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RESEARCH ARTICLE

Effect of Roxazyme G2G Supplementation on Performance and Carcass Characteristics of Broilers Fed Wheat-Based Diets

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ABSTRACT

Wheat contains both soluble and insoluble non-starch polysaccharides (NSP) which are poorly digested in broilers. Supplementation of such diets with NSP degrading enzyme helps to improve digestibility of the nutrients entrapped in the wheat cell wall thereby improving performance and carcass quality of broiler chickens. The effect of Roxazyme G2G (a cocktail of carbohydrase enzymes) supplementation on growth performance and carcass characteristics was investigated in a 42-day experiment using 120 one-day-old unsexed broiler chickens (Arbor acre strain) fed wheat-based diets without or with enzyme supplementation. The birds were randomly allotted to 3 dietary treatments. Each diet had 4 replicates of 10 birds each in a completely randomised design. Performance indices measured were the body weight gain, feed intake, feed conversion ratio and feed efficiency ratio. At day 42, birds were weighed and slaughtered by cervical dislocation. The weight of the carcass primal cuts and visceral organs were recorded. Roxazyme G2G supplementation significantly ($P<0.05$) influenced the dietary treatments, although growth performance of birds fed wheat based-diet with enzyme was identical to those without enzyme and the control diet. Similarly, enzyme supplementation did not positively increase the live weight, percentage dressed weight, eviscerated weight and other primal cuts with the visceral organs. Also, the carcass characteristics measured did not differ significantly from birds fed wheat diet without enzyme and control diet. There were no significant differences observed in feed cost/kg/bird and feed cost/kg weight gain of birds across the dietary treatments in both the starter and finisher phases. However, the feed cost/kg differ significantly ($P< 0.05$) among the dietary treatments in the two phases. It was highest (₦107.81) in birds fed wheat diet with enzyme and least (₦ 102.90) in birds on the control diet for starter phase. Also, similar trend was observed for feed cost/kg in the finisher's phase.

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INTRODUCTION

Improved efficiency of feedstuff utilisation and the use of a wide range of feed ingredients are being hindered by several factors. Among potential factors reducing nutrient bioavailability are the non-starch polysaccharides in ingredients such as soyabean meal, wheat, barley, oat, rye, sesame meal etc. Non starch polysaccharides (NSPs) are those polysaccharides (complex carbohydrates), other than starches, found in foods. The common NSPs include β-glucans, arabinoxylans and fructans (Classen and Bedford, 1991). Inclusion of feed ingredients such as wheat and barley in diets of poultry is limited due to high amounts of NSPs present in them (Mehri *et al.,* 2010). The predominant NSP in wheat for example is arabinoxylan for which poultry birds do not have the full enzyme complement to digest. Non-starch polysaccharides have been reported to reduce digestibility of several nutrients in poultry (Chesson, 2001). Nevertheless, when wheat is included in broiler diets as a source of energy, its digestion can further be improved by supplementation with exogenous carbohydrase enzyme. Exogenous

enzymes have also been reported to improve energy utilisation in broilers (Douglas *et al.,* 2000). Roxazyme 2G2 is one of the numerous exogenous enzymes used in poultry diets. It is a commercial multi-enzyme complex which contains β-xylanase activities. Its addition to relevant poultry diets usually result in numerous beneficial effects, such as increased utilisation of nutrients, reduced digesta viscosity and improved growth performance.

It was therefore the aim of this study to determine the effect of supplementing wheat-based diets with Roxazyme G2G (a cocktail of carbohydrase enzymes) on growth performance and carcass quality in 42-d-old broilers.

MATERIALS AND METHODS

Experimental site

This study was carried out at the poultry pen of the Teaching and Research Farm University of Ibadan, Oyo State in the South West geopolitical zone of Nigeria and within the Tropical rain forest region.

