

Original Research Article

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

ABSTRACT

384 mixed sexed broiler chicks raised from day-old to 4weeks of age were used to evaluate the effects of different dietary energy levels on their growth performance, heamatology and carcass characteristics. The experiment was of a completely randomized design (CRD). The diets for the both the starter and finisher were isonitrogenous. There were 3 dietary starter energy treatments (2786.80, 3015.40 and 3252.20 Kcal/kg) and 4 replicate per treatment with 32 chicks per replicate. Birds were randomly selected and slaughtered at the end of 4 weeks for carcass and haematological analysis. The feed intake and live weight of the birds were taken weekly. Data were analyzed using descriptive statistics and analysis of variance. The results showed that, the haematological parameters (ESR, PCV, Hb, RBC, MCHC, MCH, MCV, lymphocytes, Neutrophils and Eosinophils) were not consistently influenced ($P>0.05$). The belly fat, gizzard and eviscerated weight were significantly influenced by the dietary energy. The final live weight, weight gain and feed conversion ratio of birds also differ significantly ($P<0.05$).

(Key words: Performance, Haematology, Broiler Chicks, Energy, Carcass)

Introduction

Dietary energy-contributing ingredients are a major cost to the boiler diet (leeson and Summer 2001). In addition, efficiency of usage of dietary energy declines with age (Hildago *et al.*, 2004). Thus, a better understanding of how to maximize the use will reduce cost and optimize yield.

Studies on increasing dietary ME of broiler chicken through addition of fat showed improved feed consumption by reducing feed intake (Mcnaughton *et al.*, 1984; Proudfoot *et al.*, 1987; Leeson and Summer 1996; Cheng *et al.*, 1997)

Studies have been conducted to examine the effects of dietary energy on performance of broiler chickens (Jackson *et al.*, 1982a; Dozier *et al.*, 2006, 2007; Ghaffari *et al.*, 2007) and carcass characteristics (Lesson *et al.*, 1996; Dozier *et al.*, 2006) but there are contradictions in some of this published works. Some studies reported that increasing dietary energy significantly

decreased feed intake (Grobas *et al.*, 1999; Harms *et al.*, 2000; Bohnsack *et al.*, 2002; Wu *et al.*, 2005a, b; Dozier *et al.*, 2006) improved feed conversion (Bartov *et al.*, 1974 ; Grifiths *et al.*, 1977; Saleh *et al.*, 2004; Wu *et al.*, 2005b) and decrease in breast meat yield (Dozier *et al.*, 2006) but others have shown that there is no significant effect of varied dietary energy on feed intake (Summer and Leeson 1993, and Jalal *et al.*, 2006), final body weight and meat yield (Lesson *et al.*, 1996). The ingestion of varied dietary components has measurable effects on blood constituents (Animashahun *et al.*, 2006). Also nutrient levels in blood and blood fluids are considered to be proximate measures of longtime nutritional status. Esonu *et al.*, (2001) stated that the haematological constituents reflect the physiological responsiveness of the animal to its internal and external environments, which include feed and feeding. Many studies have been conducted on the blood parameters of various domestic animals and livestock (Ahamefule *et al.*, 2006). The present study was conducted with the aim of further assessing the performance, haematology and carcass characteristics of broiler chicks fed varying dietary energy levels.

Materials and Methods

A total of 384 mixed sex one-day-old broiler chicks were obtained from a commercial hatchery and reared from 1 to 4 weeks of age. Chicks were vaccinated at the hatchery for Marek's disease, Newcastle disease and Infectious Bronchitis. Three different isonitrogenous diets were formulated for both the starter diets. The experimental starter diets contains; Low Energy Starter (LES; 2786.80KcalME/Kg, 22.47%CP), Optimum Energy Starter (OES; 3015.40 KcalME/kg, 22.45%CP) and High Energy Starter (HES; 3252KcalME/Kg, 22.45%CP). The optimum starter diet was chosen because it is the acceptable range of ME used in commercial practice for broilers. Calculated values of ME used in the formulation were from the NRC (1994). The gross and proximate composition of the experimental starter diets are shown in Table 1and 2 respectively.

Table 1: Ingredients and nutrient composition of experimental starter diets

	Low Energy	Optimum Energy	High Energy
INGREDIENTS			
Maize	38	56	55
Maize offal	15	-	-

Soyabean meal	12	14	14
Groundnut cake	14.5	14.85	17
Brewers dried grain	6.35	5	-
Fish meal	5	5	5
Oyster shell	0.5	0.5	0.5
Rice bran	5	-	-
Palm oil	-	1	4.85
Bone meal	2.5	2.5	2.5
Salt	0.5	0.5	0.5
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)	2786.8	3015.4	3252.2
Ether Extract (%)	5.966	5.146	8.785
Crude fibre (%)	5.201	4.215	3.538
Calcium (%)	1.486	1.184	1.478
Phosphorous (%)	0.79	0.697	0.693
Lysine (%)	1.173	1.1896	1.194
Methionine (%)	0.624	0.615	0.603
Energy: Protein	124.02	134.32	145.06

* 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.

