Response of finishing broiler chickens fed three energy/protein combinations at Fixed E:P ratio

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Abstract

A feeding experiment was conducted to investigate the response of finishing broiler chicken to diets containing three metabolizable energy (ME)/crude protein (CP) combinations (3203.76 ME vs 19.90 %CP, 2884.15 ME vs 18.10%CP and 2566.42 ME vs 18.10 %CP) at fixed ME:CP ratio of 160:1. A total of 126 four weeks old broiler chickens were randomly allotted to three dietary treatments replicated thrice. The final live weight, weight gain, feed intake, feed conversion and PER were generally higher in the birds fed the control diet (3203.76 ME vs 19.90 %CP). There were significant ($P < 0.05$) differences among treatments in terms of final live weight, protein intake, energy intake, CP: Gain and ME:Gain, while weight gain, feed intake, feed conversion ratio and percentage mortality were statistically the same ($P > 0.05$) across the treatments. Cost per kg feed gain decreased as the energy and the protein density of the diets decreased while the cost per kg weight gain decreased with increase in energy and protein density. The digestibility percentages showed a decreasing ($P < 0.05$) trend while nitrogen retention increased with decrease in energy-protein density of the diets. Values for the haematological parameters and blood chemistry were significantly ($P < 0.01$) higher in birds fed control diet and the values decreased with decreased levels of dietary energy and protein. The results suggest that when both energy and protein density of broiler finisher diet are reduced at fixed E:P ratio the feed intake would increase while the feed utilization efficiency decreases.

Keywords: Finishing broiler chickens, energy/protein combination, energy:protein ratio

Introduction

Scientists in Nigeria and abroad have worked on the energy and protein requirements of broiler chicken. Agricultural Research Council (ARC, 1975) and National Research Council (NRC, 1994) suggested that 3200 KCal ME per kg was adequate in the finishing broiler ration. In the tropics, Olomu (1980) estimated energy requirement of finishing broiler chicken to be 3000 kCal ME per kg of feed. Babatunde and Fetuga (1976) in their studies on protein requirement of broiler recommended CP level of not less than 18% for finishing broiler chicken.

In another study, Olomu and Offiong (1980) recommended 20% CP for finishing broiler. Fetuga (1984) in his study suggested CP of 19 – 21% for 5 – 9 weeks old broiler chickens while NRC (1994) recommended a little lower CP of 18 – 20% for finishing broiler. However, the importance of energy/protein concentration ratio in the diet of poultry particularly broiler chickens has been stressed by many workers (Boorman and Wilson, 1977; Scott *et al.*, 1982; Bondi, 1987 and Pond *et al.*, 1995). The common conclusion of the above researchers indicated that when the protein level of a diet is

decreased there is always a concomitant widening of energy/protein ratio which increased feed intake in order to overcome a protein deficiency stress, and as a result of the over consumption of energy the feed efficiency of the diet was reduced since a considerable amount of energy is required for the synthesis of uric acid.

Presently there is dearth of information on the response of broiler chickens fed diets with varying protein and energy levels while energy/protein ratio is kept constant. This study is therefore aimed at investigating the performance, nutrient utilization and cost/benefit of feeding finishing broiler chickens different combination of protein/energy density at fixed E:P ratio.

Materials and Methods

Experimental Birds and Design

A total of 126 unsexed four weeks old broiler chickens of commercial broiler strain (Ariak 2000) were randomly allotted to eighteen replicate groups of seven chickens each. Six groups were assigned to each of the three dietary treatments. The experiment was arranged in a completely randomized design with dietary protein as the only source of variation. To achieve this all rations were formulated to have approximately the same energy/protein ration. To minimize any amino acid imbalances, the proportion of maize/soybean ratio was kept constant at 1:22:1 by making up the decreasing levels of maize/soybean with rice husk (Table 1).

