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Dietary effect of rice milling waste and supplementary enzyme on performance of broiler chicks

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A four- week study was conducted to determine the effects of feeding rice milling waste (RMW) and supplementary enzyme (Roxazyme G2®) on the performance of broiler chicks. One hundred and twenty (120) 7-day old broiler chicks of Anak strain were randomly divided into eight groups of 15 birds each. The groups were randomly assigned to 8 isocaloric (2.85 Mcal of ME/kg) and isonitrogenous (22.00% crude protein) diets in a 4 × 2 factorial arrangement involving a control (0%), three levels (10, 15 and 20%) of RMW and two enzyme levels (0 and 0.02%). Each treatment was replicated three times with five birds per replicate. Results show that feed intake, average daily weight gain, protein efficiency ratio, costs of daily feed intake and feed cost per kg weight gain were significantly (P<0.05) different among the treatment diets. Haematological values such as Haemoglobin concentration (Hb), mean cellular volume (MCH), mean cellular haemoglobin concentration (MCHC) and mean cell volume (MCV) were not significantly (P>0.05) affected by the treatments. Enzyme supplementation resulted in a significant (P<0.05) reduction in feed intake and enhanced significantly (P<0.05), the performance of birds that consumed such enzyme supplemented diets. It was concluded that up to 20% RMW can be included in broiler starter diet without any adverse effect on growth performance of birds. However, the significant increase in feed cost per kg weight gain emanating from the inclusion of enzyme in some of the diets may negate the positive effect that Roxazyme G2® enzyme had on growth performance of the broiler chicks.

Key words: Rice milling waste, enzyme, diets, broiler chicks, growth performance.

INTRODUCTION

Developing countries like Nigeria is facing a big problem of protein malnutrition. Animal protein is essential in human nutrition in order to solve the problem of kwashiorkor which is a resultant effect of malnutrition (Ojewole, 1993; Oladeebo et al., 2007). Food and Agricultural Organization has recommended about 36 g daily animal protein intake for an adult of 60 kg of the populace (FAO, 2006). The direct and subsequent effect of the increase in the Nigeria human population is that the demand for protein of animal origin in Nigeria is greater than the supply. Ani and Ugwuowo (2011) had attributed the low protein intake by an average Nigerian to low level of animal protein production and high cost of animal products and suggested the intensification of the production of highly reproductive animals with short generation intervals such as poultry, pigs and rabbits (Fielding, 1991; Serres, 1992; Smith, 2001). However, the major factor militating against intensive animal production in Nigeria is the high cost of feed and feed ingredients, especially the conventional energy and protein feed ingredients like maize, soybean cake and groundnut cake (Ani et al., 2012). At present, feed accounts for 75 to 80% of the cost of poultry production. The ever-increasing cost of poultry feeds with the

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attendant increase in the cost of chicken and eggs shows that there is the need to explore the use of alternative and non-conventional feed ingredients that are cheaper and locally available. One of such alternative feed ingredients is Rice Milling Waste (RMW). Dafwang and Shwarmen (1996) stated that rice milling waste is the by-product which is obtained from small-scale milling industries that processed parboiled rice through a mechanism which combines the removal of husk and polishing into one operation to produce the clean grain and rice offal which contain husk, bran, polishing and small quantities of broken grains.

According to the International Rice Research Institute (IRRI, 2008), the main by-products of rice milling are rice hulls or husk, rice bran and bravery's rice. Rice husks, the major part of RMW contains about 3.66 kCal/g energy, 5.25% crude protein and as high as 33.1% fibre. The use of rice milling waste as an ingredient in animal feeds, especially ruminants and poultry has been well documented (Dafwang and Shwarmen, 1996; Awesu et al., 2002). However, its use in the feeding of monogastric animals is limited by its high fibre content. In broilers, high fibre tends to limit the amount of intake of the available energy by the birds and it also results to the secretion of excessive nutrients (Kung et al., 2000). Agbede et al. (2002) had shown that high fibre and lignin contents of RMW are capable of reducing nutrient utilizetion and also precipitate metabolic dysfunction when digested by non-ruminants. Considering the fact that poultry cannot fully utilize high fibre diets because of the lack of the digestive framework that can elaborately digest large amount of fibre, it becomes necessary, therefore, to incorporate exogenous enzymes into their diets in order to enhance the breakdown of the non-starch polysaccharides (NSPs) present in fibre. The enzyme being considered in the present study is RoxazymeG2®, an enzyme complex derived from *Trichoderma viride* with glucanase and xylanase activity. The enzyme has been shown to increase the digestibility of fibrous feed ingredients by disrupting the plant cell walls, and by reducing the viscosity of the gut contents, thereby enhancing nutrient absorption (Choct and Annison, 1992; Bedford et al., 1992; Acromovic, 2001).

