal and Yasar (2004). Therefore this experiment was designed to evaluate the effect of non starch polysaccharides enzymes supplementation (Roxazyme G2G^{R}) on the performance of finisher broilers fed orange waste meal based diets.

MATERIALS AND METHODS

Experimental site

The study was conducted at the Poultry unit of the Teaching and Research Farm, Department of Animal Science, University of Calabar, Nigeria between October and November 2013.

Acquisition and processing of experimental materials

The orange pulp (mixtures of the mesocarp and endocarp) were collected fresh from the fruit juice industry in Calabar Export Processing Zone (EPZ), sun-dried for 10 days to reduce the moisture content to about 12%. The dried samples were milled using small hammer mill with 3 mm screen mesh. The milled stuff was stored prior to chemical analysis and feed formulation.

Proximate analysis

The proximate analysis of the orange pulp meal and the compounded rations were carried out according to the methods of AOAC (1995).

Table 1: Proximate composition of orange pulp meal and yellow maize

Constituents	% Composition	
	Orange pulp meal	Maize
Crude Protein	5.60	9.05
Crude fibre	12.60	2.52
Ash	3.90	1.74
Carbohydrate	77.23	82.75
Lipid	0.67	3.94

Values are means of triplicate determinations

Diets preparation

Five broiler finisher diets were formulated to provide 19% crude protein and a metabolisable energy of 2900kcal/kg. Diet 1 was control, having maize as its energy source, Diets 2 and 3 had maize in the control diet replaced by 15 and 30 % orange pulp meal, respectively, while Diets 4 and 5 with similar

Table 2: Gross composition of experimental diets fed to finisher broilers

Ingredients	Levels of orange pulp meal (%)				
	0 (Diet 1)	15 (Diet 2)	30 (Diet 3)	15% + 0.5g/Kg NSP (Diet 4)	30% + 0.5g/Kg NSP (Diet 5)
Maize	58.30	49.55	40.81	49.55	40.81
Orange pulp meal	-	8.75	17.49	8.75	17.49
Soybean meal	20.4	20.4	20.4	20.4	20.4
Fish meal	3.00	3.00	3.00	3.00	3.00
Wheat offal	9.00	9.00	9.00	9.00	9.00
Palm kernel cake	5.00	5.00	5.00	5.00	5.00
Table Salt	0.50	0.50	0.50	0.50	0.50
Bone meal	3.00	3.00	3.00	3.00	3.00
L-Lysine	0.20	0.20	0.20	0.20	0.20
DL-Methionine	0.10	0.10	0.10	0.10	0.10
Vitamin/mineral premix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Determined analysis					
Crude protein	19.05	18.98	18.96	19.02	19.99
ME(Kcal/kg)	2898.01	2900.3	2905.2	2903.01	2901.11
Crude fibre (%)	4.41	5.21	6.16	4.99	5.98

Vitamin/mineral premix containing the following per kg. Vitamin A 8,000000 I.U; Vitamin D3 1,600000IU; Vitamin E 5,000IU; Vitamin K 2,000mg; Thiamine 1,500mg; Riboflavin B_2 4,000mg; Pyridoxine B_6, 1,500mg; Anti oxidant 125g; Niacin1,500mg; Vitamin B_{12} 10mg; Panthotenic acids 5,000mg; Folic acid 500mg; Biotin 20mg; Choline chloride 200g, manganese 80g; Zinc 50g; 1ron 20g; copper 5g; Iodine 1.2g; Selenium 200mg; Cobalt 200mg

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Table 3: Performance of finisher broilers fed diets containing OPM with or without enzymes.

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	± SEM
Initial weight	950.60	951.83	952.08	950.83	943.96	0.78
Final weight	1895.80	2307.31	2352.08	2488.31	2362.70	6.35
Weight gain/birds	1215.20	1255.48	1400.00	1532.48	1418.76	4.58
Average daily weight gain/birds (g)	43.40	48.41	50.00	54.91	50.67	0.86
Average daily feed intake/bird(g)	138.25	149.40	136.10	143.83	130.85	1.13
Feed conversion ratio (FCR)	3.25^{a}	3.01^{a}	2.95^{ab}	2.64^{b}	2.60^{b}	0.22
Mortality	0.00	0.00	0.00	0.00	0.00	0.00

aMeans with different superscript within the same row are significantly (p<0.05) different.