Management of experimental birds

One hundred and twenty (120) broiler chicks were used for this study. The birds were reared in a well-ventilated and illuminated standard poultry house. After 7 days of brooding, the birds were randomly allotted to 3 dietary treatments containing 4 replicates of 10 birds each. The experimental diets and water were supplied *ad libitum* during the period that lasted 6 weeks. During the experimental period daily feed intake was determined by deducting the left over from the total quantity of feed supplied to the birds. Weights of birds were monitored weekly and average cost of feed intake per bird and cost of feed/kg weight were also calculated as follows;

$$\text{Feed Efficiency Ratio} = \frac{\text{Weight gain}}{\text{Feed intake}}$$

$$\text{Feed Conversion Ratio} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

$$\text{Cost of feed/kg weight gain} = \frac{\text{Feed intake X Feed cost}}{\text{Weight gain}}$$

Experimental diets

The experimental starter and finisher diets were offered to the birds at day 8 to 21 and 22 to 42 respectively. There were basal diets with 58.5% and 66.5% maize as sources of energy for starter and finisher phases respectively and 2 other diets in which maize in the basal (control) diets was replaced with 20% wheat, one of which was supplemented with Roxazyme G2G (contains endo-1,4-beta Glucanase and endo-1,3 (4)-beta Glucanase and endo-1,4-beta Xylanase) for both the starter (1-3weeks) and finisher (4-6weeks) phases (Tables 1 and 2). Diet 1 was the control which had a diet without wheat and enzyme supplementation while Diet 2 had wheat but without enzyme supplementation and Diet 3 had wheat with enzyme supplementation.

- Diet 1- Without wheat + without enzyme (control)
- Diet 2- 20% wheat + without enzyme
- Diet 3- 20% wheat + enzyme

Table 1: Gross composition of experimental broiler starter diets (g/100gDM)

Ingredient	Basal diet	20%wheat- Roxazyme)	20%wheat+ Roxazyme)
Maize	58.50	38.50	38.50
Whole wheat	0.00	20.00	20.00
Soyabean meal	19.00	19.00	19.00
Groundnut cake	16.40	16.40	16.40
Fish meal (72% CP)	2.50	2.50	2.50
Limestone	1.10	1.10	1.10
DCP (23%Ca, 18%P)	1.50	1.50	1.50
Salt	0.25	0.25	0.25
*Broiler Premix	0.25	0.25	0.25
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Roxazyme	-	-	0.025
Total	100.00	100.00	100.00
Calculated Nutrients			
Crude protein	23.01	23.43	23.43
Energy (kcal/gME)	3.03	2.94	2.94
Ether extract	4.12	3.30	3.30
Crude flbre	3.25	2.85	2.85
Lysine	1.28	1.31	1.31
Methionine	0.59	0.60	0.60
Calcium	0.99	0.97	0.97
Phosphorus	0.49	0.57	0.57

DCP = Dicalcium phosphate *Composition of premix per kg of diet: vitamin A, 12,500 I.U; vitamin D3 2,500 I.U; vitamin E, 40mg; vitamin K3, 2mg; vitaminB1, 3mg; vitamin B2, 5.5mg; niacin 55mg; calcium pantothenate, 11.5mg; vitamin B6, 5mg; vitamin B12, 0.025mg; choline chloride, 500mg; folic acid, 1mg; biotin, 0.08mg; manganese, 120mg; iron, 100mg; zinc, 80mg; copper, 8.5mg; iodine, 1.5mg; cobalt, 0.3mg; selenium, 0.12mg; Anti-oxidant, 120mg. Roxazyme G2G (contains endo-1,4-beta Glucanase and endo-1,3 (4)-beta Glucanase and endo-1,4-beta Xylanase)

Table 2: Gross composition of experimental broiler finisher's diets (g/100gDM)

