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Supplemental value of exo-enzyme in the utilization of cassava fibre meal by broiler-chickens

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This study assessed the supplemental value of Roxazyme® G2 in the utilization of cassava fibre meal (CFM) by broiler-chickens in a 56 day feeding trial. A batch of three hundred and sixty day-old Arbor acre broiler-chicks was allotted to twelve treatments replicated five times of six birds in a 4 × 3 factorial in complete randomization. Cassava fibre meal was substituted for maize at 0, 20, 40 and 60% levels and Roxazyme® G2 supplementation was at 0, 100 and 200 mgkg^{-1}. Results showed that CFM substitution at 40 and 60% levels for maize led to significant decrease ($p<0.05$) in weight gain of broiler chickens at both starter and finisher stages while feed conversion ratio was significant ($p<0.05$) at 60% CFM substitution at the starter phase. The effect of enzyme supplementation was not significant in the physiological growth of the birds at both starter and finisher stages. Eviscerated weight, liver and kidney weights were significantly ($p<0.05$) affected by CFM substitution. The effect of interaction was not significant ($p>0.05$) indicating that performance, carcass and organ description of broiler chickens were not dependent of the two factors under investigation. At starter phase, CFM substitution led to the saving of ₦0.07-0.08 per cost of feed ₦/kg weight gain and ₦0.08-0.13 per cost of feed ₦/kg weight gain on broiler finisher production. Roxazyme® G2 supplementation only at 100 mgkg^{-1} led to the saving of ₦0.03 and 0.01 per cost of feed ₦/kg weight gain at the starter and finisher stages respectively.

Key words: Broiler chickens, cassava fibre meal, Roxazyme® G2, weight gain.

INTRODUCTION

The increased cost of maize occasioned by the stiff competition for its use by man, animal and industry has been the bane to its economic incorporation as a major energy source in poultry diets, especially broiler chicken diets. This has hitherto led to increase in the cost of finished feeds with resultant increase in the cost of intensive poultry production with consequent increase in the cost of animal protein supply viś-á-viś low animal protein intake, particularly among the resource poor citizens in developing countries (Agbede, 2019). To this end, Animal Scientists, Nutritionists, Food Processors and other related professionals are pre-occupied with

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sourcing for alternative energy feed sources that could economically replace maize without compromising weight gain and health status of animal. However, many alternative plant feed resources are constrained by low crude protein, high fibre and active anti-nutritional factors (Agbede, 2019). In particular, high fibre has been reported to limit the use of alternative plant resources in animal feeds (Oloruntola et al., 2016a). However, the use of fibre degrading technology such as fermentation (Aro et al., 2012, Oloruntola et al., 2016a; Adeyeye et al., 2019) and exogenous enzyme supplementation (Fasiullah et al., 2010; Oladunjoye and Ojebiyi, 2010; Ogunsipe et al., 2015; Ogunsipe, 2017; Oloruntola et al., 2018b) has been reported to enhance the utilization of fibre rich diets.

Nigeria is the largest producer of cassava in the world estimated about 37 million metric tonnes in 2012 out of the total world production of over 280 million metric tonnes (FAO, 2013). Cassava fibre; a waste generated from cassava processing factory contains high level of cyanide, non-starch polysaccharides (10.0-38.4%) often designated as fibre (Adesehinwa et al., 2010; Aro et al., 2012), high phytate content up to 1.00% DM (Ubalua, 2007) and low protein content ranging between 2.10 and 8.20% (Aro et al., 2012; Ogunsipe et al., 2015) which often limit their utilization in monogastric diet (Aguihe et al., 2015).

The use of fibre degrading enzyme has been reported to enhance the utilization of fibre rich diet (Oloruntola et al., 2016a) by improving weight gains, feed efficiency and health status in livestock (Fasiullah et al., 2010; Oladunjoye and Ojebiyi, 2010; Ogunsipe, 2017; Oloruntola et al., 2018b). Roxazyme® G2, is a brown granulated powder, free of smells and soluble in water, having density 0.86 g/ml, a complex enzyme derived from *Trichoderma longibrachiatum* composed of β-glucanase, cellulose and xylanase and having a fibre degrading property. The supplementation of cassava fibre meal with Roxazyme® G2 in broiler chicken diet is hoped to improve broiler chicken production with minimal cost without compromising weight gain and health status of the birds.