Diet 1: Control
Diet 2: Contain 15% sweet orange pulp meal
Diet 3: Contain 30% sweet orange pulp meal
Diet 4: Contain 15% sweet orange pulp meal +NSP
Diet 5: Contain 30% sweet orange pulp meal +NSP
SEM- Standard error of mean.

The Roxazyme G2 enzyme contains enzyme complex derived from *Trichodema lonibrachiatum.* The main enzyme activities of this complex are Cellulase (endo-1, 4 -β – glucanase; EC 3.2.1.4); β-glucanase (endo-1, 3 (4) -β – glucanase; EC3.2.1.6) and xylanase (endo-1, 4 -β – xylanase; EC3.2.1.8).

Experimental birds and design

Two hundred and twenty five (225), 28- day old broiler chicks of Anak 2000 breed were obtained and distributed into five (5) groups of forty five (45) chicks per group on weight equalization basis. Groups were further divided into three replicates of fifteen chicks and randomly assigned to one of the five dietary treatments described earlier. The experimental design used was Completely Randomized Design (CRD). The feeding trial lasted for 28 days, during which water and feed were offered provided *ad libitum.* The average daily feed intake (ADFI) was measured daily by subtracting the quantity of feed left 24 hours post feeding from the initial quantity offered; while the weights gain of birds were measured weekly using digital weighing balance. Data for the feed intake and weight gain were used to compute the feed conversion ratio (FCR). At the end of the feeding trial, four birds per treatment were randomly selected, fasted for 12 hours with water only provided weighed and slaughtered for carcass and internal organs evaluation.

Data analyses

Data collected were statistically analyzed using the SAS (1990) and the significant means separated using Duncan Multiple Range Test of the same package.

RESULTS AND DISCUSSION

Proximate composition of orange pulp meal (OPM) and maize

The compositions of the OPM and maize are as presented in Table 2. The crude protein, lipids and carbohydrates of OPM are 5.60%, 0.67% and 77.23%, relative to 9.05%, 3.94%, 2.54%, 82.75%, respectively for maize. The crude fibre in the orange pulp (12.69%) is appreciably high compared with 2.52% for maize.

Bird's performance

The effect of dietary supplementation of NSP enzyme on the performance of finisher broilers fed diets containing sweet orange pulp meal (OPM) is presented Table 3. The average daily feed intake did not vary significantly (p>0.05) among treatments group, implying that the treatment diets supplied sufficient energy needed by the birds, since chickens eat to satisfy their energy requirement. The result of this study is in accordance with the findings of Jacob *et al.* (2000) and Nadeem et *al.* (2005) who reported a non- significant relationship (p>0.05) among birds fed diets with or without enzymes supplementations. Variation in the average daily weight gain was not significant (p>0.05) among treatment groups. These results are in line with the previous findings of Oke *et al*. (2007) who gave 41.30-53.91g as the mean daily weight range of finisher broilers fed diets supplemented with multi –enzyme but higher than the range (14.88-27.86g) reported by Oluremi (2007) for birds fed diets containing orange pulp meal. The result of this experiment also agreed with the findings of Moharrery (2006), who reported a non significant relationship between birds fed maize and barley diets with or without enzyme supplementation, although diets without enzyme supplementation had a lower weight gain compared to the enzyme supplemented diets. The feed conversion ratio varied significantly (p<0.05) among different dietary groups. Birds on diets with enzyme supplementations generally had lower feed conversion ratio (2.64 and 2.60 for Diets 4 and 5, respectively) relative to those on experimental diets without enzyme supplementation. It is suggested that birds on diets with

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Table 4: Internal organs and carcass characteristics of finisher broilers fed diets containing OPM

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	± SEM
Live weight(g)	2300.00	2350.00	2200.00	1850.00	2000.00	6.15
Pluck weight (g)	2184.66	3201.18	2067.02	1838.17	1843.19	6.08
Dressed weight (g)	2050.00	2125.00	1970.00	1720.00	1757.50	5.66
Dressing percentage	89.13	90.43	89.46	92.98	87.88	0.58
Carcass weight (% live weight)						
Head	2.26	2.63	2.27	2.63	2.65	0.19
Shank	4.11	4.80	3.43	5.12	5.31	0.37
Neck	6.70	5.65	5.64	7.22	5.86	0.35
Wing	9.76	9.46	8.69	9.36	12.44	0.28
Thigh	23.89	24.54	22.07	19.79	24.02	0.57
Back	15.40	11.95	15.23	15.19	16.02	0.57
Breast	20.04	24.28	24.20	21.31	17.19	0.61
Internal organs (% live wt)						
Proventriculus	0.47	0.45	0.58	0.59	0.41	0.11
Heart	0.50	0.53	0.55	0.37	0.61	0.12
Lungs	0.37	0.56	0.57	0.45	0.52	0.12
Liver	1.72^{b}	1.51^{ab}	2.12^{a}	1.93^{a}	2.10^{a}	0.21
Gizzard	3.16	3.35	3.69	4.10	3.28	0.26
Length of intestine (cm)	215.00^{b}	195.50^{b}	217.00^{b}	321.00^{a}	243.50^{a}	1.80