Ingredients	Basal diet	20% wheat - Roxazyme)	20%wheat+ Roxazyme)
Maize	66.50	46.50	46.50
Whole wheat	0.00	20.00	20.00
Soyabean meal	19.50	19.50	19.50
Groundnut cake	8.30	8.30	8.30
Fish meal (72% CP)	2.00	2.00	2.00
Limestone	1.20	1.20	1.20
DCP (23%Ca, 18%P)	1.50	1.50	1.50
Salt	0.25	0.25	0.25
*Broiler Premix	0.25	0.25	0.25
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Roxazyme	-	-	0.025
Total	100.00	100.00	100.00
Calculated Nutrients			
Crude protein	20.02	20.44	20.44
Energy (kcal/gME)	3.09	3.00	3.00
Ether extract	3.93	3.13	3.13
Crude flbre	3.03	2.63	2.63
Lysine	1.17	1.19	1.19
Methionine	0.56	0.57	0.57
Calcium	0.95	0.96	0.96
Phosphorus	0.46	0.54	0.54

DCP= Dicalcium phosphate *Composition of premix per kg of diet: vitamin A, 12,500 I.U; vitamin D3 2,500 I.U; vitamin E, 40mg; vitamin K3, 2mg; vitaminB1, 3mg; vitamin B2, 5.5mg; niacin 55mg; calcium pantothenate, 11.5mg; vitamin B6, 5mg; vitamin B12, 0.025mg; choline chloride, 500mg; folic acid, 1mg; biotin, 0.08mg; manganese, 120mg; iron, 100mg; zinc, 80mg; copper, 8.5mg; iodine, 1.5mg; cobalt, 0.3mg; selenium, 0.12mg; Anti-oxidant, 120mg. Roxazyme G2G (contains endo-1,4-beta Glucanase and endo-1,3 (4)-beta Glucanase and endo-1,4-beta Xylanase)

Carcass characteristics

Four birds per replicate were selected at random for carcass evaluation. The birds were slaughtered and parameters evaluated were: dressed weight, eviscerated weight, weight of primal cuts (wings, shanks, drumstick, breast, back and thigh) and weights of visceral organs (heart, gizzard, lungs, kidney, pancreas and spleen).

Experimental design

The experimental design used was Completely Randomised Design.

Proximate composition

The proximate composition of each of the diets was determined according to the methods of AOAC (2000).

Statistical analysis

Data obtained were analysed using descriptive statistics and ANOVA (P = 0.05) (SAS, 2012). Mean differences were separated using Duncan Multiple Range Test.

RESULTS

The result of proximate composition of experimental broiler finisher's diets is as shown in Table 3. The crude protein and crude fibre of birds fed wheat based-diets ranged from 19.73 - 22.78% and 4.23- 4.62 respectively. Performance indices of broilers fed experimental diets are shown in Tables 4 and 5. There were no significant differences observed in the Initial Weight (IW) and Feed Efficiency Ratio (FER) of birds on the experimental diets. Meanwhile, the Final Weight (FW), Weight Gain (WG), feed intake and Feed Conversion Ratio (FCR) of birds were significantly (P<0.05) influenced by the dietary treatments at the starter phase (Table 4). The FW, WG, and FCR of birds fed 20% wheat-based diet with enzyme supplementation were not significantly different from those on 20% wheat diet without enzyme. However, birds fed 20% wheat-based diet with addition of enzyme compared favourably with those on the control diet. The feed intakes of birds on wheat diet with inclusion of Roxazyme 2G2 and those on the control diet were similar and significantly different from birds on wheat based-diet without enzyme supplementation.

There were significant (P<0.05) differences recorded in the initial weight, final weight, weight gain and FCR of birds on the experimental diets at the finisher's phases (Table 5). However, the FW and WG of birds on 20% wheat based-diet without enzyme supplementation were significantly higher (2143.50g/b and 1358.50g/b) than FW and WG (2085.50g/b and 1348.28g/b) of those on wheat diet with inclusion of enzyme. There were no significant differences observed in the feed intake and FER of birds on the experimental diets.

