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Effect of feed restriction and enzyme supplementation on performance, carcass characteristics and cost benefit of marshal broiler chickens

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Abstract

The overall cost of broiler production mostly depends on the cost of feed, and this is so exorbitant as to threaten the sustainability of the enterprise. It is therefore necessary to identify means of reducing cost to increase the farmer's income. Likewise the production of lean carcass for consumer's wellbeing is paramount in broiler production. This study was conducted to investigate the effect of feed restriction with or without enzyme supplementation on performance, carcass characteristics, and cost benefit of broiler chickens for a period of fifty-six days. Three hundred, one day-old Marshal Broiler chicks were used in a 3×2 factorial experimental layout to test the effect of feed restriction (FR) at 0, 15, and 30% of ad libitum feeding with two levels of enzyme supplementation (ES) at 0 and 1000ppm. Data were collected on feed intake, weight gain, feed: gain ratio, mortality, carcass characteristics and cost benefit ratio. Data obtained were subjected to one way analysis of variance and significant mean separated. ES however improved the value obtained for these performance indices. Level of feed restriction had significant effect (P<0.05) on live weight, with (2115g) for bird on 0% level of restriction, followed by (2066g) for 15% and (1880g) for 30% level of feed restriction respectively. Likewise, the abdominal fat reduces as the level of restriction increases. Hence, enzyme supplemented diet performed better than those chickens without enzyme inclusion in their diet. In conclusion, the trials showed that as the level of feed restriction increases, feed cost /kg reduced and abdominal fat was reduced while enzyme supplementation enhanced feed utilization and improved the performance of the broilers subjected to feed restriction.

Keywords: Feed restriction, Marshal Broiler *Maxigrain®,* Final weight, Feed: gain

Effet de la restriction alimentaire et de la supplémentation en enzymes sur les performances, les caractéristiques de la carcasse et les coûts-avantages des poulets de chair Marshal

Résumé

Le coût global de la production de poulets de chair dépend principalement du coût de l'alimentation, et cela est si exorbitant qu'il menace la durabilité de l'entreprise. Il est donc nécessaire d'identifier des moyens de réduire les coûts pour augmenter le revenu de l'agriculteur. De même, la production de carcasses maigres pour le bien-être du consommateur est primordiale dans la production de poulets de chair. Cette étude a été menée pour étudier l'effet de la restriction alimentaire avec ou sans supplémentation enzymatique sur les performances, les caractéristiques de la carcasse et les coûts-avantages

des poulets à griller pendant une période de cinquante-six jours. Trois cents poussins Marshal Broiler d'un jour ont été utilisés dans une configuration expérimentale factorielle 3 × 2 pour tester l'effet de la restriction alimentaire (RA) à 0, 15 et 30 % de l'alimentation ad libitum avec deux niveaux de supplémentation enzymatique (SE) à 0 et 1000 ppm. Des données ont été recueillies sur la prise alimentaire, le gain de poids, le rapport alimentation/gain, la mortalité, les caractéristiques de la carcasse et le rapport coût-bénéfice. Les données obtenues ont été soumises à une analyse unidirectionnelle de la variance et une moyenne significative séparée. SE a cependant amélioré la valeur obtenue pour ces indices de performance. Le niveau de restriction alimentaire a eu un effet significatif (P<0,05) sur le poids vif, avec (2115g) pour l'oiseau un niveau de restriction de 0%, suivi de (2066g) pour 15% et (1880g) pour un niveau de restriction alimentaire de 30% respectivement. De même, la graisse abdominale diminue à mesure que le niveau de restriction augmente. Par conséquent, l'alimentation enrichie en enzymes a donné de meilleurs résultats que les poulets sans inclusion d'enzymes dans leur alimentation. En conclusion, les essais ont montré qu'à mesure que le niveau de restriction alimentaire augmente, le coût de l'alimentation/kg diminue et la graisse abdominale diminue tandis que la supplémentation en enzymes améliore l'utilisation des aliments et améliore les performances des poulets soumis à une restriction alimentaire.