The present study was therefore designed to investigate the dietary effect of rice milling waste and supplementary enzyme (RoxazymeG2®) on performance of broiler chicks.

MATERIALS AND METHODS

The study was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Nsukka lies in the derived savannah region, and is located on longitude 6° 25´ N and latitude 7° 24´ E (Ofomata, 1975) at an altitude of 430 to 447 m above sea level (Breinholt et al., 1981). The climatic data taken during the period of the experiment showed the study area had the natural day-length of 13 to 14 h; mean maximum weekly indoor and outdoor temperatures of 27.9 to 29.2°C and 26.8 to 30.5°C, respectively; mean minimum weekly indoor and outdoor temperatures of 20.5 to 22.3°C and 20.0 to 23.60°C, respectively, relative humidity of 73.1 to 76.6%, mean total monthly rainfall of 781.33 mm and day-length of 12 h (Oformata, 1975; Breinholt et al., 1981; Agbagha et al., 2000; Okonkwo and Akubuo, 2007; Energy Centre, 2008). The duration of the study was four weeks. The rice milling waste was purchased from a rice mill in Adani near Nsukka. Other ingredients such as groundnut cake, palm kernel cake, soybean meal, bone meal and wheat offal were sourced from Poultry International Services Nsukka. The maize and common salt were purchased from Orie Orba Market and the enzyme, vitamins, mineral mix, methionine and lysine were bought from Alpha Farms, Enugu. Some of the feed ingredients were ground before using them to formulate the experimental diets.

Formulation of experimental diets

Eight broiler starter diets containing 2.85 to 2.86 Mcal/kg of ME and 22.10 to 22.11%CP were formulated using the rice milling waste and other feed ingredients. The composition of the broiler starter diets is presented in Table 1.

Management of experimental birds

The study was conducted in accordance with the provisions of the Ethical Committee on the use of animals and humans for biomedical research of the University of Nigeria, Nsukka (2006). One hundred and twenty (120) 7 day-old commercial broiler chicks (Anak strain) were randomly divided into eight groups of 15 birds each. The groups were randomly assigned to 8 isocaloric (2.85 Mcal of ME/kg) and isonitrogenuos (22.00% crude protein) diets in a 4 × 2 factorial arrangement involving a control (0%), three levels (10, 15 and 20%) of RMW and two enzyme levels (0 and 0.02%) as shown in Table 1. Each treatment was replicated three times with five birds per replicate placed in 2.6 × 3 m deep litter pens with fresh wood shavings. Kerosene stoves placed under metal hovers provided heat during the brooding period. Feed and water were supplied *ad libitum* to the birds from 7 to 35 days of age. The birds were subjected to standard broiler management procedure. At the beginning of the experiment, chicks in each replicate were weighed together. Feed intake was determined daily by the weigh-back technique. Live weights were recorded weekly for each replicate. Feed conversion ratio was then calculated from the data generated as quantity (grams) of feed consumed per unit (grams) weight gained over the same period. All measurements were taken between 8.am and 12.00 noon. Mortality record was kept on daily basis.

The chicks were vaccinated against New Castle disease in the first and third weeks and against Gumboro disease in the second and fourth weeks. Prophylactic treatment against coccidiosis was also given to the birds at two weeks of age, using Embazin forte®.

Blood collection for haematological evaluation

During week 4 of the experiment, blood was collected with a sterile needle from the wing veins of three birds per treatment. The blood was collected into properly labeled sterile bottles containing ethylene diamine tetra acetic acid (EDTA) and used to determine hematological parameters of the birds. The packed cell volume (PVC) was determined using the micro hematocrit centrifuge. A 0.5 ml of blood was centrifuged at approximately 12000 g for 10 min in a hematocrit centrifuge. The PCV was subsequently determined by measuring the height of the erythrocyte column and expressing this as a fraction of the height of the total blood column. PCV = Height of packed cell column divide by height of whole blood column.