Table 2: Proximate Composition of Experimental Starter Diets (%)

	%DM	%CP	%EE	%FIBRE	%ASH	%NFE
Low Energy	92.74	21.48	4.36	6.45	8.13	52.26
Optimum Energy	93.43	21.48	6.06	4.26	8.51	53.12
High Energy	93.00	21.53	6.06	3.64	8.97	49.26

EE= Ether Extract, CP= Crude Protein, DM= Dry Matter, NFE= Nitrogen Free Extract

After 5 days of acclimatization and feeding with starter mash, the chicks were randomly assigned to the 3 dietary treatment starter groups of 4 replicate per treatment with 32 chicks per replicate in a completely randomized design. Feed and water were provided *ad libitum*. Other routine management procedures were strictly followed. Proximate analysis was carried out according to the procedure described by A.O.A.C (2000) on the compounded diets.

At the end of 4 weeks starter phase, 6 birds per replicate were randomly selected for determination of selected carcass characteristics, organ development and muscle measurement. They were also bled by the jugular vein from which blood was drained and collected into carefully labelled specimen bottles for haematological studies. For each treatment, the blood samples were collected in triplicate. Blood samples with EDTA were used to determine packed cell volume (PCV), red blood cell count (RBC), Erythrocyte Sedimentation rate (ESR), differential white cell count (WBC) and haemoglobin concentration (Hb). The PCV, RBC, WBC and Hb values were determined using the Wintrobe's Microhaematocrit, improved Neubaur haemocytometer and cyanomethane-moglobin method respectively (Coles, 1986). The mean corpuscular haemoglobin (MCH) was calculated according to Bush (1991). Feed intake, weight gain, feed:gain were also measured. Feed intake and feed:gain were all corrected for mortality.

Statistical Analysis

Data were analyzed as a completely randomized design by the 1-way ANOVA procedure of SAS software (SAS Institute, 2003). When dietary treatment was significant ($P < 0.05$), means were compared using Duncan's multiple comparison procedure of SAS software

Results and Discussion

Carcass Characteristics

Result of selected carcass characteristics at the end of 4 weeks starter phase is shown in Table 3. The back and eviscerated weight showed proportionate increase with increase in dietary ME from 2786.80 to 3252.20 kcal/kg. The belly fat was significantly different, increasing as the dietary ME increases. This agrees with other research works (Jackson *et al.*, 1982b; Summers *et al.*, 1992; leeson *et al.*, 1996; Ghaffari *et al.*, 2007), that increasing dietary energy could have

caused deposition of abdominal or carcass fat in broilers, though some researchers observed that increasing concentrations of dietary ME will not alter abdominal fat percentage if the ratio of calories to CP remain constant (Bartov *et al.*, 1974; Hildago *et al.*, 2004; Saleh *et al.*, 2004). The gizzard was statistically significant ($P<0.05$) and decrease proportionately alongside with the proventriculus as the dietary energy increase. This could be attributed to the extra-muscular activities undergone by the gizzard in breaking the fibre (Maize offal) 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 (NRC, 1994) 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 Hildago, et al.,(2004) who reported no differences in carcass parts in 1.9kg broilers fed diets differing in energy.

Growth Performance

Result of the growth performance of broiler chicks is shown in Table 4. There were no significant differences ($P>0.05$) in the feed intake of the chicks, though quantity of feed consumed proportionately decrease with increasing dietary ME. This result agrees with the findings of Summer and Leeson (1993) and Jalal *et al.* (2006) who showed that there is no significant effect of dietary energy on feed intake.

There were significant differences ($P<0.05$) in the total weight gain of chicks with the highest weight reported for the highest energy starter diet. Improvement in feed conversion rate appears to be due to the decrease in feed intake caused by high dietary energy. This is consistent with the findings of Jackson et al., (1982a), Dozier et al., (2006, 2007), and Ghaffari et al., (2007). Efficiency of feed utilization and live weight could be improved by high-energy diets as confirmed by our result.

Feed conversion improved significantly as the final weight (g/bird) and total weight gain increased significantly. This result was in agreement with that of Liu *et al.*, (2005) and Wu *et al.*, (2005) who reported that increasing dietary protein and energy improved feed conversion. This

implies that chicks on HES were better feed converter even though less feed was consumed. This further indicates that broilers are able to adjust their feed intake to compensate for the reduced dietary ME concentration.