Mots clés : Restriction alimentaire, Marshal Broiler Maxigrain®, Poids final, Alimentation : gain

Introduction

Feed constitutes about 60-70% of production cost. Any reduction in feed consumption will reduce the cost of production, and directly increase the profit margin (Oluyemi and Roberts, 2000). Feed restriction, which is denying birds, particularly the fast growing broilers, a full access to nutrients that are required for their normal growth and development, is categorized into quantitative and qualitative feed restrictions. In a quantitative feed restriction, birds are physically denied access to the feed, while in qualitative feed restriction birds are denied full access to certain nutrients through the provision of feed diluted mainly with inert fibers (Hocking *et al*., 2002ab; Giachetto *et al*., 2003; Leeson and Summers, 2005). Nutrient restriction is usually employed to tackle problems that accompany early-life fast growth rate in broilers, such as increased body fat deposition, high incidence of metabolic disorders, increased mortality, and high incidences of skeletal diseases (Saleh and Shariatmadari 2007; Rezaei *et al*., 2006). Feed restriction can be used during rearing to control mature body weight and reduce feed costs. There is potential for reducing maintenance costs even further through the manipulation of the bird's growth curve. A period of slow growth, followed by compensation to regular market weight, reduces production costs as well as improves feed efficiency (Tumova *et al.,* 2002). Feeding strategies in growing broiler chickens should be aimed at optimizing lean carcass meat, feed conversion ratio (FCR) and body weight gain (Teimouri *et al*., 2005). Feed enzymes have an important role to play in current farming system. They can increase the digestibility of nutrient leading to greater efficiency in the production of animal products such as meat and eggs. Poultry do not produce enzymes like cellulase, hemicellulase, xylanase and B-glucanase which are required for the digestion of cell wall component of plant material. About 85-90% of poultry feed consists of plant materials which contain large amount of dietary fibers. The nutritional strategy involving the use of commercial feed enzymes offer the potential to overcome the

problems. Also, during feed restriction the bird may not get enough nutrient and even the little available may not be properly utilized hence the use of enzymes supplemented diet, make the available diet to be better utilized (Wang *et al.*, 2005).

Materials and methods

This experiment was carried out at the poultry unit of Directorate of University farm, Federal University of Agriculture, Ogun State, Nigeria. The area is located on Latitude 7^{o} 10 N and Longitude 3^{o} 2 E. It receives a mean precipitation of 1037mm per annum an average temperature of 34.7^{0}C and an average relative humidity of 82% throughout the year. (Google Earth, 2014)

Enzyme profile

The enzyme that was used for this experiment was Maxigrain® containing Cellulase, 10000 1U, Beta-glucanase 200 IU, xylanase 1000iU, and phytase 2500 FTU marketed by Animal Care Consult Nig. Ltd.

Experimental birds and management

Three hundred, Marshall day-old broiler chicks were acquired from a reputable hatchery in Abeokuta for this experiment. The birds were randomly distributed into six treatments with five replicates of 10 birds each. Experimental treatment consisted of three levels of quantitative feed restriction (0, 15 and 30 % of *ad libitum* feeding), with two levels of enzyme supplementation (0,1000ppm). A 23.35% crude protein experimental diet was formulated (Table1). Birds were subjected to two weeks of feed restriction followed by realimentation for another two weeks at the starter phase and this was replicated at the finisher phase**.** Prior to the arrival of the birds the poultry house was thoroughly cleaned and disinfected. The feeder and drinkers were washed. Water was made available to the bird *ad libitum*. On arrival, the birds were given water containing antistress and antibiotics (Keproceryl®) for five days. The brooding was done with kerosene stove and charcoal pot. The birds were reared on deep litter in pens measuring 3mx3m for each replicate. This trial lasted for eight weeks. The routine vaccination and medication regime for broilers were strictly adhered to.

