

Effect of quantitative feed restriction with enzyme supplementation on growth performance, haematological and biochemical parameters of mashall broiler chicks

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ABSTRACT

Ninety six (96) Mashall strain day old broiler chicks were used in a completely randomized design to test the effect of quantitative feed restriction with enzyme (Maxigrain) supplementations. The chicks were all fed *ad-libitum* for the first week and at the second week, the chicks were divided into four treatment groups consisting of three replicates of eight (8) chicks each. The first group of chicks (control) was fed *ad-libitum*. The others were on restricted feeding at 15%, 30% and 45% of *ad-libitum* feeding with enzyme supplementation for 14 days. After the 14th day of feed restriction all the treatment groups were fed *ad libitum* to allow for re-alimentation for one week. Data were collected on feed intake and weight gain. Blood samples were collected for determination of haematological and serum biochemical parameters. As expected, feed intake was highest among the *ad-libitum* fed chicks compared with the restricted chicks with enzyme supplementation ($P<0.05$). The weight gain and feed conversion ratio were significantly improved with the best weight gain (412.82g) and feed conversion ratio (1.67) recorded for 15% and 45% of *ad-libitum* feeding respectively ($P<0.05$). The results for haematology and serum biochemistry revealed significant increase ($P<0.05$) in the values obtained for glucose and cholesterol, and decrease in aspartate transaminase values as the level of feed restriction increases. It was concluded that the inclusion of enzyme in restricted feeding of broiler chicks will bring about better weight and feed conversion ratio but can increase glucose and cholesterol level and decrease the aspartate transaminase value.

Keywords: Enzyme, weight gain, feed intake, feed conversion ratio, serum, haematology

INTRODUCTION

The challenge of optimizing animal performance and improve profitability while reducing dietary cost which account for 55-75% of cost of production has resulted in the development of various feed ingredients, exogenous enzymes, growth promoters, genetic selection, feeding

programme/formulation and phase feeding (starter/grower/finisher) (Plavnik and Hurwitz, 1985).

Feed restriction, whether qualitative or quantitative is denying birds the full access to nutrients that are required for their normal growth and development (Khetani *et al.*,

2009; Fanooci and Torki 2010). Early feed restriction is practiced in broilers to induce compensatory growth or catch up growth which improve efficiency of feed utilization, reduce abdominal fat, improve carcass quality and lower maintenance requirement in the grower and finisher phases (Teimouri *et al.*, 2005). This will ultimately lead to reduction in feed and production cost and at the same time producing a lean meat at cheaper prices (Zubair and Leeson, 1996; Navidshad *et al.*, 2006; Mahmud *et al.*, 2008).

Birds are known to lack microorganisms in their stomach that could aid digestion as in the case of ruminant animals, therefore their digestive system is not 100% efficient. About 15-25% of the feed they consumed are passed out in a form that are not completely digested, this is because the feed ingredients contains indigestible anti-nutritional factors that interfere with the normal digestive process resulting in reduced meat or egg production and lower feed efficiency and can trigger digestive upset (Sheppy, 2001).

Feed restriction has been used to reduce the incidence of ascites (Tottori *et al.* (1997), sudden death syndrome (Blair *et al.*, 1993; Gonzales *et al.*, 1998), and skeletal deformities (Lee and Leeson, 2001) that are undesirable effect observed in full fed broilers. Exogenous feed enzymes are used to increase the availability and digestibility of starch, protein, amino acids, and minerals such as calcium from feed ingredients. Supplementing feeds with specific enzyme help to improve the nutritional value of feed ingredients thereby increasing the efficiency

of digestion and improve the accuracy of feed formulations. This study was carried out to investigate the response of varying levels of quantitative feed restriction with exogenous enzyme supplementation on the performance, serum biochemistry and haematology of broiler chicks.

MATERIALS AND METHODS:

Study Area

The experiment was carried out at the poultry unit of University of Benin Farm project, Benin City, Nigeria. An area located between latitude 6.3337°N and longitude 5.6002°E. It has average annual rainfall of 2300mm with mean temperature and relative humidity of 32°C and 70% respectively (Osaigbovo and Orhue, 2011).