MATERIALS AND METHODS

The right to conduct this study was given by the Research Committee of the Animal Production Unit of the Department of Agricultural Science, Adeyemi College of Education, Ondo State, Nigeria.

Location of the experiment

The study was carried out at the Poultry Unit of Teaching and Research Farm of the Adeyemi College of Eduation, Ondo State, Nigeria. Ondo 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 fibre meal and procurement of Roxazyme® G2

The cassava fibre used for this study was collected from Cassava Processing Factory, km 7, Ondo-Ore Road, Ondo, Nigeria. Thereafter, the wastes were sun-dried for 5 to 7 days depending on the intensity of the sun, and were constantly turned to prevent fermentation. The sun-dried cassava fibre were milled, bagged and kept in store prior to use. The milled cassava fibre meal (CFM) was analyzed for its proximate composition, mineral and phytochemical components. Roxazyme® G2 is a product of DMS Nutritional Product Europe Ltd. The basic activity of Roxazyme® comes from cellulases, endo- 1,4-beta-glucanase (glutamate) and xylanases.

Chemical composition determination

The CFM and experimental diets were analysed for their proximate compositions as described by AOAC (2002) methods. Also, the maize, soybean meal, groundnut cake and fish meal used for the diet's formulation were analyzed for the crude protein before used. This is to prevent large variation in dietary protein after mixing. The mineral constituents were analyzed by first dry ashing the samples at 550°C using AOAC (2002) method. Phytate was quantified as described by Young and Greaves (1940) while tannin was according to Makkar and Goodchild (1996). Flavonoids and alkaloids were determined according to the methods of Bohani and Kocipai-Abyazan (1994) and Harborne (1973), respectively. Cyanide determination was by the method of Rao et al. (1997) while oxalate was by the method of Baker and Silverton (1985) (Table 1).

Experimental diets

One basal diet was formulated for each phase (starter and finisher) to meet the NRC (1994) nutrient requirements for broiler-chickens. The basal (diet 1) had its maize component replaced with CFM at 20, 40 and 60%. The basal diet, the 20% CFM-based diet, 40% CFM-based diet and 60% CFM-based diet were each mixed thoroughly in one lot and divided into three parts, making 12 diets in all. Thus, each lot of the basal diet was supplemented with Roxazyme® G2 at 0, 100 and 200 $mgkg^{-1}$. The 0% CFM-based diet was supplemented with Roxazyme® G2 at 0, 100 and 200 $mgkg^{-1}$ and designated diets 1, 2 and 3, respectively. The 20% CFM-based diet was supplemented with Roxazyme® G2 at 0, 100 and 200 $mgkg^{-1}$ and designated diets 4, 5 and 6, respectively, the 40% CFM-based diet was supplemented with Roxazyme® G2 at 0, 100 and 200 $mgkg^{-1}$ and designated diets 7, 8 and 9, respectively while the 60% CFM-based diet was supplemented with Roxazyme® G2 at 0, 100 and 200 $mgkg^{-1}$ and designated 10, 11 and 12, respectively. The gross compositions for the basal diets for the two phases are as presented in Table 2 while the analyzed phytochemical components of the diets are as presented on Table 3.

Bird's arrangement and management

A total of three hundred and sixty day old broiler-chicks of Arbor acre breed with group mean weight range 389-393±8.36 g were randomly distributed to the twelve experimental diets in completely randomized design of 4 × 3 factorial arrangements of treatments.

Table 1. Chemical composition of cassava fibre meal (n=3).

Proximate composition ($g100\ g^{-1}$)	
Dry matter	88.63
Crude protein	3.95
Crude fibre	20.02
Crude fat	3.35
Ash	4.12
Mineral content ($mgkg^{-1}$)	
Calcium (Ca)	353.02
Phosphorous (P)	262.17
Magnesium (Mg)	199.95
Sodium (Na)	104.83
Potassium (K)	114.75
Copper (Cu)	0.96
Manganese (Mn)	1.12
Phytochemical components	
Cyanide CN^- ($mgkg^{-1}$)	13.97
Tannin ($g100g^{-1}$)	0.08
Oxalate (mgg^{-1})	269.04
Phytate-P (mgg^{-1})	4.29
Phytate (mgg^{-1})	15.23
Flavonoid ($mg100g^{-1}$)	5.69
Alkaloids (mgg^{-1})	6.18

Thirty broiler-chicks were assigned to each dietary treatment replicated five times of six birds per replicate. Adequate housing and brooding conditions were maintained to ensure proper ventilation, temperature and warmth. Feeds were served *ad libitum* with clean water supplied throughout the 8 weeks experimental period.