Table 1 *Composition of the experimental diets for finishing broiler chickens*

Ingredients(%)	Rations			
	Control D1	D2	D3	
Maize	40.00	40.00	34.00	
SB-Full fat	36.00	32.70	27.80	
Rice husk	12.33	22.51	34.39	
Palm oil	4.00	1.00	-	
Bone meal	2.50	2.50	2.50	
Oyster shell	0.50	0.50	0.50	
*Premix (Vit/Min)	0.25	0.25	0.25	
Salt (NaCl)	0.25	0.25	0.25	
Methionine	0.17	0.19	0.21	
Lysine	-	0.10	0.10	
Total	100	100	100	
<u>Determined Analysis</u>	D1	D2	D3	NRC(1994)
Crude protein %	19.90	18.10	15.90	18 - 20
Fat %	11.00	8.08	7.40	
Ash %	14.31	17.40	13.40	
Fibre %	4.78	5.13	5.60	
<u>Calculated Analysis</u>				
Energy (ME) K Cal/kg	3203.76	2884.15	2566.42	3200
Energy/Protein ratio	160.20	160.20	16.40	160
Methionine %	0.45	0.45	0.45	0.32 – 0.38
Lysine %	1.06	1.08	1.02	0.85 – 1.00
Calcium %	1.33	1.33	1.33	0.80 – 0.90
Phosphorus %	0.69	0.69	0.69	0.30 – 0.35
Cost/kg (₦)	23.69	19.56	18.18	

A vitamin/trace mineral mix Agricare-mix 8 - Pfizer for finisher broiler chicken to supply per kg feed the following Vit A (I.U) 1500; Vit D₃ (I.U) 2500; Vit E (I.U) 11; Vit B₃ (mg) 40; Vit B₆ (mg) 20; Choline Chloride (mg) 400; Mn (mg) 120; Fe (mg) 70; Cu (mg) 10; I (mg) 2.2; Zn (mg) 45; Co (mg) 0.02.

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Diet and management

The ration contained 3203.76 ME vs 19.90 %CP, 2884.15 ME vs 18.10%CP and 2566.42 ME vs 15.90 %CP respectively (Table 1). The experimental birds were reared in a standard rearing houses that were adequately ventilated. The deep litter house used provided uniformly sized pens of 3.0m x 3.0m (1.21m² per bird). The pens were equipped with standard feeding troughs and drinkers. Feed and water provided *ad libitum*. All recommended health practices were strictly observed. Weekly feed intake and body weight were measured. Other parameters were calculated from the feed intake and body weights.

Metabolic trial

Metabolic trial was carried out at 8th week of experimentation in specially designed metabolic cages equipped with separate feeders and watering troughs. For the metabolic trial, two birds were randomly selected from each of the six replicates and housed together in a compartment. The selected birds were fasted for a day and 3-day acclimatization period was allowed prior to four days faecal collection, 1% boric acid solution was sprayed on the dropping regularly to prevent escape of nitrogen. Total droppings voided from each replicate group were weighed and recorded. Wet faecal samples were oven dried at 65°C and dry matter content determined. Dried droppings from the same replicates were then thoroughly pooled and ground and analysed for crude fibre, ether extract and total nitrogen content. The analysis of faecal nitrogen for nitrogen retention and nitrogen digestibility determination was based on the extraction of uric acid from poultry excreta using uranyl acetate, thereby correcting for NPN in the droppings (Oduguwa and Ogunmodede, 1995). The protein analysis of the feed and the analysis of the feed and the analysis of droppings for nitrogen were by the methods of A.O.A.C (1990). The nitrogen (N₂) retention was calculated by the formula:

$$\% \text{ Nitrogen retention} = \frac{N_2 \text{ in feed} - N_2 \text{ in excreta}}{N_2 \text{ in feed}} \times 100$$

Also, apparent N₂ digestibility was calculated as:

$$\text{Apparent N digestibility} = \frac{N_2 \text{ intake (gDM)} - N_2 \text{ output (gDM)} \times 100}{N_2 \text{ intake (gDM)}} \quad \text{after uric acid extraction}$$

$$\text{While Dry matter digestibility} = \frac{\text{Feed intake (gDM)} - \text{Faecal output (gDM)} \times 100}{\text{Feed intake (gDM)}}$$

Blood metabolites

Blood samples were collected separately from 3 birds per replicate group in specimen bottles with and without EDTA for plasma and serum analysis respectively. Packed cell volume (PCV), Haemoglobin concentration (Hb) and red blood cell (RBC) were determined using Wintrobes microhaematocrit, colorimetry – cyanomethaemoglobin method and improved Neubauer haemocytometer, respectively. Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were computed according to Jain (1986). Serum protein, albumin, globulin were analyzed colorimetrically using diagnostic reagent kit (Reanal Diagnosztikai Reagents, Keszlet, Hungary). The creatinine was determined using Jaffe reaction described by Ojo (1995).