The results of carcass characteristics of birds fed wheat-based diets supplemented with Roxazyme G2G are shown in Table 6. Birds on 20% wheat without enzyme supplementation had the highest live weight (2171.88g/b) and percentage dressed weight (90.79%) though not significantly different from birds on 20% wheat with enzyme supplementation. Similar trend was observed on the percentage eviscerated weight and back of birds on the experimental diets. There were no significant differences recorded for the relative weight of the primal cuts- head, neck, breast, wings, drumsticks, thighs and shanks of birds on the dietary treatments. There were no significant differences observed on the visceral organs of birds on the experimental diets except the gizzard (empty), abdominal fat and liver. The liver of birds fed 20% wheat without enzyme supplementation had the highest value (2.90%) while the least value (2.42%) was recorded for birds on wheat based diet with enzyme inclusion. The gizzard (empty), abdominal fat, kidney, spleen and pancreas of birds on the control diet had highest percentage relative weight, though some were not significantly different from birds on other dietary treatments.

The results of cost benefit ratio of birds on the experimental diets are as shown in Table 7. There were no significant differences observed in the weight gain, feed intake, feed conversion ratio and feed cost/kg weight gain of birds across the dietary treatments in both starter and finisher phases. Meanwhile, the feed cost/ kg differ significantly (P< 0.05) among the dietary treatments in the two phases. It was highest (₦107.81) in birds fed wheat diet with enzyme and least (₦ 102.90) birds on the control diet for starter phase. Also, similar trend was observed for feed cost/kg in the finisher's phase. However, Feed cost/ kg weight gain of birds in experimental diets was similar, although, highest value (₦236.36) was recorded in birds

Table 3: Proximate composition of experimental finisher diets (g/100gDM)

Variable	Basal diet	20% wheat - enzyme	20% wheat + enzyme
Dry matter	91.01	91.36	91.72
Crude protein	22.78	19.73	19.82
Crude fibre	4.62	4.31	4.23
Ether extract	7.79	8.06	8.01
Ash	6.21	7.30	7.36
Nitrogen Free Extract	58.60	60.60	60.58

Table 4: Performance indices of broilers fed wheat-based diets (Starter phase) (7-21days)

	Basal diet	20% wheat - enzyme	20% wheat + enzyme	SEM
Initial weight (g/b)	110.05	117.90	112.30	3.62
Final weight (g/b)	702.50^{b}	785.00^{a}	737.22^{ab}	28.85
Weight gain (g/b)	592.45^{b}	667.10^{a}	624.92^{ab}	32.37
Feed Intake (g/b)	1085.00^{b}	1115.25^{a}	1047.75^{b}	24.94
Feed conversion ratio	1.83^{a}	1.67^{b}	1.68^{b}	0.07
Feed efficiency ratio	0.55	0.60	0.60	0.03

^{ab}Means on the same row with different superscripts are significantly (P<0.05) different. g/b- gram per bird, SEM: Standard Error of Mean.

Table 5: Performance indices of broilers fed wheat-based diets (Finisher's phase) (22 – 42days)

	Basal diet	20% wheat –enzyme	20% wheat +enzyme	SEM
Initial weight (g/b)	702.50^{b}	785.00^{a}	737.22^{ab}	28.85
Final weight (g/b)	1927.00^{b}	2143.50^{a}	2085.50^{a}	40.17
Weight gain (g/b)	1224.50^{b}	1358.50^{a}	1348.28^{a}	49.89
Feed Intake (g/b)	2998.20	2872.10	2880.10	101.75
Feed conversion ratio	2.45^{a}	2.11^{b}	2.14^{b}	0.10
Feed efficiency ratio	0.41	0.47	0.47	0.03

^{ab}Means on the same row with different superscripts are significantly (P<0.05) different. g/b- gram per bird, SEM: Standard Error of Mean.