Data collection

Performance characteristics

Data were collected on daily feed intake and weekly weight gain while feed conversion ratio (FCR) was the calculated as the ratio of feed intake to weight gain.

Carcass and organ measurements

At the end of eight (8^{th}) week experimental period, three birds from each replicate were randomly selected, starved overnight, weighed, stunned and sacrificed by severing the jugular vein with sharp surgical knife and bled. The dressed birds were eviscerated for carcass evaluation and organ weight determination. The organs measured were heart, lung, liver, spleen, kidney and gizzard while intestinal length was measured using a tape rule. All organs measured were expressed in gkg^{-1} body weight, except the intestinal length that was expressed in mm. The dressed carcass and eviscerated weights were expressed in % body weight.

Cost evaluation

The cost evaluation of broiler-chickens fed with or without enzyme supplemented cassava fibre meal-based diets were determined using the under listed economic tools. The production cost of the processed cassava fibre meals were determined with respect to the sum of expenditures incurred in the processing method employed. The cost of feed was calculated based on the prevailing market price of the feed ingredients at the time of study.

$$\text{Cost of feed \$/kg} = \frac{\text{Total cost of feed compounded (\$)}}{\text{Total kg of feed compounded}}$$

Cost of weight gain \$/kg = Cost of feed \$/kg × Average feed consumed

$$\text{Cost of feed \$/kg weight gain} = \frac{\text{Cost of feed\$/kg} \times \text{Average feed consumed}}{\text{Average weight gain}}$$

Statistical analysis

Data collected were subjected to one way analysis of variance using General Linear Model of the Statistical Package for Social Sciences (SPSS) (2006). Data were tested for the main effects (cassava fibre substitution level for maize: 0, 20, 40 and 60%) and enzyme supplementation level: 0, 100 and 200 mg/kg) and a two

Table 2. Gross composition of experimental diets for broiler-chickens (g100g-1) in which maize was replaced with cassava fibre meal.

Ingredients	Levels of cassava fibre meal substitution (%)							
	Broiler starters				Broiler finishers			
	0	20	40	60	0	20	40	60
Maize	52.53	42.03	31.53	21.01	55.59	44.47	33.35	24.24
CFM	-	10.50	21.00	31.52	-	11.12	22.24	33.35
SBM	22.50	22.50	22.50	22.50	21.42	21.24	21.24	21.24
GNC	14.17	14.17	14.17	14.17	11.94	11.94	11.94	11.94
Fish meal	5.00	5.00	5.00	5.00	4.50	4.50	4.50	4.50
Bone meal	2.00	2.00	2.00	2.00	2.50	2.50	2.50	2.50
Oyster shell	0.50	0.50	0.50	0.50	0.60	0.60	0.60	0.60
Premix*	0.25	0.25	0.25	0.25	0.20	0.20	0.20	0.20
Lysine	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
DL- Methionine	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
Salt	0.30	0.30	0.30	0.30	0.35	0.35	0.35	0.35
Veg. oil	2.50	2.50	2.50	2.50	2.70	2.70	2.70	2.70
Calculated value (g100g^{-1})								
Crude protein	22.85	22.71	22.55	22.34	20.26	20.18	20.07	20.02
Crude fibre	4.53	4.71	5.26	6.09	5.02	5.87	6.30	6.85
ME (kcalkg^{-1})	3112.07	3007.60	2998.38	2911.73	3129.13	3118.84	3082.61	3013.73
Ca	1.31	1.31	1.32	1.31	1.31	1.30	1.31	1.31
Av. P	0.54	0.54	0.53	0.53	0.56	0.57	0.56	0.56
Analysed value (g100g^{-1})								
Crude protein	22.81	22.76	22.57	22.41	20.29	20.24	20.19	20.07
Crude fibre	4.46	4.62	5.31	6.11	5.05	5.79	6.35	6.83
ME (kcalkg^{-1})	3111.19	2999.03	2978.11	2917.84	3124.08	3109.26	3095.72	3030.35
Ca	1.32	1.32	1.33	1.33	1.32	1.31	1.32	1.32
P	0.56	0.55	0.56	0.55	0.57	0.56	0.56	0.57
Mg	0.33	0.32	0.32	0.33	0.32	0.33	0.32	0.33
Na	0.31	0.30	0.30	0.30	0.30	0.31	0.30	0.30
K	0.35	0.34	0.35	0.34	0.33	0.35	0.34	0.34
Cu	0.074	0.073	0.072	0.070	0.072	0.071	0.070	0.070
Mn	0.050	0.048	0.047	0.048	0.048	0.046	0.046	0.045