Haemoglobin concentration was determined spectrophotometrically (Perkin-Elmer) by the cyanomethaemoglobin method. A 0.5 ml

Table 1. Percentage composition of broiler starter diets.

Parameter	Treatment							
	1	2	3	4	5	6	7	8
RMW level (%)	**0**	**0**	**10**	**10**	**15**	**15**	**20**	**20**
Enzyme level (%)	**0**	**0.02**	**0**	**0.02**	**0**	**0.02**	**0**	**0.02**
Maize	49.00	49.00	39.00	39.00	34.00	34.00	29.00	29.00
Wheat offal	6.00	6.00	5.55	5.55	5.00	5.00	4.50	4.50
Rice milling waste	0.00	0.00	10.00	10.00	15.00	15.00	15.00	15.00
Soya bean meal	9.00	9.00	9.00	9.00	10.00	10.00	10.00	10.00
Groundnut cake	21.50	21.48	21.50	21.48	21.50	21.48	21.50	21.48
Palm kernel cake	7.50	7.50	7.95	7.95	7.50	7.50	7.50	7.50
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Enzyme level (%)	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vit-Min-Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Palm oil	0.00	0.00	0.5	0.5	1.00	1.00	1.50	1.50
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Crude protein (%)	22.10	22.10	22.09	22.09	22.11	22.11	22.10	22.10
Crude fibre (%)	4.07	4.07	7.18	7.17	8.80	8.79	11.33	11.35
Energy Mcal /kg of ME	2.85	2.85	2.86	2.86	2.85	2.85	2.85	2.85
Determined composition								
Dry matter (%)	94.70	94.70	94.75	94.75	94.70	94.70	94.60	94.60
Crude protein (%)	22.01	22.03	22.02	22.01	22.08	22.07	22.00	22.01
Ether extract (%)	15.30	15.40	17.60	17.61	21.30	21.31	21.46	21.50
Crude fibre (%)	5.20	5.32	8.50	8.52	12.42	12.45	13.55	13.54
Nitrogen-free extract (%)	42.9	42.0	36.78	36.71	28.61	26.42	26.49	26.41
Ash (%)	15.25	15.25	15.10	15.15	15.15	15.25	15.25	15.25
Gross energy (kcal/kg)	3.01	3.06	3.26	3.25	3.39	3.17	3.17	3.18

The Vit-min-premix used in this study was a product of Roche. Each 1 kg contained: Vit A (I. U) 4,000,000; Vit D (I. U) 1,000,000; Vit E (I. U) 4,800; Vit K (g) 0.8; Vit B (g) 0.4; Vit B2 (g) 1.8; Vit B6 (g) 1.2; Nicotinic acid (g) 4.8; Folic acid (g) 0.12; Ascorbic acid (g) 20.0; Chlorine (g) 120.0; Mn (g) 40.0; Fe (g) 20.0; Zn (g) 8.0; I (g) 0.62; Cu (g) 0.09.

of blood was diluted in a buffered solution of potassium ferricyanide and potassium cyanide to yield the stable haemoglobin derivative cyanmethaemglobin. The potassium ferricyanide converted the haemoglobin to methaemoglobin which was further converted to cyanmethaemoglobin by the action of potassium cyanide. Cyanmethaemoglobin produced a color which was measured in a spectrophotometer. The color relates to the concentration of hemoglobin in the blood. The absorbance of this solution was read in a colorimeter at a wavelength of 540 nm. Erythrocyte count (RBC) and leukocyte count (WBC) were determined using Neubar hemocytometer after the appropriate dilution (Mitruka and Rawnsley, 1977) and mean corpuscular hemoglobin concentration (MCHC) was determined using appropriate formula (Lamb, 1991).

