Carcass Characteristics and Gut Histomorphology of Marshall Broilers Fed Maxigrain Supplemented Diets

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Abstract

One hundred and forty four day-old Marshall Chicks were randomly assigned to six dietary treatments to assess the influence of a cocktail enzyme (maxigrain) on the carcass characteristics, visceral organ weights and gut morphology of Marshall Broilers. Completely randomised design was used for the study consisting six diets. Diet 1 was the control diet without enzyme, Diet 2; control diet with 0.1% Maxigrain inclusion, Diet 3; 5% energy reduction without enzyme, Diet 4; 5% energy reduction with 0.1% Maxigrain, Diet 5; 5% protein reduction without enzyme and Diet 6; 5% protein reduction with 0.1% Maxigrain. Diets were replicated four times with each replicate having 6 birds. Completely Radomised Design was used while the level of significance employed was $p \leq 0.05$ Results indicates that carcass characteristics observed show that only drumsticks were significantly influenced by enzyme supplementation ($p<0.05$). Gizzard, (3.80g) spleen (0.20g) and abdominal fat (1.60g)were also significantly affected by Maxigrain supplementation. Values obtained for gut morphological assessment of the ileum and jejunum showed significant improvements ($P<0.05$) in the crypt depth, 130.30μm, 136.26μm villus height 1111.80μm, 1426.90μm and villus to crypt ratio 12.82, 13.35 respectively, as a result of Maxigrain supplementation.

Keywords: Gut morphology, Marshall Broilers and Maxigrain

INTRODUCTION

Consumer preference for tender and white meat containing low contents of fat and cholesterol seems to act as catalyst engendering increased broiler production not only at festive periods but all the year round. However, dietary protein and energy provision is an expensive part of diet formulation and recently attempts have been made to reduce dietary protein and energy without a decline in broiler performance. The two main nutrients required are energy and protein, in which energy is required for growth, egg production, vital activities and body temperature maintenance which are provided from carbohydrate, lipids and protein metabolism and protein utilization is based on diet's amino acids and biological usability of them (Leeson and Summers, 2001).

The use of exogenous enzyme as a cost effective means of improving feed efficiency, poultry performance and environmental quality is already relatively commonplace. The efficacy of exogenous enzymes however depends on several factors such as the chemical characteristics of the ingredient and diet being evaluated, the microbial population in the gut (and consequently, the age of the bird), the characteristics and amounts of the enzymes used (Sarmiento-Franco *et al.*, 2003), feeding regimes and feed processing methods, and dietary nutrition levels. To be fully functional in the digestive tract, exogenous enzymes should be resistant to attack of protease in the small intestine and able to exhibit catalytic activity in the pH range 6 to 8 (Wang and Hsu, 2006).

There is however a mixed consensus on the form in which enzymes are produced either as mono-component enzymes or multi-enzymes and their efficacy in not only reducing the effects of non-starch polysaccharide, but also improving the utilization of nutrients by the animal. Thus the objective of this study was to evaluate a multi-enzyme (maxigrain) on the carcass characteristics and gut histo-morphological assessment of broilers.

MATERIALS AND METHODS

Experimental site

The study was carried out at the poultry Unit of the Teaching and Research farm, University of Ibadan, Nigeria. The experimental pens were

thoroughly cleaned, washed and disinfected. The condition of housing and management of birds were the same in all groups.

Management of birds

One hundred and forty four (144) day-old Marshall Broiler chicks were purchased from a commercial hatchery in Ibadan and randomly allotted to six (6) dietary treatments in a completely randomized design with each treatment having four replicates and six (6) birds each. Each replicate was housed in a pen fitted with all drinking and feeding facilities. Feed and water were provided *ad libitum* and all required medications and management practices were adhered to as recommended by the breeder. The experiment covered a period of seven weeks.