Chemical analysis

The proximate analysis of the diets samples were determined according to AOAC (2000).

Experimental design

Data were subjected to analysis of variance (ANOVA) in 3 X 2 factorial arrangements within a completely randomized design. Significant ($P<0.05$) differences among variables were separated using Duncan's Multiple Range Test (SAS, 2001). The birds were subjected to six treatment groups consisting of three level of quantitative feed restriction (0, 15 and 30% of *ad libitum* feeding), respectively with two levels of enzyme supplementation (-, +) at dosage 0 and 1000ppm of feed. The quantity of feed/week that was supplied for the control (ad *libitum*) was determined using the guide given by Aduku (2004)that a broiler chick required 15g feed per day in the first week, 33g in the second week, 56 g in the third week, 76g in the fourth week 93g in the fifth week, 114g in the sixth week, 133g in the seventh week, and 151g in the eighth week.

Carcass characteristics

At 56th day of age, two birds in each replicate were selected on the basis of closeness to the replicate mean, weighed, tagged and deprived of feed overnight. The birds were selected on the basis of closeness to the replicate mean weight, deprived of feed overnight and slaughtered by slitting the throat.Complete bleeding was ensured and feathers removed. The carcasses were weighed after removing heads, shanks and viscera to determine the percentage of carcass weight. The viscera (heart, liver, empty gizzard, and abdominal fat) were also weighed and percentage to live body weights calculated.

Table 1: Percentage composition of broiler starter and finisher diets

Ingredient	Composition (%) Without Enzyme		Composition (%) With Enzyme	
	Starter	Finisher	Starter	Finisher
Maize	50.00	55.00	50.00	55.00
Soybean meal	21.00	30.00	21.00	30.00
Wheat offal	12.00	5.00	12.00	5.00
Groundnut cake	10.00	3.80	10.00	3.80
Fish meal (72% CP)	2.00	1.00	2.00	1.00
Bone meal	2.50	2.50	2.50	2.50
Oyster shell	1.50	2.00	1.50 .	2.00
*Vitamin and Mineral premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.1	0.25	0.1
Methionine	0.25	0.1	0.25	0.1
Salt (NaCl)	0.25	0.25	0.25	0.25
Enzyme (ppm)	-	-	+	+
TOTAL	100.00	100.00	100.00	100.00
Calculated Analysis				
Crude protein (%)	23.35	21.25	23.35	21.25
Crude fiber (%)	3.40	4.20	3.40	4.20
Ether extracts (%)	3.32	2.21	3.32	2.21
Cal (%)	1.32	1.95	1.32	1.95
P (%)	0.71	0.70	0.71	0.71
ME (Kcal/kg)	2822.38	2921.12	2822.38	2921.38
Determined Analysis (%)				
Dry matter	89.63	88.92	90.93	88.92
Crude protein	22.94	19.07	23.30	19.07
Crude fiber	3.84	3.52	3.72	3.52
Ether extract	3.56	3.47	3.63	3.47
Ash	5.20	5.56	5.62	5.56

**Premix composition per kg diet: Vit A: 4000001U, Vit D: 80000IU, Vit E: 40000ng, Vit K $_3$: 800mg, Vit B $_1$: 1000MG, Vit B $_2$: 6000mg, Vit B $_6$: 500mg, Vit B $_{12}$: 12.25mg, Niacin: 6000mg, Panthothenic acid: 2000mg, Folic acid: 200mg, Biotin: 8mg, Manganese:300000mg, Iron: 8 000mg, Zinc: 20000mg, Cobalt: 80mg, Iodine: 400mg, Selenium: 40mg, Choline:800000mg*