Haematology

Result of the haematological parameters is shown in Table 5. The ESR, PCV, RBC and Hb were not consistently influenced by the varying dietary energy levels at 4 weeks and fell within the recommended physiological range for broiler chicks (Mitruka and Rawnsley, 1977; Olorode *et al.*, 1996). This suggests that the varied dietary energy levels did not inhibit haemopoiesis as this would have been the case if protein digestion had been interfered with.

The purpose of investigating blood composition is to have a way of distinguishing normal states from a state of stress in an animal (Tewe *et al.*, 1991). Such stress factors can be inadequate nutrition, poor management, environmental or physical stress. Diets have been reported to have significant influence on haematological variables (Veulterinora, 1991).

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.

Conclusion

From this study it has been shown that increasing the dietary ME energy can help improve the efficiency of feed utilization and feed conversion. Though further studies still needs to be done to succinctly access the performance and carcass characteristics at the finisher stage.

146 **References**

- 147 Ahamefule FO., Be Obua, IA, Ukwani, MA Oguike and RA Amaka, (2008). Haematological and
148 biochemical profile of weaner rabbits fed raw or processed pigeon pea seed meal based
149 diets. Afr. J. Agric. Res. 3: 315-319.
- 150 Animashahun Ra., SO. Omoikhoje and AM Bamgbose (2006). Haematological and biochemical
151 indices of weaner rabbits fed concentrates and *Syndrella nodiflora* forage supplement.
152 Proc. 11th Annual Conference of Animal Science Association of Nigeria. Institute of
153 Agricultural Research and Training, Ibadan, Nigeria, pp: 29-32
- 154 AOAC. Official Methods of Analysis of the Official Analytical Chemists (2000) (W. Horwitz
155 ed) 17th Ed, Association of Official Analytical Chemists, Washington DC USA.
- 156 Bohnsack, CR., RH. Harms, WD. Merkel and GB. Russell (2002). Performance of commercial
157 layers when fed diets with four levels of corn oil or poultry fat. J. Apply. Poult. Res.
158 11:68-76
- 159 Cheng, TK., M. L. Hamre, and C. N. Coon (1997) effect of environmental temperature, dietary
160 protein, and energy levels on broiler performance. J. Appl. Poult. Res. 6:1-17
- 161 Dozier, W. A., III, C. J. Price, M. T. Kidd, A. Corzo, J. Anderson, and S. L. Branton. (2006).
162 Growth performance, meat yield, and economic responses of broilers fed diets varying in
163 metabolizable energy from 30 to 59 days of age. J. Appl. Poult. Res. 15:367–382
- 164 Dozier, W. A., III, M. T. Kidd, A. Corzo, and S. L. Branton. (2007). Dietary apparent
165 metabolizable energy and amino acid density effects on growth and carcass traits of heavy
166 broilers. J. Appl. Poult. Res. 16:192-205.
- 167 Esonu, B.O; Iheukwumere, F.C; Emenalom, O.O; Uchegbu, M.C; and Etuk, E.B (2002).
168 Performance, nutrient utilization and organ characteristics of broilers fed *Microdesmis*
169 *puberula* leaf meal. Livestock production for rural development, 14:6
- 170 Ghaffari, M., M. Shivazad, M. Zaghari, and R. Taherkhani. (2007). Effects of different levels of
171 metabolizable energy and formulation of diet based on digestible and total amino acid
172 requirements on performance of male broiler. Int. J. Poult. Sci. 6:276–279.

- 173 Griffiths, L., S. Lesson, and J. D. Summers. (1977). Influence of energy system and level of
174 various fat sources on performance and carcass composition of broilers. Poult. Sci.
175 56:1018–1026.
- 176 Grobas, S., J. Mendez, C. De. Blas, and GG. Mateos (1999). Laying hen productivity as affected
177 by energy, supplemental fat, and linoleic acid concentration of the diet. Poult. Sci. 78:
178 1542-1551.
- 179 Harms, RH., GB. Russell, and DR. Sloan (2000). Performance of four strains of commercial
180 layers with major changes in dietary energy. J. Appl. Poult. Res. 9: 535-541.
- 181 Hildago, M. A., W. A. Dozier III, A. J. Davis, and R. W. Gordon. (2004). Live performance and
182 meat yield responses to progressive concentrations of dietary energy at a constant
183 metabolizable energy-crude protein ratio. J. Appl. Poult. Res. 13:319-327
- 184 Iheukwumere, F.C., I.C. Okoli, and N. T. Okeudo (2002). Preliminary studies on Napoleona
185 Imperialis seed as feed ingredient, haematology and serum biochemistry. Carcass and
186 Organ weights of weaner rabbits. Tropical animal production investigations. 5: 219-227
- 187 Jackson, S., J. D. Summers, and S. Leeson. (1982b). Effect of dietary protein and energy on
188 broiler carcass composition and efficiency of nutrient utilization. Poult. Sci. 61:2224–
189 2231.
- 190
- 191 Leeson, S., and J. D. Summers. (2001). Energy. Pages 34-99 in Nutrition of the Chicken.
192 University Books, Guelph, Ontario, Canada.
- 193 Leeson, S., L. Caston, and J. D. Summers. (1996). Broiler responses to dietary energy. Poult. Sci.
194 75:529–535.
- 195 Mcnaughton, JL., and FN. Reece (1984). Factors affecting pelleting response. 1. Influence of
196 dietary energy in broiler starter diets. Poult. Sci. 63: 682-685.
- 197 Mitruka, BM., and Rawnsley, M. (1977). Clinical, Biochemical and Haematological Reference
198 values in normal experimental animals. Masson, New York. 42 (1): 65-70