*vit A 8,000,000 i.u, vit. D_3 2,000,000 i.u, vit. E 8,000 mg, vit K_3 2,000 mg, vit. B_1 1,500 mg, vit. B_2 4,000 mg, vit. B_6 1,500 mg, vit. B_{12} 10 mcg, niacin 15,000 mg, pantothenic acid 5,000 mg, folic acid 500 mg, biotin 20 mcg, choline chloride 100,000 mg, Mn 75,000 mg, Zn 45,000 mg, Fe 20,000 mg, Cu 4,000 mg, Iodine 1,000 mg, Se 200 mg, Co 500 mg, antioxidant 125,000 mg CFM: Cassava fibre meal, SBM: Soybean meal, GNC: Groundnut cake

way interaction. Duncan option of the same statistical software was used for mean separation where identified.

RESULTS

The proximate composition (g100 g^{-1}) of cassava fibre meal (Table 1) used in this study shows a crude protein (CP) content of 3.95, crude fibre (CF) 20.02, crude fat 3.35 and ash 4.31. Macro minerals ranged (mgkg^{-1}) from 353.02 for calcium (Ca) to 104.83 for sodium (Na) while the micro minerals; Cu and Mn were 0.96 and 1.12, respectively. For the phytochemical components, tannin was 0.08 g100 g^{-1}, oxalate 269.04 mgg^{-1}, phytate-P 4.29 mgg^{-1}, phytate 15.23 mgg^{-1} while cyanide content was 13.97 mgkg^{-1} (Table 1). Results on the phytochemical components of the experimental diets (Table 3) show that oxalate, phytate-P, phytate and cyanide concentrations were significantly higher ($P<0.05$) in broiler-starter diets containing 20, 40 and 60% CFM when compared with maize-based diet while in broiler-finisher diets all the

Table 3. Phytochemical components of experimental diets for broiler-chickens.

Diets	CFM (%)	Tannin (g100 g^{-1})	Oxalate (mgg^{-1})	Phytate-P (mgg^{-1})	Phytate (mgg^{-1})	Cyanide CN^- ($mgkg^{-1}$)
			Broiler-starters			
1	0	0.05	0.17^b	2.99^b	10.61^b	2.47^b
2	20	0.06	0.28^a	3.27^a	11.61^a	9.03^a
3	40	0.06	0.30^a	3.35^a	11.89^a	9.24^a
4	60	0.06	0.30^a	3.33^a	11.82^a	9.37^a
SEM		0.10	0.07	0.11	0.68	0.32
P value		0.09	0.002	0.02	0.03	0.002
			Broiler-finishers			
1	0	0.05^b	0.21^b	3.09^c	10.97^b	2.10^c
2	20	0.08^a	0.33^a	3.45^b	12.25^a	8.71^b
3	40	0.08^a	0.34^a	3.56^a	12.64^a	9.18^a
4	60	0.09^a	0.34^a	3.59^a	12.74^a	9.46^a
SEM		0.19	0.12	0.07	0.31	0.11
P value		0.02	0.002	0.002	0.001	0.002

[abcd] Means in the same row with different superscripts differ significantly (P < 0.05); CFM: Cassava fibre meal.

phytochemical components determined were significant (P<0.05) in CFM-based diets when compared with maize-based diet.