Proximate and statistical analyses

Samples of diets and rice milling waste were analyzed for proximate composition using the methods of AOAC (1990). Gross energy of diets was determined in a Parr oxygen adiabatic bomb calorimeter. Data collected were subjected to analysis of variance as described for completely randomized design (Steel and Torrie, 1980), and differences between treatment means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of rice milling waste and supplementary enzyme on the performance of broiler chicks

The proximate composition of the rice milling waste used in formulating the experimental diets is presented in Table 2, while Table 3 shows the effect of rice milling waste and supplementary enzyme on growth performance of broiler chicks. There were significant differences ($P < 0.01$) among treatments in average daily weight gain (ADWG), average daily feed intake (ADFI), feed conversion ratio (FCR), average daily protein intake (ADPI) and

Table 2. Proximate composition of rice milling waste.

Nutrient (%DM)	Composition
Dry matter	93.65
Moisture	6.35
Crude protein	5.25
Crude fiber	33.18
Ether extract	3.9
N-free extract	28.17
Ash	23.15

protein efficiency ratio (PER). Birds on treatments 4 (10% RMW diet with enzyme) had significantly (P<0.01) higher ADWG than those on other treatments with the exception of those on treatments 5 and 6 (15% RMW diet with and without enzyme). Birds on treatments 5 and 6 and those on treatments 1, 2, 3 and 8 had similar ADWG (P>0.01). Birds on treatments 2, 5, 6 and 8 had significantly (P<0.01) higher ADWG than those on treatment 7 (20% RMW without enzyme supplementation), which had the least ADWG. The ADWG values of birds on treatments 1, 3 and 7 were similar (P>0.01). Birds on treatment 2 (0% RMW diet with enzyme) had the least feed intake of 42.62 g/bird. Birds on treatment 1 (0% RMW diet without enzyme) had significantly lower ADFI (46.20 g/bird) than birds on other treatments. Birds on treatment 7 (20% RMW diet without enzyme) had the highest feed intake (60.78 g/bird). Birds on treatment 5 had similar (P>0.01) ADFI with those in treatment 8, while birds on treatments 3 and 6 had comparable ADFI (P>0.01).

Birds on treatment 7 (20% RMW diet without enzyme) had the highest FCR value but this was similar to the FCR value of birds on treatments 3 (0% RMW diet without enzyme supplementation) and 8 (20% RMW diet with enzyme). Birds on treatments 5, 6 and 8 had significantly (P<0.01) higher FCR values than those on treatments 1, 2 and 4. The FCR values of birds on treatments 3, 5, 6 and 8 were similar (P>0.01). Birds on treatments 1, 2 and 4 had the least FCR values and these were similar (P>0.01) to the FCR value of birds on treatment 3. Chicks fed 20% RMW diet (without enzyme supplementation) had significantly (P<0.01) higher protein intake than those on other treatments (Table 5). Chicks on control diets (0% RMW with or without enzyme supplementation) consumed a significantly (P<0.01) lower protein than those on other treatments. In general, protein intake increased as the levels of RMW in the diets increased. The PER values of birds on treatment was significantly (P<0.01) higher than the PER values of birds on other treatments with the exception of treatment 4 (10% RMW diet with enzyme supplementation). Birds on treatments 1 and those on treatments 4 and 5 had similar PER values, while those on treatments 3, 5, 6 and 8 also had similar PER values. Birds on treatment 7 (20% RMW diet without enzyme) had the least PER value. There were significant (P<0.01) interactions between RMW and enzyme levels in ADWG, ADFI, ADPI and PER.

Enzyme supplementation improved (P<0.05) ADWG at the 10 and 20% RMW inclusion levels; reduced (P<0.05) ADFI at all the RMW inclusion levels; reduced (P<0.05) ADPI at the 0 and 20% RMW inclusion levels and increased (P<0.05) PER at the 0, 10 and 20% RMW inclusion levels. As shown in Table 3, the average daily weight gain decreased significantly at the 20% RMW inclusion level, without enzyme supplementation. The efficiency of feed utilization and protein efficiency ratio also decreased with increasing RMW level in the diets. The decrease in the performance of the treated birds could be attributed to the content of fibre in the diets which was highest at the 20% RMW inclusion level (Table 1). Kung and Grueling (2000) had reported that high dietary fibre resulted in the limitation of the amount of energy available to birds and correspondingly contri-buted to excessive nutrient excretion. Delorme and Wojcik (1982) had shown that excess fibre in the diets of monogastric animals impairs the utilization of other nutrients especially crude protein. The decrease in the efficiency of feed utilization could also have resulted from the increase in feed intake occasioned by high dietary fibre content. However, supplementation of the 20% RMW diet with enzyme improved ADWG, feed efficiency and PER. Agbede et al. (2002) and Shakouri and Kermanshashi (2004) had earlier reported a similar improvement in the performance of broiler birds fed diet that was supplemented with enzyme. The reports of Broz et al. (1994) and Zobell et al. (2000) had also shown that exogenous enzymes compliment the digestive enzymes of poultry by hydrolyzing the non-starch polysaccharides (NSPs) in cereals and vegetable proteins, thereby decreasing gut viscosity, and thus improve nutrient absorption.