* *Enzyme 1000ppm*

Results and discussion

The nutrient content of the experimental diet was within the recommended nutrient requirement of broilers. In this study, after feed restriction of two weeks, the restricted birds had a significance lower body weight than the birds on *ad libitum* and this continues throughout the trial, more so the bird on enzyme supplemented diet had a better body weight gain compared than diet without enzyme. Also, the results indicated that the growth of broiler chicken is related to the feed intake supporting the evidence that the body weight gain of broiler chicken could be restricted by feed restriction (Summers *et al.,* 1990). Following feed restriction, the restricted bird had significance lower body weight than the birds on (*ad libitum)*. Body weight and the feed intake at the end of the experiment were progressively reduced by each level of feed restriction. Feed: gain ratio was superior for birds subjected to 30% level of feed restriction compared to the birds on *ad libitum* as reported by Zubair and Lesson (1994) and Camacho *et al.*(2004).

The result of these studies showed that the entire enzyme supplemented groups recorded a better feed efficiency than the diet that had no enzyme, best feed: gain was observed at 30% level of restriction compared to other diets, these was similar to the report of Hajati (2010).

Moreover, the result of the cost benefit of Marshall Broiler chicken shows that as the duration of feed restriction increased, feed cost /kg reduced. Birds restricted at 30% level of feed restriction had the smallest production cost of **N**697.03 followed by 15% level of feed restriction and subsequently,**N** 835.25 respectively as at the period of research of this study.

Table 2:Main effect of feed restriction and enzyme supplementation on performance characteristics and cost benefit of marshal broiler at finisher phase (0-8 weeks of age)

	Level of feed Restriction (%)			SEM	Enzyme supplementation		SEM
	0	15	30		-	+	
Parameters							
Initial weight(g)	43.00	43.19	42.78	0.96	43.11	43.16	0.50
Final weight (g)	2090.40[a]	1956.00[b]	1900.00[c]	89.32	1948.90[b]	2015.30[a]	72.90
Total weight gain (g)	2047.4[a]	1912.51[b]	1857.22[c]	89.36	1905.68[b]	1972.58[a]	72.80
Daily weight gain g/bird	36.57[a]	34.15[b]	33.16[c]	1.58	34.03[b]	35.22[a]	2.32
Total feed intake(g)	4290.23[a]	3646.50[b]	3000.43[c]	44.26	3648.39	3643.02	60.70
Daily feed intake (g)	76.61[a]	65.12[b]	53.58[c]	0.78	65.14	65.05	1.14
Feed: gain	2.09[a]	1.91[b]	1.62[c]	0.08	1.97[b]	1.85[a]	0.06
Mortality	0.04	0.04	0.06	0.00	0.08	0.08	0.00
Total feed cost / bird	568.25[a]	501.50[b]	430.03[c]	3.12	500.56	499.30	9.30
Total cost / bird	835.25	768.56[b]	697.03[c]	7.33	765.57	768.32	12.00
Cost efficiency	1749.98[a]	1463.50[b]	1108.26[c]	35.33	1495.12	1495.00	79.00

[a, b, c,] mean in the same roll not sharing comm on superscript are significantly different ($p<0.05$) SEM: Standard error mean

Level of feed restriction had significant ($P<0.05$) effect on live weight, with 2115gfor bird on 0% level restriction, followed by 2066g for 15% and 1880g for 30% level feed restriction. There was decrease in weight across the restriction and this became more with increasing severity of feed restriction. The main effect of enzyme supplementation had significant ($p< 0.05$) effect on live weight, abdominal fat and breast weight of the retail cut part as those on enzyme supplemented diet performed better than those chickens without enzyme inclusion in their diet. In this study, carcass characteristics were affected by feed restriction as weight of breast was significantly ($P<0.05$) different. Similarly, level of feed restriction had significant effect on the abdominal fat part; which decreased as the level of feed restriction increased. Planvnik and Harwortz (1983) reported a decrease in fat pad, with lower body weight gain in relation to the (ad *libitum)* birds.

Also, Pinchasov and Jensen (1989) reported carcass analysis that abdominal fat decreases as feed restriction increases.

