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Dietary effects of cassava powder and Roxazyme® G2G on growth performances, haematological profile and serum lipid of broiler chicks

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ABSTRACT

A feeding trial was carried out to investigate the response of broiler chicks to cassava peel meal supplemented with Roxazyme® G2G. Cassava peel meal based diet containing 0, 20 and 40% at the expense of maize was divided into 3 equal portions; each portion had 0, 100 and 200 mg/kg Roxazyme® G2G supplementation to make a total of nine diets. A total of 450 day old broiler chicks with weight range between 396 and 401 g were randomly distributed to the diets in a 3 × 3 factorial arrangement at 50 chicks per treatment; replicated five times of ten birds per replicate. The results obtained shows significant decrease ($p<0.05$) in final live weight (FLW), (554.65 g versus 510.11 and 521.00 g), average weight gain (AWG) (24.02 g/b/d versus 21.90 and 22.08 g/b/d) and average feed intake (44.23 g/b/d versus 42.02 and 42.83 g/b/d) of broiler chicks at 0% vs 20 and 40% cassava peel meal, respectively. While the feed conversion ratio (FCR) was not significant ($p>0.05$). Enzyme supplementation improved performance of broiler chicks by 2.39 and 5.87% in the FLW, 3.88 and 7.63% in average daily weight gain (ADWG), 6.03 and 7.54% in FCR over birds fed non-enzyme supplemented diets. Haematological and serum indices of the birds were similar, irrespective of enzyme supplementation. From the findings of this study, an optimum supplementation of Roxazyme® G2G at 100 mg/kg of either 20 or 40% cassava peel meal substitution in broiler chick diet is recommended.

INTRODUCTION

The use of many agro-based wastes in livestock feeds is plagued by their high anti-nutritional contents, low crude protein and high non-starchy polysaccharides often designated as fibre (Madubuike and Obadimma, 2009). Thus, diets high in fibre have been reported not to be well utilized by broiler chickens for growth (Furda, 1990). Exogenous enzyme supplementation had been reported to play significant roles in the enhancement of low quality feeds in animal nutrition (Friesen et al., 1992; Bedford, 2000; Marquardt, 1997; Kim et al., 2005; Fasiullah et al., 2010; Oladunjoye and Ojebiyi, 2010).

Cassava peel contains cyanogenic glucosides primarily linamarin (80% of total glucosides) and lostaustralin (20% of total glucosides), which upon hydrolysis yields cyanohydrins, which further liberates hydrogen cyanide (HCN) by the presence of endogenous enzyme linamarase (White et al., 1998). Aside from the high hydrogen cyanide, cassava peel is also constrained by high fibre content (10.0–38.4%) (Oboh, 2006; Adesehinwa et al., 2011; Aro and Aletor, 2012), high phytate content up to 1.0% DM, resulting in low phosphorous availability (Ubalua, 2007), and low crude protein ranging between 2.10–8.2% (Devendra, 1977; Oboh, 2006; Aro and Aletor, 2012). To this end, processing techniques such as fermentation (Oboh and Akindahunsi, 2003; Obadina et al., 2006; Oboh, 2006; Aro et al., 2008), soaking (Oluremi and Nwosu, 2002), and Avizyme®1300 supplementation (Adesehinwa et al.,

2008) has being employed to enrich the nutrient status of cassava peel. Results from these studies has not been able to establish the satisfactory level of substituting cassava peel meal for maize in broiler chicken diet.

This study therefore aimed to assess the nutritive value of cassava peel meal supplemented with Roxazyme® G2G; a fibre degrading enzyme, in broiler chick diet. It is hoped that this biological component will help degrade the high fibre in cassava peel meal and possibly unlock the nutrients present in the plant cell matrix for broiler chick utilization.

MATERIALS AND METHODS

Location of the experiment

The right to conduct the study was given by the Research Committee of the Animal Production and Health Department of the Federal University of Technology, Akure, Ondo State, Nigeria. The study was carried out at the Poultry Unit of the Department of Animal Production and Health, The Federal University of Technology, Akure, Ondo State of the South-western part of Nigeria. Akure is located between 07°15' N, 05°05' E with annual rainfall of 1800–3600 mm, 54–91% relative humidity and mean daily temperature 22–35°C throughout the year (Maps-street view, 2015).

