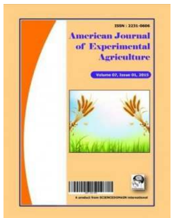

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Growth Performance, Hematology and Carcass Characteristics of Broiler Chicks Fed Diets with Varying Energy Levels

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Authors' contributions

This work was carried out in collaboration between all authors. Author OFA designed the study, wrote the protocol and wrote the first draft of the manuscript. Author GEO reviewed the experimental design and all drafts of the manuscript. Authors KOB and ATL managed the analysis of the study. Author AFF performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Three hundred and eighty-four unsexed Anak broiler chicks raised from day-old to 28 days of age were used to evaluate the effects of different dietary energy levels on their growth performance, hematology and carcass characteristics. The experiment was of a completely randomized design (CRD). The diets for the starter were isonitrogenous. There were 3 dietary energy treatments (2786.80, 3015.40 and 3252.20 kcal/kg) and 4 replicates per treatment with 32 chicks per replicate. Birds were randomly selected and slaughtered for carcass and hematological analysis. The feed intake and live weight of the birds were determined weekly. Birds fed the 3252.20 kcal/kg energy diet had the highest (P<0.05) final weight, average weight gain and total weight gain. The lowest (P<0.05) Feed Conversion Ratio (FCR) was recorded for birds fed the 3252.20 kcal/kg energy diet.

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The Packed Cell Volume (PCV), though not statistically significant, increases linearly with increase in dietary energy. Birds fed diets containing 3252.20 kcal/kg energy recorded the highest (P<0.05) abdominal fat, gizzard and eviscerated weight. The results, however, indicated that the cost of feed per unit weight gain was lowest in High energy diet followed by Optimum and Low energy diets respectively.

Keywords: Performance; hematology; broiler chicks; energy; carcass.

1. INTRODUCTION

Dietary energy-contributing ingredients are a major cost to broiler diets [1]. In addition, dietary energy represents one of the most variable components in poultry ration. This variations stems from effort to manage stress imposed on broiler chickens vis-à-vis changes in environmental temperature most especially in the tropics [2]. Also, control over energy intake is important because it affects growth rate and has potentially negative effect on carcass characteristics [3]. In Nigeria, like most other African countries, there is a quest for subsistence chicken production which depends primarily on the procurement of started chicks of 4-5 weeks old. At this age it is expected that the chicks would have been established enough to withstand management at household and peasant levels. Thus, there is a readily available market for the started chicks, hence, the need explore the optimum dietary energy that will optimize growth performance of chicks at this age for enhanced marketability.

Studies have been conducted to examine the effects of dietary energy on performance of broiler chickens [3-6] and carcass characteristics [4,7]. Some reported that increasing dietary energy significantly decrease feed intake [4] improve feed conversion [8,9,10] and decrease breast meat yield [4]. However, others have shown that there were no significant effects of varied dietary energy on feed intake, final body weight and meat yield [7]. Nutrients levels in blood and body fluids are considered to be proximate measures of longtime nutritional status [11]. [12] stated that the hematological constituents reflect the physiological responsiveness of the animal to its internal and external environments, which include feed and feeding. The present study was conducted with the aim of assessing the optimum performance, haematology and carcass characteristics of broiler chicks fed diets with varying energy levels.

2. MATERIALS AND METHODS

A total of 384 unsexed one-day-old Anak broiler chicks were obtained from a commercial hatchery and reared from 1 to 28 days of age. Three isonitrogenous diets were formulated; Low Energy Starter (LES; 2786.80 kcalME/kg, 22.47% CP), Optimum Energy Starter (OES; 3015.40 kcalME/kg, 22.45% CP) and High Energy Starter (HES; 3252 kcalME/kg, 22.42% CP). The OES diet was based on the acceptable range of Metabolizable Energy (ME) used in commercial practice and meet the ME requirements for broiler chicks [13]. The gross and proximate composition of the experimental starter diets are shown in Table 1.