Table 6: Carcass characteristics of broilers fed wheat-based diets (%)

	Basal diet	20% wheat -enzyme)	20% wheat +enzyme)	SEM
Live weight (g)	1966.25[b]	2171.88[a]	2089.38[ab]	63.76
Dressed weight	87.05[b]	90.79[a]	88.71[ab]	1.56
Eviscerated weight	70.78[b]	74.20[a]	71.84[ab]	1.17
Head	2.38	2.41	2.40	0.08
Neck	4.18	4.25	4.03	0.20
Breast	18.87	20.09	19.08	0.65
Back	12.57[b]	13.94[a]	13.52[ab]	0.62
Wings	7.53	7.88	7.60	0.38
Drumsticks	8.86	9.08	9.05	0.25
Thighs	10.20	10.82	10.54	0.34
Shanks	3.68	3.89	3.75	0.15
Gizzard full	3.08	2.90	2.92	0.10
Gizzard empty	1.91[a]	1.72[b]	1.72[b]	0.06
Abdominal fat	1.50[a]	1.28[b]	1.13[b]	0.13
Lung	0.59	0.64	0.69	0.08
Kidney	0.20	0.18	0.19	0.01
Liver	2.70[ab]	2.90[a]	2.42[b]	0.14
Spleen	0.15	0.11	0.09	0.03
Heart	0.50	0.50	0.48	0.02
Pancreas	0.28	0.21	0.22	0.03

[ab]Means on the same row with different superscripts are significantly (P<0.05) different. SEM: Standard Error of Mean.

Table 7: Cost benefit ratio of enzyme supplemented wheat based diets fed to broilers.

	Basal diet	20% wheat - enzyme	20% wheat + enzyme	SEM
Starter phase				
Weight gain (kg/b)	0.59	0.67	0.62	0.03
Feed Intake (kg)	1.09	1.12	1.05	0.03
Feed Conversion Ratio	1.83	1.67	1.68	0.07
Feed cost/kg	102.90[c]	106.74[b]	107.81[a]	0.00
Feed cost (₦/kg/bird)	111.65	118.75	112.66	2.60
Feed cost/kg weight gain (₦/kg)	189.49	177.49	187.58	7.67
Finisher phase				
Weight gain (kg/b)	1.22	1.36	1.35	0.05
Feed Intake (kg)	3.00	2.87	2.88	0.10
Feed Conversion Ratio	2.45	2.11	2.14	0.10
Feed cost/kg	97.1[c]	103.5[b]	104.6[a]	0.00
Feed cost (₦/kg/bird)	291.24	297.30	301.25	10.26
Feed cost/kg weight gain (₦/kg)	236.36	218.88	224.76	10.05

[abc]Means on the same row with different superscripts are significantly (P<0.05) different. Kg- kilogram, kg/b- kilogram per bird, ₦ -naira, ₦/kg -naira per kilogram, ₦/kg/b -naira per kilogram per bird. □160 = 1US dollar, SEM: Standard Error of Mean

on the control diet and least value (₦218.88) was recorded for birds fed wheat diet without enzyme supplementation at the finisher phase.

DISCUSSION

Supplementation of poultry diets with enzymes has been reported to destroy the anti-nutritive factors in cereals, by enhancing the overall digestibility of the feed and nutrient availability (Choct *et al.,* 1999). The improved final weight, weight gain, feed intake and feed conversion ratio of birds fed 20% wheat diet with enzyme supplementation at both the starter and finisher phases support the findings of Awoyemi (2012) who reported increase in performance parameters measured when birds were fed 20% wheat based-diets supplemented with exogenous enzyme at the starter phase. Similarly, according to Awoyemi (2012), an improved final weight, weight gain and feed intake of birds fed with 10% wheat diet with enzyme supplementation at the finisher phase was reported. In the present study, supplementation of diet with enzyme did not positively improve the growth performance of birds on the dietary treatments when compared with those on wheat diet without dietary supplemental enzyme inclusion. This was contrary to the findings of Lazaro *et al.* (2003) who reported that enzyme supplementation of wheat-based diets improved broiler performance through increased feed intake and improved nutrient digestibility. One obvious reason for an apparent lack of response is the possibility that the diets fed were of extremely good quality and allows the birds to perform close to their genetic potential. In such cases, enzyme supplementation would be likely to produce a negligible beneficial response (Acamovic, 2001). In many reports, there are frequent instances where enzyme supplementation has failed to result in improved performance. However, it is incorrect to come to the general conclusion, as is often done, that a particular enzyme supplement adds little value to the particular ingredient or component (Acamovic, 2001). Dietary constituents may also reduce the activity of supplementary enzymes either because the enzymes attach strongly to a component such as tannin or because a functional co-factor such as a particular trace element is replaced by another that hinders an activity (Bedford and Classen, 1992).