Experimental diets

Six experimental diets were formulated, with a cocktail enzyme (maxigrain) incorporated into the diet at the rate of 100g/tonne of feed for both starter and finisher diets. The diets are Diet 1 (control diet without enzyme), Diet 2 (basal diet with 0.1% maxigrain inclusion), Diet 3 (5% energy reduction without enzyme), Diet 4 (5% energy reduction with 0.1% Maxigrain), Diet 5 (5% protein reduction without enzyme) and Diet 6 (5% protein reduction with 0.1% Maxigrain).

Carcass evaluation

At the end of the eighth weeks of the feeding trial, one bird from each replicate was randomly selected and weighed. The selected birds were fasted overnight and slaughtered by severing the jugular vein for carcass evaluation. The live weight and the relative weights of different cut parts as well as the visceral organs were recorded.

Gut-histomorphology

Examinations of intestinal morphology were carried out according to the method of Iji*et al.* (2001). Intestine samples from each section were fixed in 10% buffered formalin until they were analyzed. Each segment was embedded in paraffin. A 5-µm section of each sample was placed onto a glass slide and stained with alcian blue/haematoxylin and eosin for examination with a light microscope. Villus height and crypt depth were measured at 100×magnification using computer software (Sigma Scan, Jandel Scientific, San Rafael, CA, USA), and then the ratio of villus height to crypt depth was calculated.

Proximate analysis

Samples of the feed ingredient were taken and proximate analysis carried out according to the methods of A.O.A.C (1990). This analysis was carried out to determine the nutrient composition (crude protein, ether extract, dry matter, crude fibre and ash) of the diets in order to permit usage for poultry rations formulations.

Statistical analysis

Data generated were statistically analysed using Analysis of Variance (ANOVA) tool Significant means were separated at $p<0.05$ using Duncan Multiple Range Test.

RESULTS

Carcass and visceral organ weights

A summary of the different parts of broiler carcass and organ weights expressed as percentages of live weight are presented in table 1. The dressed weight and all other carcass parts expressed as percentage live weight, revealed there were no significant ($p>0.05$) differences between the diets except for the drumstick weights which was significantly influenced by enzyme supplementation ($p<0.05$), with diet 2 (control/0.1% enzyme) having the lowest value (10.16 % of Live weight, LW) while the highest weight (12.29 % LW) was on diet 3 (5% energy reduction/no enzyme). Organ weights (Table 2) also showed that only gizzard, spleen and abdominal fat were significantly affected ($p<0.05$) by the treatments. Diet 6 (5% protein reduction/0.1% enzyme) produced the lowest spleen weight (0.10% LW), while weights for gizzard and abdominal fat were the highest on the same diet.

Table 1: Carcass characteristics of broilers fed maxigrain supplemented diets treatments (% Live Weight)

Parameter	1	2	3	4	5	6	SEM
Dressed weight	70.30	65.52	66.18	68.19	67.81	66.96	0.81
Thigh	10.89	10.14	10.60	10.33	11.08	10.22	0.18
Drumstick	10.76^{ab}	10.16^{b}	12.29^{a}	10.28^{b}	10.94^{ab}	10.51^{ab}	0.30
Breast	16.80	15.04	16.31	16.62	15.93	16.59	0.41
Back	14.40	14.16	13.54	13.2	13.67	14.57	0.40
Wing	7.19	8.81	9.12	9.27	9.14	9.18	0.22
Head	3.13	2.43	3.26	2.61	2.71	2.90	0.12
Neck	5.57	5.74	6.40	4.95	5.44	5.94	0.36
Shank	5.22	4.28	5.45	5.10	5.10	5.04	0.22

[a,b] – means with different superscripts within the same row are significantly different
1 - Control diet without enzyme 4 - 5% energy reduction with 0.1% maxigrain
2 – Control diet with 0.1% maxigrain 5 - 5% protein reduction without enzyme
3 - 5% energy reduction without enzyme6 - 5% protein reduction with 0.1% maxigrain

Table 2: Visceral organ weights of broilers fed maxigrain supplemented diets treatments (% of live weight)