Processing of cassava peel and procurement of Roxazyme® G2G

Cassava peel used in this study was collected from Cassava Sunshine Factory located at Kilometer 7, Ondo-Ore Express Road, Ondo, Nigeria. The peel was chopped and gradually sun-dried with regular turning to prevent fermentation and then milled, bagged and kept for use.

Roxazyme® G2G is a product of DMS Nutritional Product Limited at Het Overloon 1, 6411 TE, Netherlands. Enzymatic activity in the product is:

endo-1,4-beta-glucanase: min. 8000 u/g feed
endo-1,3 (4)-beta-glucanase: 18000 u/g feed
endo-1,4-beta-xylanase: 26000 u/g feed

Chemical analysis

Milled samples of cassava peel and experimental diets were analysed for proximate composition (AOAC, 2002). Mineral constituents of cassava peel meal and experimental diets were analysed by first dry-ashing the flour at 500°C. The ash was dissolved in 0.1 M HCl and transferred to 100 ml standard flask using distilled de-ionised water. Magnesium (Mg), Manganese (Mn), Calcium (Ca), Iron (Fe), Zinc (Zn), and Copper (Cu) were determined by means of atomic absorption spectro-photometer PYE Unican Sp, 9, Cambridge, UK. Sodium (Na) and Potassium (K) were determined by flame photometry (Jenway Ltd., Dunmow, Essex, UK) while Phosphorus (P) was determined by the vanado-molybdate method (AOAC, 2002) using a corning calorimeter 253. Phytate was quantified as described by Young and Greaves (1940) while tannin was according to Makkar and Goodchild (1996) and cyanide by the method of Oboh et al. (2002).

Experimental diets

A 3 × 3 factorial study was used in this experiment. Nine experimental diets were formulated. The basal diet, which is diet 1 (control diet) was formulated to meet the NRC (1994) requirement for broiler chicks. Diets 2 and 3 of equal quantity as the basal diet (control diet) were supplemented with 100 and 200 mg/kg Roxazyme® G2G, respectively. Diets 4, 5 and 6 has 20% cassava peel meal in place of maize component supplemented with 0, 100 and 200 mg/kg Roxazyme® G2G, respectively while diets 7, 8 and 9 has 40% cassava peel meal substitution at the expense of maize with addition of 0, 100 and 200 mg/kg Roxazyme® G2G, respectively (Table 1).

Management of birds and data collection

A total of 450 day-old broiler chicks of Marshal Breed with group weight ranging between 396 and 401 g were randomly distributed to the nine treatment diets in a 3 × 3 factorial arrangement of treatments. Fifty (50) broiler chicks were assigned to each dietary treatment replicated five times of ten birds. Adequate housing and brooding conditions were maintained to provide adequate ventilation, temperature and warmth. Birds were vaccinated as prescribed by the veterinary officers of Federal University of Technology, Akure. Feeds and water were offered *ad-libitum* throughout the 21 days experimental period. Data were collected on daily feed intake and weekly weight gains. Feed conversion ratio was calculated as: Average feed intake (g)/Average weight gain (g).

Haematological and serum determination

At 21st day of age, blood samples (2 ml each) were collected from 4 chicks per replicate (20 chicks per treatment) by puncturing the wing and gently shaked. The blood samples were collected into bijour bottles containing a speck of ethylene diamine tetra acetic acid

Table 1. Gross composition of experimental diets (%) for broiler chickens aged 1-21 days.