After a 5-day pre-experimental period with the optimum energy, the chicks were randomly assigned to the 3 dietary treatments at 4 replicates per treatment and 32 chicks per replicate in a completely randomized design. Feed and water were provided *ad libitum*. Other routine management procedures as practiced at the experimental farm (Teaching and Research Farm, Federal University of Technology, Akure) were strictly followed. Proximate analysis of diets was carried out according to the procedure described by [14]. Feed intake and weight gain were recorded at weekly intervals during the experimental period. At the end of 4 weeks, 6 birds per replicate were randomly selected for determination of selected carcass characteristic. The chicks were also bled by the jugular vein into bottles for hematological variables using the procedure described by [15].

2.1 Statistical Analysis

Data were analyzed using the one-way ANOVA procedure of SAS software [16]. When dietary treatment was significant (P<0.05), means were compared using Duncan's multiple comparison procedure of the same statistical package.

Table 1. Ingredients and nutrient composition of experimental starter diets

Ingredients	Low energy	Optimum energy	High energy
Maize	38.00	56.00	55.00
Maize offal	15.00	-	-
Soyabean meal	12.00	14.00	14.00
Groundnut cake	14.50	14.85	17.00
Brewers dried grain	6.35	5.00	-
Fish meal	5.00	5.00	5.00
Oyster shell	0.5.0	0.50	0.50
Rice bran	5.00	-	-
Palm oil	-	1.00	4.85
Bone meal	2.50	2.50	2.50
Salt	0.50	0.50	0.50
Lysine	0.15	0.15	0.15
Methionine	0.25	0.25	0.25
Premix*	0.25	0.25	0.25
Total	100	100	100
Calculated composition			
Crude Protein%	22.47	22.45	22.42
Metabolizable Energy (Kcal/Kg)	2786.80	3015.40	3252.20
Ether Extract (%)	5.97	5.15	8.79
Crude fibre (%)	5.20	4.22	3.54
Calcium (%)	1.49	1.18	1.48
Phosphorous (%)	0.79	0.70	0.69
Lysine (%)	1.17	1.19	1.19
Methionine (%)	0.62	0.62	0.60
Energy: Protein	124.02	134.32	145.06
Proximate composition			
DM%	92.74	93.43	93.00
CP%	21.48	21.48	21.53
EE%	4.36	6.06	6.06
CF%	6.45	4.26	3.64
Ash%	8.13	8.51	8.97
NFE%	52.26	53.12	49.26

** supplied per kg of diet: Vit A, 10,000 IU; Vit D, 2,800 IU; Vit E, 35,000 IU; Vit K, 1,900 mg; Vit B12 19 mg; Riboflavin, 7,000 mg; Pyridoxine, 3,800 mg; Thiamine, 2,200 mg; D-Pantothenic acid, 11,000 mg; Nicotinic acid, 45,000 mg; Folic acid, 1,400 mg; Biotin, 113 mg; Cu, 8,000 mg; Mn, 64,000 mg; Zn, 40,000 mg Fe, 32,000 mg; Se, 160 mg; Iodine, 800 mg; Cobalt, 400 mg; Choline, 475,000 mg; Methionine, 50,000 mg; BHT, 5,000 mg; Spiramycin, 5,000 mg.*
EE= Ether Extract, CP= Crude Protein, DM= Dry Matter, NFE= Nitrogen Free Extract, CF= Crude Fibre

3. RESULTS AND DISCUSSION

3.1 Growth Performance

Result of the growth performance of broiler chicks is shown in Table 2. There were significant differences (P<0.05) in the total weight gain of chicks with the highest weight reported for the HES diet. This is consistent with the findings of [2,4-6] who reported highest weight gain for broiler chickens fed the highest dietary energy levels. There were no significant differences (P>0.05) in the feed intake of the chicks, though quantity of feed consumed numerically decreased with increasing dietary ME. This result agrees with the findings of [7] that showed that providing diets of 2700 to 3300 kca/kg for broiler chickens had no effect on feed intake. Inconsistencies abound in some studies as to whether broiler chickens has the ability to adjust caloric intake when fed varying dietary energy levels [4,7] or eat to some levels without recourse to the varying energy levels [10,17]. Total energy intake and energy consumed/kg live body weight showed that, although feed intake decreased linearly with increasing dietary energy, same amount of energy was consumed by birds in all the treatment groups during the trial (P>0.05). Total protein intake and grams of protein consumed per kg live body weight, because protein levels of all diet remain constant, increased significantly (P<0.05) with decreasing dietary energy. Feed intake to body weight gain data (FCR) shows that birds offered diets of lower energy responded by being significantly (P<0.05) less efficient in terms of feed utilization. This result was in agreement with [5,7] who reported poorer feed conversion for broilers fed low average metabolizable energy diet. This implies that chicks on HES were better feed converter. This further indicates that broilers are able to adjust their feed intake to compensate for the increased dietary ME concentration.