Parameter	1	2	3	4	5	6	SEM
Heart	0.53	0.55	0.47	0.55	0.47	0.55	0.02
Spleen	0.15^{ab}	0.20^{a}	0.12^{ab}	0.15^{ab}	0.14^{ab}	0.10^{b}	0.01
Liver	2.42	2.48	2.14	2.50	2.40	2.43	0.09
Gizzard	3.15^{b}	3.40^{ab}	3.03^{b}	3.80^{a}	2.92^{b}	3.42^{ab}	0.10
Pancreas	0.27	0.26	0.25	0.25	0.28	0.24	0.02
Kidney	0.70	0.79	0.74	0.72	0.63	0.58	0.04
Lungs	0.56	0.55	0.48	0.52	0.50	0.56	0.02
Abdominal fat	1.39^{a}	1.54^{a}	0.18^{b}	1.20^{a}	1.60^{a}	1.81^{a}	0.14

[a,b] – means with different superscripts within the same row are significantly different
1 - Control diet without enzyme 4 - 5% energy reduction with 0.1% maxigrain
2 – Control diet with 0.1% maxigrain 5 - 5% protein reduction without enzyme
3 - 5% energy reduction without enzyme6 - 5% protein reduction with 0.1% maxigrain

Gut-histomorphological measurements

Results of the histomorpholigical measurements of the ileum presented in Table 3 showed that the crypt depth, villus height and villus:crypt ratio were significantly affected by enzyme supplementation ($p<0.05$). Values for crypt depth were highest on diet 6 and lowest on diet 4. Inversely villus height was highest on diet 4 and lowest on diet 6. This trend was also observed for the villus:crypt ratio ($p<0.05$), which was highest on diet 4 and lowest on diet 6. Also morphological measurements for the jejunum presented in Table 3 showed that crypt depth and villus height were significantly influenced by the diets ($p<0.05$), villus:crypt ratio was however not influenced by the treatment diets ($p>0.05$).

Table 3: Gut histomorphology of broilers fed maxigrain supplemented diets treatments (µm)

Parameter	1	2	3	4	5	6	SEM
Ileum							
crypt depth	124.49^{a}	110.80^{ab}	115.23^{ab}	80.40^{b}	92.37^{ab}	130.30^{a}	6.44
villus height	865.00^{ab}	910.80^{ab}	1007.90^{ab}	1111.80^{a}	1014.50^{ab}	791.90^{b}	38.67
v/c ratio	8.03^{ab}	8.54^{ab}	9.01^{ab}	12.82^{a}	8.97^{ab}	6.83^{b}	0.76
Jejunum							
crypt depth	136.26^{a}	93.79^{c}	129.0^{a}	128.55^{a}	111.80^{b}	107.71^{bc}	2.64
villus height	1415.43^{a}	1102.65^{c}	1426.90^{a}	1246.37^{b}	986.72^{d}	1344.91^{ab}	20.05
v/c ratio	11.44	10.90	13.35	10.67	8.93	11.68	0.75

[a,b] – means with different superscripts within the same row are significantly different
1 - Control diet without enzyme 4 - 5% energy reduction with 0.1% maxigrain
2 – Control diet with 0.1% maxigrain 5 - 5% protein reduction without enzyme
3 - 5% energy reduction without enzyme6 - 5% protein reduction with 0.1% maxigrain

DISCUSSION

Numerous studies of exogenous enzyme supplementation in broiler diets have been conducted and improvements of the performance of broiler chicks and nutrient availability have been well documented. Supplementation with enzyme can help to eliminate the effects of anti-nutritional factors and improve the utilization of dietary energy and amino acids resulting in improved performance of chicks (Fuente *et al.*, 1995; Cowan *et al.*, 1996; Yu et al., 2007).