Ingredients	**Diets**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Levels of cassava peel substitution (%) and enzyme supplementation (mg/kg)								
	0 (0)	**0 (100)**	**0 (200)**	**20 (0)**	**20 (100)**	**20 (200)**	**40 (0)**	**40 (100)**	**40 (200)**
Maize	51.19	51.19	51.19	40.95	40.95	40.95	30.71	30.71	30.71
CPM	-	-	-	10.24	10.24	10.24	20.48	20.48	20.48
SBM	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
GNC	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Methionine	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Veg. Oil	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Calculated value (%)									
Crude protein	23.14	23.14	23.14	22.53	22.53	22.53	21.92	21.92	21.92
Crude fibre	3.32	3.32	3.32	4.60	4.60	4.60	5.88	5.88	5.88
ME (kcal/kg)	3090.82	3090.82	3090.82	2993.54	2993.54	2993.54	2896.26	2896.26	2896.26
Ca	1.30	1.30	1.30	1.32	1.32	1.32	1.35	1.35	1.35
Av.P	0.59	0.59	0.59	0.59	0.59	0.59	0.58	0.58	0.58
Lysine	1.38	1.38	1.38	1.36	1.36	1.36	1.33	1.33	1.33
Methionine	0.51	0.51	0.51	0.49	0.49	0.49	0.47	0.47	0.47
Analyzed value (%)									
Crude protein	23.08	23.08	23.08	22.58	22.58	22.58	21.98	21.98	21.98
Crude fibre	3.36	3.36	3.36	4.62	4.62	4.62	5.76	5.76	5.76
ME (kcal/kg)	3111.19	3111.19	3111.19	2979.03	2979.03	2979.03	2932.11	2932.11	2932.11
Fat	4.51	4.51	4.51	3.44	3.44	3.44	2.94	2.94	2.94
Ash	3.34	3.34	3.34	4.71	4.71	4.71	4.11	4.11	4.11
Ca	1.32	1.32	1.32	1.33	1.33	1.33	1.34	1.34	1.34
P	0.61	0.61	0.61	0.60	0.60	0.60	0.60	0.60	0.60

***2.5 kg/ton vitamin A 8000000 i.u; vitamin D3 2000000 i.u; vitamin E 8000 mg; vitamin K3 2000 mg; vitamin B1 1500 mg; vitamin B2 4000 mg; vitamin B6 1500 mg; vitamin B12 10 mcg; niacin 15000 mg; pantothenic acid 5000 mg; folic acid 500 mg; biotin 20 mcg; choline chloride 100000 mg; manganese 75000 mg; zinc 45000 mg; iron 20000 mg; copper 4000 mg; iodine 1000 mg; selenium 200 mg; cobalt 500 mg; antioxidant 125000 mg.

CPM, Cassava peel meal; SBM, soybean meal; GNC, groundnut cake.

Figures in parenthesis are levels of enzyme in the diets while figures not in parenthesis are CPM substitution levels.

Table 2. Chemical composition of cassava peel.

Proximate composition (g/100g), energy value (kcal/kg) and fibre fractions (g/100g)													
Dry matter	**Crude protein**	**Crude fibre**	**Crude fat**	**Ash**	**NFE**	**GE**	**ME**	**NDF**	**ADF**	**Hemi-cellulose**	**Cellulose**	**ADL**	**NFC**
89.81	4.68	18.45	3.95	3.08	59.65	3089.26	2604.49	41.04	17.76	23.28	13.37	4.39	46.15

Mineral constituents (mg/kg)								
K	**Ca**	**Mg**	**P**	**Na**	**Mn**	**Cu**	**Fe**	**Zn**
126.67	360.00	216.67	245.33	116.33	1.33	1.03	9.33	3.33

Anti-nutritional components						
Tannin (g/100g)	**Oxalate (mg/g)**	**Phytate-P (mg/g)**	**Phytate (mg/g)**	**Flavonoid (mg/100g)**	**Alkaloids (mg/g)**	**Cyanide CN^- (mg/kg)**
0.09	263.19	4.36	15.96	6.08	6.56	15.88

(EDTA) powder as anticoagulant were used for the determination of the packed cell volume (PCV), red blood cell (RBC) counts, white blood cell (WBC) counts and haemoglobin concentration. The PCV was determined using the Wintrobe's microhaematocrit technique while the RBC, WBC, haemoglobin concentration values were determined using the improved Neubauer haemocytometer and cyanomethane-moglobin methods (Coles, 1986). The mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH) and mean corpuscular volume (MCV) were calculated while the erythrocyte sedimentation rate (ESR) was determined as described by Jain (1986). Another blood samples were collected in heparinised bottle for the serum determination. The serum total protein, albumin, globulin, cholesterol, urea, high density lipoprotein (HDL), low density lipoprotein (LDL), alkaline phosphatase (ALP), aspartate transaminase (AST), alanine transaminase (ALT) were determined with a Reflectron® Plus 8C79 (Roche Diagnostic, GonbH Mahnheim, Germany), using commercial kits.