Economics of production analysis (Table 2) indicated that the highest cost per kg feed (₦121.85) was in the HES based diet compared to ₦113.56 and ₦106.74 respectively for OES and LES. The LES based diet was the cheapest. Feed cost per weight gain was lowest (₦327.48) in the HES diet as compared to OES (₦341.55) and LES (₦374.85) diets respectively.

3.2 Hematology

Result of the hematological parameters is shown in Table 3. The ESR, PCV, RBC and Hb were not consistently influenced by the varying dietary energy levels at 4 weeks (28 days) and fell within the recommended physiological range for broiler chicks [18,19]. This suggests that the varied dietary energy levels did not inhibit haemopoesis as this would have been the case if protein digestion had been interfered with. The Leucocyte, Neutrophils and Eosinophils showed no significant differences (P>0.05) under the varied dietary energy treatments. This implies that the birds ability to fight disease invasion, phagocytosis, was not impaired by the diets. This observation also did not affect the health status of the birds as they were healthy and active all through the experimental period. The purpose of investigating blood composition is to have a way of distinguishing normal states from a state of stress in an animal. Such stress factors can be inadequate nutrition, poor management, environmental or physical stress. Diets have been reported to have significant influence on hematological variables [20].

3.3 Carcass Characteristics

Result of selected carcass characteristics at the end 28 days period is shown in Table 4. The back and eviscerated weight showed numerical increase with increase in dietary ME from 2786.80 to 3252.20 kcal/kg. The abdominal fat was significantly different (P<0.05), decreasing as the dietary ME decreases. This agrees with the findings of [3,7,8], that carcass fat deposition is confounded with intakes of protein and amino acids, and that when feed intake is elevated, there is a concomitant increase in crude protein intake, a situation known to reduce carcass fat deposition. However, others observed that increasing concentrations of dietary ME will not alter abdominal fat percentage if the ratio of calories to CP remain constant [17]. The gizzard was statistically significant (P<0.05) and decrease numerically alongside with the proventiculus as the dietary energy increase. This could be attributed to the extra-muscular activities undergone by the gizzard in breaking the fibre (Maize offal and Rice bran) diet portion, mainly predominant in the low energy starter diet. In this work, the fibre content of the LES was not above that recommended for broilers [13] and also did not affect the gut dimensions. The heart increases proportionately with increase in ME. The effort by the heart in meeting up with the need of oxygenated blood for metabolism could be responsible for the changes in weight as influenced by the varying dietary energy. All other parameters considered for carcass characteristics were not consistently influenced by the varying dietary energy. This agrees with the findings of [17], who reported no significant differences (P>0.05) in carcass parts in broilers fed diets differing in energy.

Table 2. Performance of broiler chicks fed diets varying in energy levels

Parameters	LES	OES	HES
Initial weight (g/bird)	55.00±5.77	55.00±5.77	57.50±5.00
Final weight (g/bird)	800.00±73.50^{b}	885.00±73.50^{a}	920.00±46.90^{a}
Total weight gained(g/bird)	745.00±70.50^{b}	830.00±37.40^{a}	862.50±49.20^{a}
Total feed intake (g/bird)	1617.50±33.00	1580.00±14.10	1522.50±60.80
Average weight gained (g/bird)	26.61±2.52^{b}	29.64±1.34^{a}	30.80±1.76^{a}
Average feed intake (g/bird/day)	57.77±1.18	56.43±0.50	55.45±2.17
Feed conversion ratio (FCR)	2.19±0.25^{a}	1.91±0.81^{b}	1.80±0.13^{b}
Nutrient Intake			
Total protein intake (g)	363.45±12.25^{a}	354.71±15.22^{b}	341.34±16.63^{c}
Protein/kg body weight	454.31±10.57^{a}	400.00±13.77^{b}	371.02±14.28^{c}
Total energy intake (kcal)	4507.65±12.26	4764.33±10.47	4951.47±11.56
Energy/kg body weight	5634.50±20.25	5383.42±25.22	5382.03±30.15
Economics of production			
Cost of feed consumed (₦)	172.65	179.42	185.52
Cost of feed/kg weight gain (₦)	374.85	341.55	327.48