Bedford (1997) and Gunal and Yasar (2004) had also reported that feed enzymes have the ability to alter the bacterial population by digesting the long chain carbohydrate molecules utilized by some bacteria to colonize the tract, and this increases the quantity of protein vis-à-vis amino acid digested in the pre caecal section of the tract. As shown in Table 3, feed intake increased with the increase in RMW levels. Such increase can be attributed to the bulky nature and low total digestible nutrient of the feed. Moran (1977) and Isikwenu et al. (2000) had also attributed high feed intake to high dietary fibre level. Interestingly, there was a significant reduction in the feed intake of birds that consumed such enzyme supplemented diets. A similar observation had been documented by Richter et al. (1995), Samarasinghe et al. (2000) and Ani et al. (2011). Broz and Frigg (1990) and Broz et al. (1994) had also observed the positive effect the inclusion of Roxazyme G2® enzyme (*Trichoderma viride*) in the diets of poultry had on feed intake and weight gain. There is therefore, a strong indication that the feeding value of RMW can be enhanced by supplementing RMW based diets with Roxazyme G2® enzyme.

Table 3. Effect of rice milling waste and supplementary enzyme on the performance of broiler chicks.

Parameter	Treatment								SEM
	1	2	3	4	5	6	7	8	
RMW level (%)	0	0	10	10	15	15	20	20	
Enzyme level (%)	0	0.02	0	0.02	0	0.02	0	0.02	
Initial body weight (g)	90.67	91.67	89.33	90.67	91.33	90.67	91.33	90.33	1.32
Final body weight (g)	1323.33	1356.67	1300.00	1466.67	1463.33	1406.67	1263.33	1370.00	32.91
Average daily body wt gain (g)	44.02^{bc}	45.18^{b}	43.24^{bc}	49.14^{a}	49.00^{ab}	47.00^{ab}	41.86^{c}	45.70^{b}	1.02
Average daily feed intake (g)	46.20^{f}	42.62^{g}	51.91^{d}	49.52^{e}	56.04^{b}	54.24^{cd}	60.78^{a}	57.41^{b}	0.84
Feed conversion ratio	1.05^{c}	0.94^{c}	1.20^{abc}	1.01^{c}	1.14^{b}	1.15^{b}	1.45^{a}	1.26^{ab}	0.07
Average daily protein intake(g)	10.39^{d}	9.60^{e}	11.59^{c}	11.05^{c}	12.49^{b}	12.24^{b}	13.56^{a}	12.81^{b}	0.19
Protein efficiency ratio	4.24^{b}	4.71^{a}	3.73^{c}	4.45^{ab}	3.92^{bc}	3.84^{c}	3.09^{d}	3.57^{c}	0.13

a, b, c…..g means on the same row with different superscripts are significantly (P<0.01) different. SEM = Standard error of the mean.

Table 4. Cost implication of feeding dietary rice milling waste and supplementary enzyme to broiler chicks.