Data analyses

Data collected on daily feed intake, weekly weight changes and haematological and serum variables were subjected to analyses of variance using the General Linear Model of the Statistical Analysis System (SAS, 2002) for completely randomized design. Data were tested for main effects (cassava peel substitution levels and enzyme levels) and two-way interaction. Duncan option of the same statistical software was used to separate the means which were identified at a significant level p<0.05.

RESULTS

Proximate composition (Table 2) of the experimental diets and fibre fractions of cassava peel meal (CPM) reveal the potential of cassava peel as feed component in broiler chick diet. Cassava peel meal used in this study has appreciable levels of nutrients as revealed in the proximate constituents.

The neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicelluloses, cellulose, acid detergent lignin (ADL) and NFC of the experimental diets (Table 3) have their values significantly increased (p<0.05) at higher levels of CPM substitution. The various anti-nutritional components of the diets, such as cyanide, oxalate, phytate-P and phytate contents were significantly higher (p<0.05) at 20 and 40% CPM at the expense of maize components while tannin, flavonoid and total alkaloids were similar (p>0.05) for all the diets as shown in Table 4.

The results in Table 5 reveal that the substitution of CPM resulted to a significant decrease (p<0.05) in the feed intake and weight gains while the FCR was similar (p>0.05). Average daily feed intake (ADFI) decreased by 5.00 and 3.17% in chicks fed on 20 and 40%, respectively, when compared with those on 0% CPM substitution. FLW significantly decreased (p<0.05) by 7.87 and 8.03% and ADWG by 7.95 and 8.83% in broiler chicks on 20 and 40% CPM substitution, respectively when compared with birds fed control diet. However, feed utilization by the chicks fed the control and CPM-based diet was not significant (p>0.05).

Table 3. Fibre fractions of cassava peel and experimental diets for broiler chickens aged 1–21 days.

Fibre fractions	Diets					
	1	2	3			
	Levels of cassava peel substitution (%)					
	0	20	40	SEM	P-value	Cassava peel
NDF	31.13[c]	31.96[b]	32.71[a]	0.06	0.001	41.04
ADF	13.41[b]	13.81[b]	14.18[a]	0.02	0.02	18.22
Hemicellulose	17.72[c]	18.13[b]	18.53[a]	0.04	0.03	24.04
Cellulose	9.77[b]	9.74[b]	9.95[a]	0.03	0.03	13.49
ADL	3.64[c]	4.07[b]	4.23[a]	0.03	0.01	4.73
NFC	37.94[b]	37.31[b]	38.26[a]	0.15	0.03	46.64

[abc], Means with different superscripts along the same column are significant ($p<0.05$).

Table 4. Anti-nutritional components of experimental diets for broiler chickens aged 1-21 days.

Parameters	Diets				
	1	2	3		
	Levels of cassava peel substitution (%)				
	0	20	40	SEM	P-value
Cyanide (mg/kg)	1.07[b]	9.94[a]	10.04[a]	0.52	0.001
Tannin (%)	0.05	0.06	0.06	0.04	0.07
Oxalate (%)	0.22[b]	0.32[a]	0.34[a]	0.03	0.001
Phytate-P (mg/kg)	3.02[b]	3.43[a]	3.44[a]	0.17	0.03
Phytate (mg/kg)	10.72[b]	12.17[a]	12.21[a]	0.82	0.03
Flavonoid (%)	0.40	0.42	0.42	0.02	0.12
Total Alkaloids (%)	0.44	0.45	0.48	0.02	0.14

[ab], Means with different superscripts along the same column are significant ($p<0.05$).

Table 5. Effect of cassava peel meal (%), enzyme supplementation (mg/kg) and interaction on broiler-chickens aged 1–21 days.