Several studies have investigated the effects of enzyme supplementation on carcass characteristics of broilers. Khan (2006) observed that enzymes treated diets improved the dressing percentage of birds. Abbas *et al*. (1998) also found out that enzyme supplementation to fibrous diet improved the growth rate, thereby increasing the dressing percentage. In contrary to previous studies (Pasquier *et al*., 1996; Gao *et al*., 2007), enzyme supplementation in this present study did not positively increase the live weight, percentage dressed weight, eviscerated weight and other primal cuts with the visceral organs. More so, the weights of these organs (liver, spleen, and heart) were not significantly influenced by the experimental diets and this supports the report of Iyayi and Yahaya (1999). However, gizzard weight of birds fed wheat diet supplemented with enzyme was improved. This contradicts the results of Viveros *et al*. (1993), who reported that addition of enzyme to barley-based diets produced an effect on digestive tract of the bird, reducing the relative weight of upper tract (mainly proventriculus and gizzard), and the size of the small intestine and colon of chicks but agrees with the reports of Cumming (1994) and Hetland *et al*. (2005). The authors observed increased gizzard size as a result of whole-wheat feeding or insoluble fibre addition. According to Hetland *et al.* (2004) increase in gizzard weight plays important role in the utilisation of whole grains. Increased liver weight were observed in birds fed 20% wheat without enzyme and this can be attributed to high level of NSPs in the diet. This corroborates the findings of Inyang (2012) and Agboola *et al*. (2013) who reported increased liver weight in birds fed 10% whole wheat without enzyme

supplementation. Gao *et al*. (2007) reported that enzyme supplementation can change the nutritional status and improve growth performance of broiler chickens fed a wheat-based diet. Increased carcass yield by addition of enzymes has also been reported by Leeson *et al*. (1996). Decreased dressed weight observed in this study is in disagreement with the report of Omojola and Adesehinwa (2007), who noted superior significant difference in dressing percentage of birds on enzyme-supplemented diets. This could probably be that the enzyme effect was not pronounced because of a negative interaction between wheat and enzyme observed in the present study. According to Bedford (1996), the degree of improvement obtained by adding enzymes to the diet depends on many factors including the type and amount of cereal in the diet, the level of anti-nutritive factor in the diet, the spectrum and concentration of enzymes used etc. The differences observed in this present work and that of Omojola and Adesehinwa (2007), Iyayi and Yahaya (1999) and other several authors could be as a result of one of the factors mentioned above.

Birds fed wheat-based diets with or without enzyme had relatively high feed cost/kg/bird (₦ /kg) when compared to birds on the control diet. The feed cost per kilogram per bird was least in the control diet (₦111.65) and (₦291.24) for starter and finisher phases respectively when compared to feed cost of wheat-based diets. This is probably as a result of slight differences in the price of maize (₦70.00/kg) and wheat (₦80.00/kg) at the period of the experiment. This result corroborates with the findings of Awoyemi (2012) on cost benefits of birds fed varying levels of wheat diets supplemented without or with enzyme.

Conclusion and Recommendation

The results of this study showed that enzyme supplementation did not positively influence the growth performance and carcass characteristics of birds fed 20% wheat-based diets when compared to those without enzyme supplementation.

It can be recommended that the energy level of diets with enzyme inclusion should be lower than the diets not supplemented with enzyme for effectiveness in the activity of supplemental enzyme and to maximize enzyme-ingredients interactions.

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