Positive growth performance response has been recorded in some studies when corn based diets were supplemented with enzymes, either multiple enzymes which contained xylanase, protease and amylase or single protease enzyme (Zanelle *et al.*, 1999; Ghazi *et al.*, 2002; Yu *et al.*, 2007). Results for carcass cuts measured revealed that altering the energy or protein levels and or maxigrain supplementation had no effect on cut weights. However it was observed that drumstick weights were significantly lower when maxigrain

was supplemented in the control and 5% energy reduced diets compared with to negative energy control diet. While this could not be explained, it could be that muscle deposition was diverted to other parts of the carcass, even though no trend was observed for other carcass cuts. Also there could be a correlation between the thigh weights and dressed weight; which could be inferred from the observation that the lowest numerical value for dressed weight was on the un-supplemented negative energy control. Work done by Panda *et al.* (2012) showed that there was no significant difference in the carcass characteristics among dietary groups except the abdominal fat content. This was also in agreement with Meng*et et al.* (2000), Slominsk*et al.* (2006), Jia *et al.* (2008), who reported that multi-carbohydrase enzymes improved fat digestibility and apparent metabolisable energy contents of diets containing oil seeds. Though Panda *et al.* (2013) reported a low abdominal fat content in low AME (apparent metabolisable energy) diet supplemented with multi-carbohydrase enzyme.

It was observed that visceral organ weights were numerically lower on the un-supplemented diets and this was significantly reflected for the gizzard, spleen and abdominal fat. In general, enzyme supplementation increased the relative size of digestive organs which was in agreement with Hajati*et al.*(2009), who observed higher organ weights when feeding diets supplemented with enzymes.

Gut histomorphological measurement showed that the villi height values for ileum were significant influenced ($p<0.05$) by enzyme supplementation; this improvement may be due to the degrading effect of the enzyme on possible NSPs (non-starch polysaccharides) present, which ensure there is low amount of substrate available for bacterial growth especially in the distal part of the intestine. This was in agreement with the findings of Oliveira *et al.* (2008) who reported that enzyme based diets caused a higher effect upon the perimeter area and villi height of ileal mucosa as a result of their ability to quantitatively lower the substrate available for bacterial growth. Alternatively, villi height values for jejunum were significantly reduced ($p>0.05$) on diets without enzyme supplementation compared with treatment with enzyme.

The crypt depth values of the treatment with enzyme supplementation at both the ileum and jejunum section were observed to decrease significantly ($p<0.05$) when compared to the diets without enzyme except on the reduced protein diet (Diet 5).This agreed with Wu *et al.* (2004) which stated the addition of xylanase in wheat based broiler diet decrease crypt depth in the jejunum and ileum. However, the consistent reduction in the crypt was compensated for by the increase in villi height. Tiago *et al.* (2012) observed that the crypt is responsible for the production of enterocytes which will compose the intestinal villi and their depth reflects the degree of exigency of the synthesis of these cells. It was also stressed that the more the crypt is demanded in terms of cell renewal, the greater the depth. It could be opined that the lower the crypt depth values observed in the enzyme supplemented diets was a result of the enzyme being able to liberate more nutrients through degradation of NSP (non-starch polysaccharides) present in the feed. Though the villus: crypt ratio was significantly influence enzyme supplementation, at the jejunum there was no significant effect of diet on values. The villus crypt ratio is known to affect the overall performance of broilers and is an indicator of good intestinal health (Tiago *et al.*, 2012).

CONCLUSION

This study has demonstrated the influence of enzyme (maxigrain) inclusion on the carcass and gut histomorphology of broiler chicken. Maxigrain enzyme was effective in releasing sufficient nutrients to meet the requirement of the birds, while at the same time influencing carcass and organ weights. Also enzyme supplementation was observed to significantly influence crypt depth, increase villus height and ratio of villus height to crypt depth at the ileum and the jejunum. Improvement in performance could be attributed to increase in the area of absorption of nutrients in the small intestine as also the improvement in the small intestine morphology adapted to the increase nutrients in the small intestine. Maxigrain a multi-enzyme supplementation helped in the elimination of anti-nutritional factors and as well improve nutrient utilization.

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