Feeding and Management of Birds

A total of ninety six Mashall day old broiler chicks were brooded together at the first week and fed *ad-libitum*. At the beginning of the second week, the birds were randomly distributed into four (4) treatments with three (3) replicates of eight (8) birds each. Experimental treatment was made up of four levels of quantitative feed restriction; 0, 15, 30 and 45% respectively. The zero level represented the *ad-libitum* feeding while others were restricted at 15, 30 and 45% of *ad-libitum* feeding had their diets supplemented with Maxigrain enzyme at 0.5g/kg of feed. Quantitative feed restriction lasted for two (2) weeks (14days) and was followed by one (1) week (7days) of re-alimentation. The diets composition is shown in table 1.

Table 1. Percentage Composition of Broiler Starter Diet

	% Composition With Enzyme (+)	% Composition Without Enzyme (-)
Ingredients		
Maize	50.00	50.00
Soybean meal	25.00	25.00
Brewer Dried Grain (BDG)	12.00	12.00
Fish meal (63%CP)	6.25	6.25
Palm oil	2.00	2.00
Bone meal	2.60	2.60
Oyster shell	1.40	1.40
*Vitamin and Mineral		
premix	0.25	0.25
Methionine	0.25	0.25
Salt	0.25	0.25
Enzyme (ppm)	+	-
TOTAL	100	100
Calculated Analysis		
Crude protein (%)	22.69	22.69
Crude fibre (%)	4.72	4.72
Ether extract (%)	3.43	3.43
Calcium (%)	0.19	0.19
Phosphorus (%)	0.52	0.52
ME (KCal/kg)	2966.36	2966.36

*Premix composition per kg diet: Vit.A; 400000IU, Vit D;80000IU, Vit K₃; 800mg, Vit B₁; 10000MG, Vit B₂;6000mg, Vit B₆: 500mg, Vit B₁₂:12.25mg, Niacin: 600mg , Panthothenic acid: 2000mg, Folic acid: 200mg, Biotin: 8mg, Manganese: 300000mg, Iron: 8000mg, Zinc: 20000mg

*Enzyme 1000ppm.

Apart from feeding, clean water was sufficiently supplied to the birds, appropriate record keeping was carried out, administration of vaccines, antibiotics, and vitamins were given when necessary. The quantity of feed given per week for the control was determined using the guide given by Aduku (2004) that a broiler chick requires 15g feed per day in the first week, 33g in the second week, 56g in the third week, and 76g in the fourth week. Performance data collected were feed intake,

initial and final body weight, feed conversion ratio was calculated using feed intake and body weight gain. Mortality was recorded as they occurred. Percentage mortality was thereafter calculated. Feed intake was determined as the difference in the quantity of the feed offered to the birds in each week and the left over at the end of the week. Body weight was calculated weekly by subtracting the initial weight at the beginning of each week from the final weight at the end of each week whilst feed

conversion ratio was calculated as the total

Blood parameters

During the second week of feed restriction, about 5.0ml of blood was collected from randomly selected chicks (three per replicate) with 2.0ml for haematological studies and 3.0ml for serum biochemistry. This was done with the help of syringe and needle into a bottle containing anti-coagulant, ethylene diamine tetra acetic acid (EDTA) at the fourth week. Haematological parameters considered were the packed cell volume (PCV), haemoglobin concentration (Hb), white blood cell (WBC), and red blood cell (RBC), following standard procedure described by Davice and Lewis (1991). The serum biochemical parameters considered include the urea, cholesterol, glucose, creatine, total serum protein, (TSP), serum albumin (SA), sodium, chlorine and potassium following standard procedure described by Baker and Silverton (1985).

Statistical Analysis: All data collected were subjected to analysis of variance (ANOVA) in a Completely Randomized Design. Significant (P<0.05) differences among

feed intake divided by the weight gain.

means were separated using Duncan’s Multiple test (SAS, 1999).