- 199 National Research Council (NRC) (1994). Nutrient Requirement of Poultry. 9th Rev. Ed.
200 National Academy of Science, Washington D.C.
- 201 Olorode BR., AA. Onifade, AO Opara, GM Babatunde (1996). Growth, nutrient retention,
202 haematology and serum biochemistry of fed shea butter or palm kernel cake in the humid
203 tropics. J. Appl. Anim. Res. 10: 173-180.
- 204 Proudfoot, FG and HW. Hulan (1987). Interrelationships among lighting, ambient temperature,
205 and dietary energy and broiler chicken performance. Poult. Sci. 66: 1744-1749.
- 206 Saleh, E A., S. E. Watkins, A. L. Waldroup, and P. W. Waldroup. (2004). Effects of dietary
207 nutrient density on performance and carcass quality of male broilers grown for further
208 processing. Int. J. Poult. Sci. 63:1-10
- 209 Saleh, E A., S. E. Watkins, A. L. Waldroup, and P. W. Waldroup. (2004). Consideration for
210 dietary nutrient and energy feeding programs for growing large male broilers chickens for
211 further processing. Int. J. Poult. Sci. 3:11-16
- 212 SAS institute 2000. SAS/STAT User's Guide. SAS Institute Inc., Cary, NC.
- 213 Veulterinora M (1991). Nutrition and erythropoiesis. In: CRC Handbook of Nutritional
214 requirements in functional context. M. Rechcigi (ed.) Boca Ration, CRC Press Pp 65-74.
- 215
- 216
- 217
- 218
- 219
- 220

221 Appendix

222 **Table 3: Selected Carcass, Muscle and Organ weights of broiler chicks fed varying dietary**
 223 **energy levels at 4weeks old**

	LES	OES	HES
Carcass Parameters			
Dressed Wt	91.41±1.40	91.94± 0.33	91.78±2.16
Eviscerated Wt	69.88±0.18 ^a	73.49±1.07 ^b	73.24±0.54 ^b
Thighs	95.36±11.70	101.84±6.23	100.65±6.75
Drum sticks	68.44±10.03	78.01±10.64	77.46±17.31
Shanks	48.29±6.19	50.30±8.39	46.05±4.53
Wings	93.95±9.10	103.48±16.63	91.74±8.10
Chest	116.37±10.85	113.21±18.76	117.31±11.88
Back	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	10.79±5.32 ^a	17.39±2.79 ^{ab}	20.59±6.18 ^b
Muscle			
Thigh weight	31.79±3.38	32.42±3.57	29.52±2.43
Drumstick weight	22.71±0.84	25.07±3.66	23.16±4.08
OB weight	9.10±1.21	8.86±2.13	10.90±1.49
IB weight	26.28±3.80	29.81±6.62	31.04±7.33
Relative Organ			
Heart	5.15±0.33	6.93±2.05	7.28±1.68
Lungs	6.19±2.04	5.64±0.93	6.41±1.71
Liver	34.21±15.28	27.73±4.28	28.09±6.00
Spleen	1.41±0.35	1.27±0.13	1.59±0.98
Gizzard	31.62±2.26 ^a	29.06±2.45 ^{ab}	25.76±3.38 ^b
Proventriculus	8.36±1.19	7.91±1.62	7.08±0.88

224 LES=low energy starter, OES= optimum energy starter, HES= high energy starter
 225 Mean values bearing different superscript in a row differ significantly (P<0.05), OB=Outer
 226 breast, IB= inner breast

227
 228

Table 4: Growth Performance of broiler chicks fed varying dietary energy levels at 4 weeks

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)	22.19±0.25 ^a	1.91±0.81 ^b	1.80±0.13 ^b

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).

Table 5: Haematological parameters of broiler chicks fed varying dietary energy levels at 4 weeks

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)