Table 3: Interaction of feed restriction level and enzyme supplementation on performance of marshal broiler chicken at week (08 weeks)

Level of feed restriction	0		15		30		SEM
	With and without enzyme						
Enzyme supplementation	-	+	-	+	-	+	
Parameter							
Initial weight (g)	43.00	43.00	43.00	43.30	43.10	43.00	
Final weight(g)	2060.80^{ab}	2120.00^{a}	1908.00^{c}	2004.00^{b}	1878.00^{dc}	1922.00^{b}	179.29
Total weight gain(g)	2017.00^{ab}	2077.80^{a}	1864.46^{c}	1961.00^{b}	1834.98^{d}	1878.98^{c}	179.22
Daily weight gain(g/d)	36.03^{ab}	37.09^{a}	33.29^{c}	35.02^{b}	32.77^{d}	33.55^{c}	3.16
Total feed intake(g)	4298.24^{a}	4282.22^{a}	3644.00^{b}	3648.92^{b}	3002.93^{c}	2997.93^{c}	84.68
Daily feed intake(g)	76.75^{b}	76.47^{a}	65.07^{b}	65.15^{b}	53.62^{c}	53.50^{c}	14.97
Feed: gain	2.13^{a}	2.06^{ab}	1.95^{b}	1.86^{bc}	1.59^{c}	1.59^{c}	0.187
Protein efficiency ratio	2.50^{ab}	2.52^{a}	2.34^{bc}	2.37^{bc}	2.42^{b}	2.57^{a}	0.21
Mortality (%)	0.01	0.03	0.01	0.03	0.06	0.00	0.00
Total feed cost/bird	569.40^{a}	567.01^{a}	501.83^{b}	501.30^{b}	430.56^{c}	429.50^{c}	9.25
Total cost /bird (₦)	834.44^{a}	836.10^{a}	766.83^{b}	770.30^{b}	695.56^{c}	698.50^{c}	75.00

^{a,b,c}: means in the same row not sharing common superscript are significantly different ($p<0.05$)
SEM: Standard error mean

Table 4: Main Effect of feed restriction and enzyme supplementation on carcass characteristics of marshal Broiler at 8 week

	Level of feed restriction (%)				Enzyme supplementation		
Parameters	0	15	30	SEM	-	+	SEM
Live weight (g)	2115.00^{a}	2066.00^{b}	1880.00^{c}	4.25	2007^{b}	2260^{a}	3.22
Dressing %	68.50	69.70	67.00	4.25	67.22	70.52	2.37
Abdominal fat (%)	1.34^{a}	0.83^{b}	0.63^{c}	0.53	0.69^{b}	1.21^{a}	0.34
up Retail cut –parts (1)							
Breast	20.22^{a}	19.40^{b}	18.35^{c}	1.52	18.10^{ab}	19.21^{a}	0.83
Drumstick	11.00	11.00	10.91	0.83	10.92	11.04	0.45
Wing	9.23	9.19	9.04	0.52	9.21	9.10	0.53
Back	12.98	13.52	12.50	1.64	13.35	12.65	0.96
Thigh	11.86	11.21	11.11	1.27	11.14	11.64	0.45
Neck	4.68	5.36	5.15	0.53	4.49	5.22	0.33
Shank	4.75	5.01	4.62	0.49	4.76	4.82	0.26
Visceral organs (2)							
Spleen	0.15	0.14	0.11	0.03	0.12	0.15	0.02
Heart	0.46	0.48	0.45	0.05	0.46	0.47	0.03
Liver	2.25	1.89	1.99	0.54	1.97	2.12	0.31
Emptied Gizzard	2.04	2.04	2.10	0.24	2.14	1.99	0.11
Small Intestine	4.04	4.10	4.37	0.64	4.31	4.04	0.34
Large Intestine	0.37	0.36	0.36	0.15	0.39	0.37	0.08
Caeca	0.71	0.83	0.91	0.26	0.82	0.81	0.15
Lung	0.61	0.56	0.72	0.11	0.66	0.59	0.07