RESULTS

The effect of quantitative feed restriction with enzyme supplementation is as shown in Table 2. The initial and final weight of the broiler chicks showed no significant differences amongst the groups (P>0.05). Feed intake was significantly higher among broiler chicks fed on *ad-libitum* feed without enzyme supplementation (P<0.05). The weight gain of broiler chicks was significantly improved by feed restrictions coupled with enzyme supplementation (P<0.05). The highest weight gain (406.40g) was realized among broiler chicks fed on 15% of *ad-libitum* feed restriction with enzyme supplementation (P<0.05). Feed intake was highest among broiler chicks fed on *ad-libitum* feed without enzyme supplementation (P<0.05). Feed conversion ratio was significantly (P<0.05) improved among feed restricted chicks supplemented with enzyme, with 45% of *ad-libitum* feeding recording the best (1.67).

Table 2. Effect of quantitative feed restriction with enzyme supplementation on performance of Mashall broiler chickens (0-4 weeks)

Level of Feed Restriction (%)	0	15	30	45
Enzyme Supplementation	-	+	+	+
Initial Weight (g)	127.30±28.36 ^a	126.90±30.04 ^a	125.96±29.98 ^a	127.60±27.66 ^a
Final weight (g)	450.00±38.88 ^a	533.30±43.43 ^a	477.80±11.08 ^a	494.40±41.53 ^a
Weight Gain (g)	322.70±35.71 ^b	406.40±47.81 ^a	351.84±14.10 ^{ab}	366.80±01.90 ^{ab}
Feed Intake (g)	1022.40±201.77 ^a	916.80±96.17 ^b	732.30±88.33 ^c	611.00±209.63 ^d
FCR	3.17±0.78 ^a	2.26±0.02 ^b	2.10±0.17 ^b	1.67±0.60 ^c
Mortality (%)	0.02	0.00	0.00	0.00

^{a, b, c} :means within the same row bearing different superscripts differ significantly (P<0.05).

FCR: Feed Conversion Ratio

The results of the effect of feed restriction with enzyme supplementation on serum biochemistry and haematological parameters of Marshall Broiler chicken at the end of the second week of feed restriction being their third week of growth are shown on Table 3. The level of feed restriction and enzyme supplementation had significant effect ($P<0.05$) with respect to serum biochemistry parameters such as urea, sodium, potassium, globulin, cholesterol, glucose and aspartate transaminase as well as in packed cell volume, haemoglobin, MCV, MCHC, white blood cell, lymphocytes and granulocytes. Urea concentration was significant among the treatment groups with 30% feed

restriction with enzyme having the highest value. Significant differences ($P<0.05$) were observed among the treatments for sodium at 0% restriction (control) and potassium with 45% feed restriction with enzyme having the highest values. Globulin, cholesterol, glucose and aspartate transaminase showed significant difference ($P<0.05$) across the level of restriction. However, there was no significant difference on globulin at 0% and 15% level of restriction. Cholesterol and glucose levels increased across the treatment groups as the diet restriction level increased while aspartate transaminase level decreased across the treatment.

Table 3. Effect of Feed Restriction with Enzyme supplementation on Haematological and Serum Biochemical Parameters of Marshal Broiler Chicks