Parameter	Treatment								SEM
	1	2	3	4	5	6	7	8	
RMW level (%)	0	0	10	10	15	15	20	20	
Enzyme level (%)	0	0.02	0	0.02	0	0.02	0	0.02	
Cost of 1kg of feed (₦)	44.25	56.25	42.61	54.61	42.80	54.80	42.30	54.30	-
Total feed intake (kg)	1.29^{f}	1.19^{g}	1.46^{d}	1.39^{e}	1.57^{b}	1.52^{cd}	1.70^{a}	1.61^{b}	0.02
Total weight gain (kg)	1.23^{d}	1.27^{c}	1.21^{e}	1.38^{a}	1.32^{b}	1.37^{a}	1.17^{f}	1.28^{c}	0.02
Cost of daily feed intake (₦)	2.04^{g}	2.40^{e}	2.21^{f}	2.71^{c}	2.40^{e}	2.97^{b}	2.57^{d}	3.12^{a}	0.05
Cost of total feed intake (₦)	57.38^{g}	66.75^{e}	62.07^{f}	75.73^{c}	67.20^{e}	83.30^{b}	72.05^{d}	87.27^{a}	1.18
Cost of feed per kg wt gain (₦)	46.46^{h}	52.88^{e}	51.13^{f}	55.16^{d}	48.79^{g}	63.02^{b}	61.34^{c}	68.42^{a}	1.85

a, b, c…..g means on the same row with different superscripts are significantly (P<0.01) different.
SEM = Standard error of the mean.

Cost implication of feeding varying dietary levels of rice milling waste and supplementary enzyme to broiler chicks

The cost implication of feeding varying dietary levels of rice milling waste and supplementary enzyme to broiler chicks is presented in Table 4. There were significant differences (P<0.01) among treatments in total feed intake, total weight gain, cost of daily feed intake, cost of total feed intake and cost of feed per kg weight gain. The total feed intake followed the same pattern with daily feed intake. Chicks on treatments 4 (10% RMW diet with enzyme supplementation) and 6 (15% RMW diet with enzyme supplementation) had similar total weight gain values and these were significantly (P<0.01) higher than the total weight gain values of chicks on other treatments. Chicks on treatment 5 (15% RMW diet without enzyme supplementation) had significantly (P<0.01) higher total weight values than those on treatments 1, 2, 3, 7 and 8. The total weight gain values of chicks on treatments 2 and 8 were similar (P>0.01) and these were significantly (P<0.01) higher than the total weight gain values of chicks on treatments 1, 3 and 7. Chicks on treatment 7 had the least total weight gain (P<0.01). Chicks on treatments 8 (20% RMW diets with enzyme supplementation) had the highest cost of feed per kg weight gain value cost of feed per kg weight gain. This was followed by chicks on treatments 6, 7, 4, 2, 3 and 5 in descending order. Chicks on treatment 1 had the least cost of feed per kg weight gain value feed cost per kg gain. The costs of daily feed intake and total feed consumed increased significantly (P<0.01) with enzyme inclusion in the diets. Birds on treatment 8 (20% RMW diet with enzyme supplementation) had the highest costs of daily feed intake and total feed consumed, while birds fed the control diet (without enzyme inclusion) had the least costs of daily feed intake and total feed consumed.

There were significant (P<0.01) interactions between RMW and enzyme levels in total feed intake, total weight gain, cost of daily feed intake, cost of total feed intake and cost of feed per kg weight gain.

Enzyme supplementation reduced (P<0.05) total feed intake at all the RMW inclusion levels; increased (P<0.05) total weight gain at all the RMW inclusion levels; increased (P<0.05) the costs of daily feed intake and total feed intake in all the RMW inclusion levels, and increased

Table 5. Effect of rice milling waste and supplementary enzyme on hematological parameters of broiler chicks.

Parameter	Treatment								SEM
	1	2	3	4	5	6	7	8	
RMW level (%)	**0**	**0**	**10**	**10**	**15**	**15**	**20**	**20**	
Enzyme level (%)	**0**	**0.02**	**0**	**0.02**	**0**	**0.02**	**0**	**0.02**	
Packed cell volume (%)	30.5^{bc}	33.0^{a}	29.00^{c}	30.00^{b}	30.00^{bc}	33.00^{a}	29.5^{c}	32.00^{ab}	0.61
Hemoglobin Con. (g/100 mol)	10.00	11.00	10.33	10.00	10.00	11.00	10.67	9.67	0.61
Red blood cell count (106/mm^3)	5.03^{d}	5.51^{a}	5.01^{d}	5.17^{c}	5.05^{cd}	5.58^{a}	4.85^{e}	5.33^{b}	0.04
White blood cell count (106/mm^3)	11.46^{c}	12.58^{ab}	11.20^{c}	11.10^{c}	10.55^{d}	13.10^{a}	10.00^{e}	12.29^{b}	0.17
Mean cell Hem. Con. (%)	32.80	33.35	33.37	34.52	34.34	34.71	33.35	32.79	2.53
Mean cell hem. (pg)	19.88	19.96	19.34	19.96	19.80	19.71	20.02	19.45	1.12
Mean cell volume (um^3)	60.64	59.89	58.03	57.88	59.41	59.15	60.04	60.83	1.22

a, b, c…..e means on the same row with different superscripts are significantly (P<0.01) different. SEM = Standard error of the mean.