^{a,b,c}: means in the same row not sharing common superscript are significantly different ($p<0.05$)
SEM: Standard error mean
*1, 2, Expressed as percentages of live weight. `

Table 5: Interaction of feed restriction and enzyme supplementation on carcass characteristics of Marshall Broiler at 8 weeks

Level of feed restriction	**0**		**15**		**30**		
	With and without enzyme						
Enzyme supplementation	-	+	-	+	-	+	SEM
Live weight(g)	2030[a]	2200[b]	2003[b]	2130[c]	1870[d]	1890[d]	0.12
Dressing percentage	66.33[a]	70.58[b]	67.67[b]	71.66[a]	67.67[b]	69.33[ab]	12.61
Abdominal fat (%)	0.94[b]	1.743[a]	0.71[c]	0.94[b]	0.30[c]	0.96[b]	0.89
Retail cut – part % (1)							
Breast weight	19.94[ab]	20.19[a]	18.62[b]	20.19[a]	17.75[c]	18.94[b]	3.70
Thigh	11.59	12.12	10.89	11.52	10.95	11.27	3.10
Drumstick	10.54	11.46	11.39	10.61	10.81	11.03	1.90
Wing	9.12	9.33	8.44	8.95	9.05	9.04	1.50
Back weight	13.33	12.63	12.42	14.57	12.15	12.85	3.90
Neck weight	4.63	4.70	5.09	5.60	5.02	5.23	1.30
Shank	4.76	4.74	4.62	5.41	4.91	4.33	0.90
Visceral organs % (2)							
Dressed weights):							
Heart	0.44	0.48	0.48	0.48	0.47	0.43	0.30
Liver	2.04	2.46	2.03	1.75	1.84	2.15	0.10
Small intestine	4.09	3.98	4.48	3.72	4.35	4.40	0.90
Emptied Gizzard	2.11	1.97	2.11	1.97	2.19	2.03	0.54
Caeca	0.66	0.76	0.87	0.80	0.93	0.80	2.23
Large intestine	0.38	0.36	0.33	0.40	0.46	0.25	0.15
Caeca	0.66	0.76	0.87	0.80	0.93	0.80	2.23
Lung	0.64	0.56	0.56	0.57	0.79	0.65	0.26

[a,b,c]: means in the same row not sharing common superscript are significantly different ($p<0.05$)

SEM: Standard error mean

*1, 2, Expressed as percentages of live weight.

The report of this work is in contrast to the finding of Jones and Farell (1992), whose finding reported a large abdominal fat deposition in the carcass of restricted birds after realimentation. The author reported the result of the carcass analysis taken after refeeding, hence, this is not likely to have been if it has been done prior to refeeding. According to the finding of this study abdominal fat significant reduced as restriction increased. Moreover, the result of the interactive effect of the carcass characteristics of this study is related to the findings of Wang *et al*. (2005). Alam *et al*. (2003) and Hajati (2010). There studies reported an increased carcass yield characterised with high fat deposition and also increased in breast meat yield. However, the result of this work is in contrast to those authors that reported that carcass characteristics were not significantly improved for bird fed with enzyme supplemented diet.

Conclusion and recommendation

The study can be concluded that as feed restriction increased, feed cost/kg reduced. Hence an increase to farmers income. The study furthered revealed that as duration of feed restriction increased abdominal fat reduced while enzyme supplementation enhanced feed utilization and improved the performance of the broilers subjected to feed restriction. High cholesterol is a serious condition in human that can built up in the artery walls and cause many cardiovascular diseases, when it occurs. Therefore, chicken with low fat is therefore recommended to reduce cholesterol intake in daily diet. The amount of lean meat consumed can affect the cholesterol pool in the blood, although chicken has the same amount of cholesterol as lean red meat but with better advantage of less saturated fat and thus an effect on total dietary cholesterol of the consumer.

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