Data collection and analysis

Weekly records were taken on body weight and feed intake. Daily record of mortality and health problems were recorded and mortality was expressed as the percentage at the end of experiment. Daily quantity of wet droppings voided and feed intake were taken during the metabolic trials and expressed in terms of dry matter (DM). Percent digestibilities were calculated. The data generated from the study were subjected to analysis of variance and significant means separated using Duncan's Multiple Range Test as outlined by Steel and Torrie (1980) at the 0.05 level of probability.

Results and Discussion

The analysis of the diets (Table 1) was done on dry matter (DM) basis, the energy/protein ratio, methionine, lysine, calcium and phosphorus concentrations were similar across all dietary

treatments. There was variation in protein, energy and fat content. Despite the variations in the levels of maize, full-fat soyabean, rice offal and palm oil in the experimental diets, there was an excellent uniformity in the E:P ratio. As mentioned in the introduction, the widening or decline of E:P ratio that was extensively reported by Boorman and Wilson (1977); Scott *et al.*, (1982) and Pond *et al.*, (1995) were completely eliminated to arrive at fixed E:P ratio of 160:1 recommended by NRC (1994). The control diet (D1) was formulated to meet the minimum requirement of finishing broiler chicken (NRC, 1994).

Linear growth response was observed in terms of performance (Table 2). This suggested that any further reduction in energy – protein density,

at E:P ratio of 160:1 would result in poorer performance. However, birds fed diet D1 containing 19% CP and 3203.76 ME had the highest ($P<0.05$) final weight. This was a direct effect of the corresponding high intake of protein and energy which were properly utilized for growth. The weight gain for the control group (D1) was numerically higher ($P>0.05$) than that of other dietary combinations and the difference was not significant ($P>0.05$). This was because of feed intake that increased linearly to overcome energy-protein deficiency and the efficiency of feed conversion decreased proportionally. The CP:Gain and ME:Gain ratios (Table 2) buttressed ($P<0.05$) the earlier observation noted in the feed conversion efficiency.

Table 2 Performance of experimental birds at the finisher phase

Measurements	D1	D2	D3	SEM
Initial live weight (g)	467.30	467.30	457.29	21.10
Final live weight (g)	1535.17 ^a	1336.80 ^{ab}	1261.99 ^b	62.73
Weight gain (g)	1067.87	869.50	804.70	67.26
Feed intake (g)	2880.62	3072.02	3175.90	188.37
Energy intake (ME) Kcal/kg	9226.26	8860.11	8148.38	211.00
Protein intake (g)	573.24 ^a	556.04 ^a	504.96 ^c	3.22
Feed conversion ratio	2.69	3.53	3.95	0.46
ME: Gain ratio	8.64 ^a	10.19 ^b	10.13 ^c	0.19
CP: Gain ratio	0.54 ^a	0.64 ^b	0.63 ^c	0.05
PER	1.86	1.56	1.56	0.00
Mortality %	2.38	2.38	2.38	0.00

Mean on the same row having the same superscript or no superscript are not significantly different ($P>0.05$)

Table 3 Feed cost analysis

	D1	D2	D3
Cost of feed/kg (₦*)	23.16	19.56	18.18
Total cost of feed/bird (₦)	68.24	60.09	57.74
Feed cost/kg wt. Gain (₦)	63.73	69.04	57.74
Marginal cost/kg wt. Gain (₦)	0.00	6.31	8.08

*All costing were done in Naria

Efficiency of the diet was reduced even though the E:P ratio was kept fixed and the efficiency declined progressively with the increase in feed intake. The feed intake was statistically ($P>0.05$) the same across the treatments. Birds on treatments D2 and D3 consumed more feed to compensate for the dietary inadequacy, as birds

are known (Scott, *et al.*, 1982) to consume more feed to meet their nutritional needs. The overall best performance response observed in the control group (D1) could be attributed to the relatively good proximate composition of the diet (D1), low dietary fibre content as well as better digestibility (Table 4).

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Table 4 Results of Metabolic trials at Finisher Phase of broiler chicken

Parameters	D1	D2	D3	SEM
Dry Matter digestibility	77.22 ^a	71.53 ^b	68.71 ^c	0.14
Crude fibre digestibility (%)	30.04 ^a	23.64 ^b	21.94 ^b	0.20
Ether extract digestibility (%)	88.17 ^a	79.11 ^b	73.02 ^c	0.20
Nitrogen retention (%)	54.87 ^c	64.32 ^b	73.02 ^c	0.28
Apparent nitrogen digestibility (%)	87.55	86.85	87.40	0.23

Means on the same row having the same superscript are not significantly different.