(P<0.05) feed cost per kg weight gain at all the RMW inclusion levels. Data on cost implication of feeding varying dietary levels of rice milling waste and supplementary enzyme to broiler chicks (Table 4) reveals that the costs of daily feed intake and total feed consumed increased significantly (P<0.01) with enzyme inclusion in the diets.

The observed increase may have resulted from the increase in ADFI, poor efficiency of feed conversion and utilization, and poor growth rate of birds that consumed diets containing high levels of RMW. The present results completely disagree with earlier reports (Mikulshi et al., 1998; Ajaja et al., 2003) which stated that there was reduction in feed cost per kg weight gain of chicks fed enzyme-supplemented diets. Moreover, the significant increase in the costs of daily feed intake and total feed intake as well as feed cost per kg weight gain may negate the positive effect which the dietary inclusion of Roxazyme G2® enzyme had on growth performance of the broiler birds.

Effect of rice milling waste and supplementary enzyme on haematological traits of broiler chicks

The effect of graded levels of rice milling waste and supplementary enzyme on the hematological traits of broiler chicks is shown in Table 5. There were significant differences (P<0.01) among treatments in packed cell volume (PCV), red blood cell (RBC) count and white blood cell (WBC) count. Birds on treatments 2 and 6 had similar PVC values with those in treatment 8 and these were significantly higher than the PVC values of birds on other treatments. Birds on treatments 2 and 6 had similar RBC values and these were significantly (P<0.01) higher than the RBC values of birds on other treatments. Birds on treatments 6 had similar WBC value with those on treatment 2 and this was significantly (P<0.01) higher than the WBC values of birds on other treatments.

Birds on treatment 7 had the least RBC and WBC values. There were significant (P<0.01) interactions between RMW and enzyme levels in PVC, RBC and WBC. Enzyme supplementation increased (P<0.05) PVC and RBC at all the RMW inclusion levels and increased (P< 0.05) WBC at the 0, 15 and 20% RMW inclusion levels.

There were no significant (P>0.05) differences among treatments in hemoglobin concentration (Hb), mean cellular volume (MCH), mean cellular hemoglobin concentration (MCHC) and mean cell volume (MCV). There were significant (P<0.01) interactions between RMW and enzyme levels in PVC, RBC and WBC. Enzyme supplementation increased (P<0.05) PVC and RBC at all the RMW inclusion levels and increased (P<0.05) WBC at the 0, 15 and 20% RMW inclusion levels.

As shown in Table 5, haemoglobin concentration, mean cellular volume, mean cellular hemoglobin concentration and mean cell volume were not significantly (P>0.05) affected by the treatments. However, the RBC and WBC were decreased at the 20% RMW inclusion level. The observed decrease in the RBC and WBC values of birds that consumed the 20% RMW diet without enzyme supplementation (treatment 7) might have been occasioned by the poor growth performance of the birds.

Jean (1993) had shown that the erythrocytes (RBC) and leucocytes (WBC) of animals in good health varies between species and individuals in the same species according to their condition of health. The erythrocytes and leucocytes profiles of animals are influenced by many factors including diets (Talebi et al., 2005). Nevertheless, enzyme supplementation of the diets had significantly enhanced the PCV, RBC and WBC of the treated birds, especially at the 20% RMW inclusion level. Interestingly, the hematological values obtained in the present study are within the normal range reported by Merck Veterinary Manual (1979), Jean (1993) and Swenson and Reece (1993).

Conclusion

The results obtained in the present study show that up to 20% RMW can be included in broiler starter diet without any deleterious effect on growth performance of birds. Although, the inclusion of enzyme in some of the diets enhanced the growth rate of birds, such inclusion increased the cost of feed per kg gain, thereby negating the positive effect it had on growth rate of chicks.

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