Level of Feed Restriction (%)	0	15	30	45	SEM
Enzyme Supplementation	-	+	+	+	
Serum Biochemistry					
Urea (mg/dl)	25.00 ^b	15.00 ^d	26.00 ^a	17.00 ^c	0.35
Sodium (meq/l)	135.00 ^a	129.00 ^d	130.00 ^c	134.00 ^b	0.35
Potassium (meq/l)	3.00 ^a	3.20 ^{ab}	3.50 ^{ab}	3.80 ^b	0.35
Chlorine (mmol/l)	20.00	19.33	22.00	19.00	0.57
Creatinine (mg/dl)	0.60	0.70	0.97	0.90	0.34
Total Protein (g/dl)	6.60	6.40	7.10	6.50	0.35
Albumin (g/dl)	3.10	2.90	3.20	3.50	0.35
Globulin (g/dl)	3.50 ^{ab}	3.50 ^{ab}	3.90 ^b	3.00 ^a	0.35
Cholesterol (mg/dl)	115.00 ^d	117.00 ^c	118.00 ^b	124.00 ^a	0.35
Glucose (mg/dl)	37.00 ^d	44.55 ^c	50.90 ^b	55.10 ^a	0.36
AST (u/l)	112.00 ^a	101.00 ^b	90.00 ^c	68.00 ^d	0.35
Haematology					
Packed Cell Volume (%)	28.17 ^b	28.50 ^b	25.00 ^c	30.97 ^a	0.26
Red Blood Cell (10 ⁶ µl)	2.71	2.75	2.67	2.71	0.26
Haemoglobin (g/dl)	10.57 ^b	10.60 ^b	9.90 ^c	11.47 ^a	0.26
MCH (pg)	41.93	41.70	40.80	39.93	0.26
MCV (fl)	114.03 ^b	117.20 ^a	104.50 ^d	105.87 ^c	0.26
MCHC (g/dl)	36.63 ^c	36.00 ^d	38.50 ^a	37.27 ^b	0.26
White Blood Cell (10 ⁴ µl)	2.57 ^a	2.38 ^a	2.50 ^a	1.31 ^b	0.26
Differential Counts					
Monocytes (10 ³ µl)	6.47	6.53	6.80	6.77	0.32
Lymphocytes (10 ³ µl)	70.20 ^a	70.00 ^a	61.20 ^b	74.40 ^a	3.87
Granulocytes (10 ³ µl)	6.37 ^a	6.43 ^a	5.10 ^b	6.43 ^a	0.27

^{a, b, c} means within the same row bearing different superscripts differ significantly (P<0.05).

SEM: Standard Error of Mean

AST: Aspartate Transaminase

A: 0% feed restriction without enzyme supplementation

B: 15% feed restriction with enzyme supplementation

C: 30% feed restriction with enzyme supplementation

D: 45% feed restriction with enzyme supplementation

MCV: Mean Corpuscular Volume

MCH: Mean Corpuscular Haemoglobin

MCHC: Mean Corpuscular Haemoglobin Concentration.

DISCUSSION

This report which revealed significant improvement in feed conversion ratio as a result of quantitative feed restriction with enzyme supplementation agreed with Deaton (1995) and Lee and Lesson (2001) who stated that restricted feeding improved feed conversion ratio and allowed a complete recovery of body weight if the degree of restriction was not severe. The response in the performance of the chicks placed on various levels of feed restriction could be attributed to the effect of enzyme enabling better utilization of feed by these groups of broiler chicks. It also showed that the chicks had better opportunity for re-alimentation when they were returned to feeding. The findings in this study are in agreement with Pinheiro *et al.* (2004) who reported that there was interaction between feed restriction and enzyme supplementation for percentage weight gain. They further stated that early feed restriction for birds fed supplemented diets had higher percentage weight gain than the non-supplemented birds. Casiroa *et al.* (1997) and Ferraris *et al.* (2001) on the other hand reported that birds that were subjected to feed restriction had increased intestinal absorption and gastrointestinal tract length due to the action of exogenous enzyme which availed the chicks of faster rate of re-alimentation. The percentage mortality of 0.02 for control (0% *ad-libitum* feeding) and none for 15%, 30% and 45% level of feed restriction with enzyme supplementation was in agreement with Tion *et al.* (2007) who reported that feed restriction had no effect on mortality rate. Similarly, Fontana *et al.* (1992) and Robinson *et al.* (1992) reported a reduction in mortality rate when quantitative feed restriction was practiced.