Performance response of broiler chickens

The results on broiler-starter and broiler finisher performance (Tables 4 and 5) show that replacement of maize with CFM at 40 and 60% substitution levels resulted in significantly (P<0.05) lower weight gain showing a weight reduction between 1.75 and 5.51% when compared with birds on the control diet but enzyme supplementation particularly at 100 $mgkg^{-1}$ led to a numerical improvement in weight gain by 0.42% compared with broiler chickens on non-enzyme supplemented diet at the starter stage and between 2.61 and 4.18% compared with broiler chickens on the control diet but enzyme supplementation led to numerical improvement in weight gain by 0.32-0.37% compared with broiler chickens on the non-enzyme supplemented diet at the finisher phase. Average feed consumption was not significantly (P>0.05) influenced by CFM substitution at the two physiological growth phases but feed conversion ratio was significant in broiler chickens fed 60% CFM-based diet at the starter phase. Cost consideration (Tables 4 and 5) shows a significant reduction (P<0.05) in the feed cost ₦/kg, cost of weight gain ₦/kg and cost of feed ₦/kg weight gain of broiler chickens fed cassava fibre meal when compared with those on the control diet at both the starter and finisher stages. Although, raising a kilogramme of broiler chickens when substituting maize with CFM in broiler chicken diet resulted in saving cost of ₦0.07-0.08 per cost of feed ₦/kg weight gain on broiler starter production and ₦0.08-0.13 per cost of feed ₦/kg weight gain on broiler finisher production. This however, might not justify the substitution of maize with cassava fibre meal particularly at higher level because of the negative effect on broiler growth. Enzyme supplementation recorded a saving cost of ₦0.03 per cost of feed ₦/kg weight gain only at 100 mg/kg at the starter phase. The effect of interaction was not significant showing that the performance on broiler chickens was independent of the two factors under consideration.

Carcass evaluation and organ characteristics

Table 6 shows that broiler chickens had lower eviscerated weight but higher heart, liver and kidney weights when fed diets containing 60% CFM against those fed in the control and up to 40% CFM in place of maize. The effect of enzyme supplementation did not influence the carcass and organ weights of the birds. Also, the dependency of one factor over the other was not significant.

DISCUSSION

One pertinent question this study tries to address was whether a high fibrous cassava fibre meal with or without enzyme supplementation could economically replace maize as energy source in broiler diets without compromising weight gain or health status of the birds.

Table 4. Performance and cost implications of broiler-starters fed CFM supplemented with roxazyme® G2.

		Initial wt g/b	FLW g/b	TWG g/b	AWG g/b/d	TFC g/b	AFC g/b/d	FCR	Feed cost $/kg	Cost of weight gain $/kg	Cost of feed $/kg weight gain
Diets	**CFM (%)**										
1	0	50.29	553.68[a]	503.39[a]	23.97[a]	876.32	41.73	1.74[a]	0.64[a]	0.56[a]	1.13[a]
2	20	50.54	557.67[a]	507.13[a]	24.15[a]	878.97	41.85	1.73[a]	0.61[b]	0.54[b]	1.05[b]
3	40	50.50	545.05[b]	494.55[b]	23.55[b]	871.01	41.48	1.76[a]	0.59[c]	0.51[c]	1.05[b]
4	60	50.40	526.07[c]	475.67[c]	22.65[c]	888.63	42.32	1.86[b]	0.57[d]	0.51[c]	1.06[b]
SEM		0.52	10.31	12.09	0.43	11.86	0.54	0.21	1.06	3.42	1.03
P value		0.91	0.03	0.03	0.03	0.52	0.37	0.03	0.01	0.02	0.02
Diets	**Enzyme ($mgkg^{-1}$)**										
1	0	50.46	547.33	496.87	23.66	894.01	42.57	1.80	0.61	0.54	1.09
2	100	50.39	549.52	499.13	23.76	867.74	41.32	1.73	0.61	0.53	1.06
3	200	50.46	540.01	489.55	23.31	874.45	41.64	1.79	0.62	0.54	1.10
SEM		0.52	10.31	12.09	0.43	11.86	0.54	0.21	1.06	3.42	1.03
P value		0.77	0.42	0.22	0.68	0.38	0.41	0.49	0.32	0.54	0.23
CFM (%) × Enzyme ($mgkg^{-1}$)											
SEM		1.12	17.03	19.93	0.85	15.97	0.78	0.83	0.11	8.25	16.47
P value		0.85	0.87	0.65	0.82	0.61	0.49	0.55	0.31	0.41	0.35