Diets	CPM (%)	Enzyme (mg/kg)	Initial weight (g/b)	FLW g/b	TWG (g/b)	AWG (g/b/d)	TFC (g/b)	AFC (g/b/d)	FCR
1	0		50.25	554.65a	504.39a	24.02a	929.25a	44.23a	1.85
2	20		50.40	511.00b	464.60b	22.11b	882.53b	42.02b	1.91
3	40		50.14	510.11b	459.86b	21.90b	899.43b	42.83b	1.96
SEM			0.77	13.70	13.39	0.62	13.52	0.65	0.05
P-value			0.97	0.04	0.04	0.04	0.04	0.03	0.26
Diets									
1		0	50.13	507.71	457.46	21.79	911.79	43.40	1.99
2		100	50.40	545.75	495.38	23.59	911.59	43.40	1.84
3		200	50.27	526.30	476.03	22.67	887.84	42.28	1.87
SEM			0.77	13.70	13.39	0.62	13.52	0.65	0.05
P-value			0.97	0.28	0.27	0.15	0.38	0.38	0.38
CPM (%)*Enzyme (mg/kg)									
SEM			1.33	23.75	23.19	1.07	23.42	1.12	0.08
P-value			0.99	0.76	0.75	0.57	0.45	0.46	0.58

[ab], Means with different superscripts along the same column are significant ($p<0.05$).
CPM, Cassava peel meal.

Table 6. Cost implications of broiler-chickens aged 1–21 days fed enzyme supplemented cassava peel meal-based diets.

Diets	CPM (%)	Enzyme (mg/kg)	AWG (kg)	AFC (kg)	Feed cost (₦/kg)	Cost of feed consumed (₦)	Cost of feed (₦/kg weight gain)	Cost differential	Relative cost benefit (%)
1	0		0.50[a]	0.93[a]	126.60[a]	117.73[a]	232.61	-	-
2	20		0.46[b]	0.88[b]	120.97[b]	106.47[b]	231.45	1.16	0.50
3	40		0.46[b]	0.96[ab]	115.34[c]	103.78[b]	225.56	7.05	3.03
SEM			0.03	0.07	0.00	8.81	7.69		
P-value			0.04	0.04	0.002	0.001	0.61		
Diets									
1		0	0.46	0.91	120.47	109.62	238.30	-	
2		100	0.50	0.91	120.97	110.05	220.10	18.20	7.64
3		200	0.48	0.89	121.47	108.11	225.23	13.07	5.48
SEM			0.03	0.07	0.00	8.81	7.69		
P-value			0.15	0.38	0.32	0.54	0.12		
CPM (%)*Enzyme (mg/kg)									
SEM			0.03	0.06	0.00	16.43	28.85		
P-value			0.75	0.45	0.49	0.42	0.58		

[abc], Means with different superscripts along the same column are significant (p<0.05).
CPM, Cassava peel meal.

Although, enzyme supplementation at 100 and 200 mg/kg did not influence the performance of the birds, however there was numerical improvement in ADWG by 7.36 and 3.88% and in FCR by 7.54 and 6.03% at 100 and 200 mg enzyme supplementation, respectively. However, interactive effect of CPM and enzyme supplementation did not affect the performance of the chicks.

Cost indices (Table 6) such as feed cost and cost of feed consumed decreased significantly (p<0.001 and 0.002) in broiler chicks fed CPM-based diets while cost of feed ₦/kg weight gain was similar (p>0.05). Enzyme supplementation and interactive effect between the main factors did not show any difference in all the cost indices determined.

Results in Table 7 show that all the blood indices of the chicks did not differ (p>0.05) significantly except the eosinophils that decreased significantly (p<0.05) at 40% CPM substitution (2.40%) when compared with 1.71 and 1.99% of broiler chicks fed 0 and 20% CPM, respectively. Mean cell volume (MCV) was significant (p<0.05) with chicks showing lower MCV (93.59 and 96.19fl) in 100 and 200 mg/kg enzyme supplemented diets compared with the value 100.64 fl in those fed 0 mg/kg enzyme supplementation. Cassava peel meal and enzyme interaction was not significant (p>0.05) for all the blood indices measured. Of the serum metabolites determined (Table 8), the blood uric acid was significantly (p<0.05) higher while LDH was significantly (p<0.05) lower in broiler chicks fed CPM-based diets compared with those fed maize-based diets. Enzyme supplementation showed similar (p>0.05) cholesterol levels in chicks fed 0 and 20% CPM (103.79 and 104.38 mg/dL, respectively) compared with the higher value (p<0.05) 110.28 mg/dL in chicks fed 40% CPM substitution.