The effect of feed restriction with enzyme supplementation on the results of this study

showed significant increase in the concentration of serum glucose and total cholesterol, suggesting that the enzyme supplementation increased the nutrient utilization and metabolism (particularly protein anabolism), therefore promoting the growth of birds. The observed increase in the serum glucose and cholesterol concentration across the treatment groups may imply that the added enzyme had the ability to facilitate glucose and cholesterol metabolism. The serum biochemical profile revealed that the serum concentration of the urea decreased averagely across the level of feed restriction (i.e from 0% to 45%). This may be attributed to the ability of the enzyme to metabolize urea to uric acid. The findings of these results are in partial agreement with Rahimi *et al.* (2015) who reported that there was no difference in blood metabolic contents in term of glucose, total protein, albumin, globulin, uric acid and triglycerides between broilers raised under normal feeding programme and those on quantitative restricted feeding. However, the findings are in agreement with other authors who reported that there was increase in glucose concentration in broilers that were deprived for 4 hours per day from 1 to 21 days (Zhan *et al.* 2007) and from 7 to 21 days (Onbasilar *et al.* 2009). It also agreed with the findings of Demir *et al.* (2004) who reported that feed restriction caused an increase in the total cholesterol content in the blood compared to the broilers that were fed *ad-libitum*. The decreasing level of AST obtained in this study was at variance with Jang *et al.* (2009) who found higher AST content in the plasma of 35days old broiler that were fed 70% and 85% *ad-libitum* intake between 8 and 14 days of age and Rajman *et al.* (2006) who observed no differences in AST content in blood at 44days of age due to feed restriction from 16 days of age onwards.

From the study, feed restriction and enzyme supplementation which showed significant effect on packed cell volume (PCV) and haemoglobin with 45% feed restriction with enzyme supplementation having the highest values but within the normal range of 24.90 – 40.70% for PCV and 7-13g/dl for haemoglobin. This result is in agreement with Merck (1979) who described PCV as a simple screening test for anaemia and the quickest direct way of assessing the values of RBC in circulation. The study also agreed with Iheukwumere *et al.* (2002) who reported similar values for birds fed restricted diet. The RBC concentration among the various treatments which showed no significant difference amongst the groups indicated that oxygen dissolved food carrying characteristics of the red blood cells was unaltered by feed restriction and enzyme supplementation, implying that RBC was still able to perform haematological functions even with the severity of feed restrictions. The haemoglobin (Hb) values for all treatments increased significantly and were however within the normal range of 6.0 – 13.0g/dl for broilers (Aiello and Mays, 1998; Okuedo, 2003).

The white blood cells showed no significant difference among the various treatment with 45% feed restriction and enzyme supplementation being the lowest. The result was however within the range of 1.2 to 3.0 x10⁴ul reported by Jain (1993). Simaraks *et al.* (2004) and Iheukwumere *et al.* (2006) suggested that within the specified range blood cells perform their phagocytic and immune function without the occurrence of infection or inflammation. The values for lymphocytes and granulocytes for both the control and feed restricted birds followed similar trend with 30% *ad-libitum* feed restriction having significantly (P<0.05) lower value but were within the reference values of 47.20 to 85.00% and 0.06 to 6.20% respectively for healthy broiler

chicken as stated by (Riddell, 2011), an indication that they were well fitted within the normal range of blood for the normal healthy broiler chickens however, Jain (1993) and Islam *et al.* (2004) reported lymphocytes range of 45.0 to 70.0% and 70.4 to 72.1% respectively as normal range of lymphocytes for chickens. Lymphocytes were the most numerous and frequent WBC type followed by monocytes and granulocytes. Bounous *et al.* (2000) observed the same trend and describe the lymphocytes as the most numerous WBC in chickens. The normal values recorded in this study implied that the birds lymphocytes were able to secrete antibodies which helped to bind the foreign microorganisms in the body tissues and mediated their destruction (Britannica, 2013) while the monocytes are usually effective in the direct destruction of pathogens and clean-up of cellular debris from sites of infection.

CONCLUSION AND RECOMMENDATIONS

The study concluded that with the use of exogenous enzyme (Maxigrain) at 0.5g/kg of feed, broiler starter chicks feeding can be restricted for up to 30% of *ad-libitum* feeding without any detrimental effect on performance, haematological and biochemical parameters. However for the best body weight gain, 15% *ad-libitum* feeding is recommended.

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