[abcd] Means in the same row with different superscripts differ significantly ($P < 0.05$); SEM: Standard error of the mean, CFM: Cassava fibre meal, FLW: Final live weight, TWG: Total weight gain, AWG: Average weight gain, TFC: Total feed consumption, AFC: Average feed consumption, FCR: Feed conversion ratio

This is because the price of maize has significantly increased recently owing to the stiff competition for its use by man and animal. This study showed that the crude protein and crude fibre of CFM used in this study were lower than the values earlier reported (Aro et al., 2012; Oboh, 2006). It also showed that CFM contained some nutritionally needed mineral elements that can be harnessed for feed formulation. In addition the cyanide content (13.97 mg/kg) was lower than the range of 19.00-44.60 mg/kg reported by Oboh and Akindahunsi (2003), Oboh (2006) and Ngiki et al. (2014). The observed difference could be due to the processing method adopted. Gradual sun-drying process, which was the processing method adopted in this current study had been reported to reduce cyanide concentration in cassava waste (Aro et al., 2010) while in most cases the phytochemical components typified by phytate, tannin, oxalate, flavoniod and alkaloids were similar to the values reported by Oboh (2006) and Aro et al. (2010) for microbially fermented cassava wastes.

The lower weight gain recorded for birds on CFM-based diets could be attributed to the effect of high fibre (Madubuike and Obadimma, 2009) and possible toxigenic effect of residual cyanide (Aro et al., 2013), which increased with increased maize substitution in diets. Diets high in non-starch polysaccharides had been reported to compromise weight gain by poultry (Rahman et al., 2005). In this present study, feeding CFM at 40 and 60% substitution levels for maize as source of energy resulted in significant decrease in weight gain. The poor feed conversion ratio of broiler starters on higher substitution of CFM

Table 5. Performance and cost implications of broiler-finishers fed CFM supplemented with roxazyme® G2.

		Initial wt g/b	FLW g/b	TWG g/b	AWG g/b/d	TFC g/b	AFC g/b/d	FCR	Feed cost $/kg	Cost of weight gain $/kg	Cost of feed $/kg weight gain
Diets	**CFM**										
1	0	50.29	2366.15[a]	2315.86[a]	41.35[a]	5613.13	100.23	2.42	0.58[a]	3.25[a]	1.40[a]
2	20	50.54	2370.01[a]	2319.47[a]	41.42[a]	5685.61	101.53	2.45	0.54[b]	3.06[b]	1.32[ab]
3	40	50.50	2305.76[a]	2255.26[b]	40.27[b]	5719.32	102.13	2.54	0.51[c]	2.91[c]	1.29[b]
4	60	50.40	2269.29[b]	2218.95[b]	39.62[b]	5777.92	103.17	2.60	0.49[d]	2.82[d]	1.27[b]
SEM		0.52	61.36	58.04	2.46	59.96	1.99	0.21	0.09	0.24	6.67
P value		0.91	0.03	0.04	0.03	072	0.69	0.35	0.01	0.02	0.04
Diets	**Enzyme (mgkg^{-1})**										
1	0	50.46	2322.03	2271.57	40.56	5713.05	103.17	2.51	0.54	3.09	1.36
2	100	50.39	2329.01	2278.70	40.69	5741.16	102.52	2.52	0.54	3.08	1.35
3	200	50.46	2332.37	2281.91	40.71	5725.27	102.23	2.52	0.55	3.15	1.38
SEM		0.52	49.11	43.04	2.46	59.96	1.99	0.06	0.14	13.72	6.29
P value		0.77	0.21	0.25	0.19	0.65	0.67	0.41	0.89	0.64	0.42
CFM (%) X Enzyme (mgkg^{-1})											
SEM		1.12	27.33	32.65	0.87	35.97	3.78	0.35	0.17	13.25	8.47
P value		0.85	0.34	0.77	0.74	0.85	0.59	0.63	0.31	0.54	0.65

[abcd] Means in the same row with different superscripts differ significantly (P < 0.05); SEM: Standard error of the mean, CFM: Cassava fibre meal, FLW: Final live weight, TWG: Total weight gain, AWG: Average weight gain, TFC: Total feed consumption, AFC: Average feed consumption, FCR: Feed conversion ratio.

could be due to the fibrousness of the diet which could have limited the utilization of the diet. High fibrous diet has been reported to bring about physical bulk which limited feed intake by broiler chickens (Uchegbu et al., 2011) or reduce nutrient absorption as a result of decreased villus height particularly in young birds (Jankwowski et al., 2011).