DISCUSSION

The depressed body weight and feed intake in broiler chicks fed higher substitution of CPM could be attributed to the high fibre in diets and anti-nutritional levels. High fibre and anti-nutritional contents had been reported to implicate the utilization of agro-based by-products or impede the extraction of nutrients by birds for faster

Table 7. Haematological profile of broiler chickens aged 1–21 days fed enzyme supplemented cassava peel meal-based diets.

Diets	CPM (%)	Enzyme (mg/kg)	ESR (mm/hr)	PCV (%)	RBC (10^9/ml)	HbC (g/dL)	MCH (pg)	MCV (fl)	MCHC (%)	Het (%)	Lym (%)	Mon (%)	Eos (%)	Bas (%)
1	0		2.17	29.62	3.14	10.06	32.10	94.57	33.95	22.08	61.45	12.11	1.71[c]	2.64
2	20		2.34	29.98	3.01	10.26	34.15	99.77	34.32	22.28	60.48	12.12	1.99[b]	2.60
3	40		2.39	29.84	3.11	10.35	33.31	96.07	34.74	22.02	60.83	12.25	2.40[a]	2.43
SEM			0.35	0.13	0.09	0.19	1.12	2.97	0.17	0.06	0.62	0.15	0.48	0.35
P-value			0.17	0.32	0.18	0.22	0.13	0.24	0.53	0.39	0.25	0.27	0.04	0.13
Diets														
1		0	2.23	30.03	2.99	10.20	34.14	100.64[a]	33.98	21.88	60.90	12.20	2.00	2.68
2		100	2.46	29.68	3.09	10.22	33.14	96.19[b]	34.51	22.57	61.08	12.19	2.06	2.37
3		200	2.21	29.73	3.18	10.25	32.28	93.59[b]	34.52	21.94	60.77	12.09	2.05	2.62
SEM			0.35	0.13	0.09	0.19	1.12	2.97	0.17	0.06	0.62	0.15	0.48	0.35
P-value			0.13	0.59	0.37	0.22	0.30	0.04	0.26	0.37	0.72	0.25	0.11	0.19
CPM (%)*Enzyme (mg/kg)														
SEM			0.61	1.87	0.63	0.75	0.97	6.01	0.38	0.88	0.73	0.63	0.38	0.75
P-value			0.13	0.84	0.59	0.61	0.66	0.82	0.42	0.65	0.48	0.41	0.58	0.62

[ab], Means with different superscripts along the same column are significant ($P<0.05$).
CPM, Cassava peel meal; ESR, erythrocyte sedimentation rate; PCV, packed cell volume; RBC, red blood cell; HbC, haemoglobin concentration; MCH, mean corpuscular haemoglobin; MCV, mean cell volume; MCHC, mean corpuscular haemoglobin concentration.

Table 8. Serum chemistry of broiler chickens aged 1–21 days fed enzyme supplemented cassava peel meal-based diets.

Diets	CPM (%)	Enzyme (mg/kg)	Total protein (g/dL)	Albumi (g/dL)	Globulin (g/dL)	Albumin: Globulin	Urea (mg/dL)	Cholesterol (mg/dL)	HDL (mmol/L)	LDL (mmol/L)	LDH (U/L)	ALT (U/L)	AST (U/L)	ALP (U/L)
1	0		4.77	2.55	2.22	1.15	12.27[a]	106.35	29.53	11.38	1.02[b]	1.09	27.21	23.79
2	20		4.88	2.63	2.25	1.17	11.71[b]	107.40	29.92	11.31	1.06[a]	1.07	29.40	25.63
3	40		4.56	2.48	2.08	1.19	11.82[b]	104.69	30.30	11.28	1.07[a]	1.09	28.90	25.69
SEM			0.11	0.11	0.13	0.02	0.51	1.04	0.59	0.04	0.03	0.02	1.03	1.04
P-value			0.23	0.78	0.48	0.16	0.003	0.31	0.14	0.19	0.001	0.12	0.48	0.18
Diets														
1		0	4.67	2.55	1.90	1.34	12.35	103.79[b]	29.83	10.75	1.04	1.09	28.15	24.06
2		100	4.79	2.50	2.00	1.25	11.74	104.38[b]	29.92	11.82	1.04	1.08	27.84	25.52
3		200	4.74	2.60	1.91	1.36	11.70	110.28[a]	30.00	11.41	1.07	1.08	29.52	25.54
SEM			0.11	0.11	0.13	0.02	0.51	1.04	0.59	0.04	0.03	0.02	1.03	1.04
P-value			0.31	0.27	0.81	0.16	0.29	0.03	0.51	0.48	0.24	0.23	0.15	0.36