The lower body weight noticed in the treatments D2 and D3 (as showed in Table 2) was in agreement with the observations of Chi (1985) who noticed delayed attainment of target weight in chickens when dietary nutrients intake was low, particularly the energy and protein density of the diet. The digestibility percentages showed a decreasing trend across the treatments while the nitrogen retention increased across the treatment. This is explainable by the bulkiness and the degree of dilution of diets with fibre sources – rice husk (Table 1). The implications of dilution of diet with a fibre-rich feedstuff have been well documented by Longe and Ogedegbe, (1989). These workers observed a proportionate decline in the percentage digestibility when chicken diets were diluted with fibrous feedstuff. The dietary inclusion (Table 1) of high amount of rice husk (22.51 – 34.39%) increased the fibre content of the resulting rations (D2 and D3) which resulted in progressive decline in the digestibility percentages (Table 4) and the overall nutrient utilization. This observation corroborate the fact

that Non-starch polysaccharide (NSP) depressed metabolizable energy (ME) and crude protein (CP) utilization hence the lower weight gain, poor feed conversion ratio noticed in treatments D2 and D3.

Values for the haematological parameters particularly the PCV, Hb, RBC and MCHV (Table 5) were significantly ($P < 0.05$) higher in birds fed control diet (3203.76 ME vs 19.9% CP) than in birds fed diets with lower energy protein density (D2 and D3) and the values decreased with decreased levels of dietary levels of energy and protein. Total blood protein, albumin and globulin values (Table 5) also showed linear relationships. The values decreased with decrease in the level of ME and CP in the diet inspite of the fact that E:P ratio were the same. Total blood protein was reported (Allison, 1955) as an indication of reduction in total protein in an animal. The gradual reduction ($P < 0.05$) in total blood protein (Table 5) indicated a decline in the efficiency of protein utilization.

Table 5 *Haematology and serum chemistry of experimental broiler chickens (8 weeks old)*

Parameters	Rations			SEM
	D1	D2	D3	
PCV (%)	33.20 ^a	31.10 ^b	29.57 ^c	0.04
Hb(g/dl)	11.06 ^a	10.27 ^b	9.71 ^c	0.05
RBC (10 ⁶ /mm ³)	3.70 ^a	3.47 ^b	3.21 ^c	0.04
MCHC (fl)	90.00 ^a	89.01 ^b	88.50 ^c	0.05
MCH (f/mg)	30.00	29.63	29.60	0.02
MCHC	34.00	33.00	32.57	0.03
Total protein (mg/dl)	85.19 ^a	80.83 ^b	77.64 ^c	0.38
Albumin (mg/dl)	57.30	48.83	46.80	0.42
Globulin (mg/dl)	33.89	32.00	30.48	0.73
Albumin/globulin ratio	1.51	1.53	1.52	0.03
Uric acid (mg/dl)	41.08 ^a	38.42 ^b	37.50 ^c	0.15
Creatinine (mg/dl)	1.94 ^a	1.88 ^b	1.73 ^c	0.01

Means within the same row with the same superscript or no superscript are not significantly different ($P>0.05$)

PCV = Packed cell volume; Hb = Haemoglobin RBC = Red blood cell; MVC = Means corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration.

This also provided a possible explanation for the observed steady decline in weight gain across the dietary treatment (Table 2). Babatunde and Pond (1981) noted that blood uric acid concentration was inversely related to efficiency of protein utilization. In this study, the blood uric acid decreased with decreased level of dietary protein levels. This suggested that there could be another source of creatinine and uric acid in the blood since the control (D1) group birds that had the highest serum creatinine and uric acid also have the heaviest body weight (Table 2). This perhaps may be due to the break down of phosphocreatine.

Treatment D3 was the poorest in the economy of production by gaining 1 kg body weight with ₦ 1.81 which was not significantly different ($P>0.05$) across the experimental treatments. The cost benefit pattern (cost of feed/kg weight gain) followed an increasing trend with decreasing energy and protein content of the diets. The successful reduction in the cost of feed per kilogram was not translated into least cost of production per kg gain and so the relatively cheaper diets D2 and D3 did not bring about efficient feed conversion that could result in the least cost of production. This result agreed with findings of Ekenyem (2002) who reported that reducing feed cost/kg was only justifiable

when production results is comparable with the standard (control). The overall response assessment showed that when both energy and protein density of broiler diets are reduced at fixed E:P ratio the feed intake would increase while the feed utilization efficiency decreases.

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