The similar feed consumption, weight gain and feed conversion ratio of birds fed enzyme supplemented diets in spite of the low metabolizable energy of CFM-based diets could be due to the nutritional adequacy of the text diets as alternative energy source to maize or possibly the role of Roxazyme® G2 to make up for the deficit in energy content as earlier reported by Gao et al. (2008) or the role of exo-enzyme in improving the nutritive value of high fibre diets (Anglelovicova et al., 2005; Raza et al., 2009; Ogunsipe et al., 2015; Oloruntola et al., 2016b). This thus suggests that the villus which is important in nutrient absorption was neither compromised by cassava fibre meal inclusion or exo-enzyme supplementation in broiler chicken diets.

The plausible reason for this is that exogenous enzyme has the ability to decrease the viscosity of the digesta in the lumen with a concomitant release of nutrients for utilization by the birds. In this study, the effect of enzyme supplementation was not significant. The non-interaction effect in all the performance indices of birds fed enzyme and non-enzyme supplemented CFM-based diets in this study suggest that broiler chicken performance was not dependent on the two factors under consideration. The present result is in consonance with the result by Oloruntola et al. (2018) on pawpaw leaf meal × enzyme supplementation but apposite to the results

Table 6. Carcass weight (% body weight) and organ description (gkg^{-1} body weight) of broiler-chickens fed CFM supplemented with or without Roxazyme® G2.

		Dressed weight	Eviscerated weight	Heart	Lung	Liver	Spleen	Kidney	Gizzard	Intestinal length (mm)
Diets	**CFM (%)**									
1	0	86.32	76.23^{a}	3.78^{b}	5.83	18.03^{b}	1.16	4.32^{b}	18.75	2093.61
2	20	85.24	76.85^{a}	4.16^{a}	5.83	18.07^{b}	1.17	4.42^{b}	19.74	2203.81
3	40	84.64	75.19^{a}	4.22^{a}	5.85	18.15^{b}	1.17	4.42^{b}	19.78	2233.31
4	60	84.62	73.89^{b}	4.19^{a}	5.89	18.46^{a}	1.16	4.63^{a}	20.35	2229.68
SEM		0.81	0.72	0.39	0.19	0.44	0.18	0.31	0.62	6.03
P value		0.29	0.02	0.03	0.14	0.04	0.11	0.02	0.39	0.31
Diets	**Enzyme (mgkg^{-1})**									
1	0	84.93	76.01	4.05	5.95	18.43	1.18	4.43	19.93	2199.63
2	100	85.19	76.17	4.08	5.76	18.31	1.16	4.44	19.66	2164.77
3	200	85.50	74.44	4.24	5.84	18.22	1.16	4.48	19.37	2205.56
SEM		0.81	0.72	0.14	0.19	0.44	0.18	0.31	0.62	6.03
P value		0.26	0.14	0.59	0.58	0.21	0.25	0.13	0.27	0.24
CFM (%) × Enzyme (mgkg^{-1})										
SEM		2.61	1.04	0.81	0.42	2.03	0.17	0.26	2.84	3.09
P value		0.73	0.38	0.63	0.09	0.21	0.13	0.29	0.52	0.65

[ab] Means in the same row with different superscripts differ significantly (P < 0.05), CFM: Cassava fibre meal, SEM: Standard error of the mean.

obtained by Daudu et al. (2012) on ginger by-product × enzyme supplementation.

Similar dressed weight of birds fed maize and CFM-based diets in this study could be ascribed to the similar nutrient utilization by the birds as shown in the feed conversion ratio and this is in consonance to the earlier report by Agbede and Aletor (2003) when gliricidia leaf protein concentrate (GLPC)-based diets were fed to broiler-chickens. In this study, the carcass cuts as well as the relative organs weight except eviscerated weight, heart, liver and kidney were not significantly affected by the dietary treatments suggesting that the development of the carcass cuts and relative organ weights of the experimental birds were identically supported by the test diets. The similar heart, liver and kidney weights up to 40% substitution of maize with cassava fibre meal in this study suggest that the levels of hydrogen cyanide (HCN) and other phytochemical components present in the diet did not trigger the increased activity of these organs.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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