Table 8. Contd.

CPM (%)*Enzyme (mg/kg)												
SEM	0.08	0.27	0.23	0.68	0.42	2.79	1.27	1.73	0.04	0.06	1.92	3.05
P-value	0.62	0.38	0.41	0.45	0.76	0.32	0.52	0.31	0.52	0.68	0.42	0.16

[ab], Means with different superscripts along the same column are significant (P<0.05).
CPM, Cassava peel meal; HDL, high density lipoprotein; LDL, low density lipoprotein; LDH, lactate dehydrogenase; ALT, alanine transaminase; AST, aspartate transaminase; ALP, alkaline phosphatase.

growth (Adegbola and Oduozo, 1992; Akpan and Ikenebomeh, 1995; Uchegbu et al., 2011). The significant decrease in weight gain and feed intake reported in this study is in line with the reports by various researchers (Ani and Okeke, 2003; Ademola et al., 2009; Daudu et al., 2012; Igene et al., 2012) on the use of alternative feed resources. The supplementation of enzyme resulting in similar weight gains and feed intakes of broiler chicks in this study attests to the works by previous researchers (Acamovic, 2001; Ogunsipe, 2014) that exogenous microbial enzymes could reduce anti-nutritional effects and manipulate gut flora population as well as supplementing endogenous enzymes and improve the nutritional value of fibre rich diets with resultant effect on weight gain and feed intake. The improvement in performance of birds fed enzyme-supplemented diets could be that the birds efficiently utilized the nutrient and energy from the diets as reported by Fasiullah et al. (2010). The non-interactive effect of the two main factors on the performance of the chicks suggests that the substitution level of CPM in broiler chick diets might not be dependent on the levels of exogenous-enzyme supplementation in the diets. This was in contrast with the reports by Daudu et al. (2012) that ginger by-product × enzyme supplementation had significant interaction on the performance of broiler chickens.

The similar haematological and serum indices in this study are similar with broiler chicks fed black seed extracts (Siddiqui and Sayed, 2015). This suggests the nutritional adequacy of dietary protein in the diets as earlier reported by Mohammed et al. (2012) that good quality diet enhances the erythropoietic and haemopoetic syntheses. The non-significant interaction between CPM and enzyme supplementation in the haematological and serum indices of the broilers in this study further shows that blood synthesis and serum metabolites were independent of the two factors under consideration. The numerically higher eosinophils coupled with lower MCV in broiler chicks fed dietary substitution of CPM in place of maize could possibly be due to the residual high tannin in the cassava based diets which could affect the immune system of the birds. Age, hormones and stress during blood collection have also been reported to affect eosinophil levels in birds (Maxwell, 1993; Fudge, 2000; Latimer and Bienzle, 2000; Thrall, 2004). Uric acid is a waste product formed from the breakdown of proteins. The low blood uric acid level observed in chicks fed CPM indicates that the kidneys of the birds are not impaired. The LDH values observed in chicks fed dietary substitution of cassava peel is not worrisome as these values fall within the normal range for healthy birds (Viveros et al., 2002; Del Bianchi et al., 2005).

Conclusion

Based on the findings from this work, Roxazyme G2G; a fibre degrading enzyme with the potency to release entrapped nutrients in plant cell matrix can be incorporated into broiler chick diets at the recommended dosage of 100 mg/kg, as this dosage recorded the best performance of broiler chicks in terms of utilizing the minimum feed for maximum growth as evidenced in the FCR and higher saving cost in broiler chick production.

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