LES=low energy starter, OES= optimum energy starter, HES= high energy starter. Mean values bearing different superscript in a row differ significantly (P<0.05). Cost of feed: LES = ₦106.74/kg; OES= ₦113.56/kg; HES=₦121.85/kg

Table 3. Hematological parameters of broiler chicks fed varied dietary energy levels

Parameters	Units	LES	OES	HES
ESR	mm/hr	4.00±0.82	3.00±0.01	3.63±1.11
PCV	%	25.25±2.22	26.00±0.80	27.00±0.82
RBC	$x10^{6}/mm^{3}$	2.24±0.40	2.16±0.33	2.46±0.30
Hb	g/dl	8.43±0.75	8.70±0.33	9.03±0.25
Lymphocytes	%	61.75±3.20	61.00±2.16	59.75±2.63
Neutrophils	%	27.75±2.87	28.25±2.22	29.25±2.63
Monocytes	%	8.25±1.71	7.75±2.63	7.00±0.82
Eosinophils	%	3.00±0.82	2.00±1.83	3.00±0.82
Basophil	%	1.25±0.50	1.00±1.16	1.00±1.16

LES=low energy starter, OES= optimum energy starter, HES= high energy starter, Hb= Haemoglobin, PCV= Packed cell volume, ESR= Erythrocyte sedimentation rate, RBC= Red blood cell. Mean values bearing different superscript in a row differ significantly (P<0.05)

Table 4. Main effects of varied dietary energy on carcass characteristics (kg) of broiler chicks and relative organ weight

	LES	OES	HES
Dressed Wt (%LW)	91.41±1.40	91.94± 0.33	91.78±2.16
Eviscerated Wt(%LW)	69.88±0.18[b]	73.49±1.07[a]	73.24±0.54[a]
Thighs (g/kg LW)	95.36±11.70	101.84±6.23	100.65±6.75
Drum sticks(g/kg LW)	68.44±10.03	78.01±10.64	77.46±17.31
Shanks (g/kg LW)	48.29±6.19	50.30±8.39	46.05±4.53
Wings(g/kg LW)	93.95±9.10	103.48±16.63	91.74±8.10
Breast(g/kg LW)	116.37±10.85	113.21±18.76	117.31±11.88
Back(g/kg LW)	145.13±8.56	150.70±26.60	163.46±19.57
Head (g/kg LW)	34.93±2.73	36.61±2.99	37.64±3.41
Neck (g/kg LW)	38.62±10.81	51.54±8.07	42.70±10.58
Belly fat(g/kg LW)	10.79±5.32[b]	17.39±2.79[ab]	20.59±6.18[a]
Heart(g/kg LW)	5.15±0.33	6.93±2.05	7.28±1.68
Lungs(g/kg LW)	6.19±2.04	5.64±0.93	6.41±1.71
Liver(g/kg LW)	34.21±15.28	27.73±4.28	28.09±6.00
Spleen(g/kg LW)	1.41±0.35	1.27±0.13	1.59±0.98
Gizzard(g/kg LW)	31.62±2.26[a]	29.06±2.45[ab]	25.76±3.38[b]
Proventiculus(g/kg LW)	8.36±1.19	7.91±1.62	7.08±0.88

LES=low energy starter, OES= optimum energy starter, HES= high energy starter. Mean values bearing different superscript in a row differ significantly (P<0.05), LW= Live weight

4. CONCLUSION

This study showed that performance characteristics as well as cost of raising broiler chicks are affected by the varying dietary energy levels. It was concluded that the optimum performance for enhanced marketability, while minimizing cost, could be attained when the high energy starter diet is used.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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