Means with different superscript within the same row are significantly ($p<0.05$) different

Diet 1: Control Diet 2: Contain 15% sweet orange pulp meal (SOPM)
Diet 3: Contain 30% sweet orange pulp meal (SOMP) Diet 4: Contain 15% OPM + NSP enzyme supplementations
Diet 5: Contain 30% OPM + NSP enzyme supplementations
SEM Standard error mean

enzyme supplementations had more efficient energy utilization than birds fed un-supplemented diets. Enzymes breakdown the NSP, decreased intestinal viscosity and eventually improve the digestibility of nutrients by improving gut performance (Nadeem et *al.*, 2005; Balamurugan and Chandrascharan, 2010)

Mortality

There was zero mortality across the treatment groups throughout the experimental period, suggesting that the diets did not contain any substances detrimental to the well being of the birds.

Internal organs and carcass characteristics,

Table 4 shows the carcass and internal organs characteristics of broilers fed sweet orange pulp meal (SOPM) diets with or without dietary enzyme supplementation. Dressing percentage expressed as percentage of the live weight did not vary significantly ($p>0.05$) among treatment groups. The weight of cut parts as a percentage of live weight were not significantly ($p>0.05$) influenced by the treatment groups. Variation in the mean weight of the internal organs as percentage live weight followed a similar trend in that there were not significantly ($p>0.05$) influenced, except for the liver and the intestinal length which were significantly ($p<0.05$) increased. The percentage liver weight ranged from 1.51 in birds on diet 2 to 2.12 in birds fed diet 3. Liver weight of birds fed diets 3, 4, and 5 were however statistically similar ($p>0.05$) to each other. Decrease in liver size has been attributed to an attempt to detoxify the toxic components of the diets. In this experiment, the higher liver weight observed for birds on the experimental diets relative to control diet, imply that these diets did not contain any toxic substances whose effects were detrimental to the birds.

Table 5: Economics of feeding OPM enzyme supplemented diet on finisher broilers.

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	± SEM
Cost/kg of feed (₦)	98.32	91.32	84.33	96.32	94.82	1.08
Cost of feed consumed (₦)	518.15	452.04	458.76	459.29	494.10	2.82
Cost/kg gain (₦)	426.39	360.06	327.69	364.96	348.26	2.58

Diet 1: Control Diet 2: Contain 15% sweet orange pulp meal
Diet 3: Contain 30% sweet orange pulp meal Diet 4: Contain 15% OPM + NSP enzyme supplementations
Diet 5: Contain 30% OPM + NSP enzyme supplementations SEM - Standard error of mean

The intestinal length ranged from 195.5cm in birds fed diet 2 to 243.5cm in birds fed diet 5. The intestinal length was significantly longer in birds fed diets 4 and 5. The various non-starch polysaccharides (Jorgensen *et al.*, 1996) are known to lengthen the size of the intestine.

Economic efficiency

The economic efficiency of feeding sweet orange pulp meal with or without enzyme supplementations to finisher broilers is presented in Table 5. The cost/kg of feed did not differ significantly ($p>0.05$) among the treatment groups, though it was cheaper producing diets containing SOPM with or without enzyme supplementations than the control diet. The cost of feed consumed was statistically similar across the dietary treatment groups. The higher feed intake observed in birds on diets 4 and 5 significantly influenced the cost of feed consumed. Variation in the cost/kg weight gain was not significant ($p>0.05$) among treatment groups. The use of enzymes in diets 4 and 5 did not significantly increase the cost of producing 1kg of poultry meat.

CONCLUSION AND RECOMMENDATION

It was concluded that orange pulp meal could replace maize at 30 per cent in the broiler finisher diet with or without enzyme supplementation.

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