GROWTH PERFORMANCE OF BROILER CHICKS FED VARYING LEVELS OF ENERGY AND PROTEIN DIETS UNDER SINGLE VERSUS DOUBLE PHASE FEEDING

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ABSTRACT: A total of 240 days old broiler chicks were randomly divided into ten treatment groups of 24 birds per group with each group replicated twice. Nine of the ten groups were fed single phase diets of varying protein and energy levels, while the tenth which was the control was fed the two stage diets (0-5 weeks starter phase, and 6 – 8 weeks finisher phase). A 3 x 4 – 2 factorial design which was an adaptation of 3x4 factorial design was used in this experiment. Feed and water were served *ad libitum* throughout the duration (0-8 weeks) of the experimental period. All necessary vaccinations and preventive medication were carried out at various periods of the experiment. The parameters measured in this experiment were body weight, body weight gain, feed intake and feed to gain ratio. Data were analysed with the aid of a computer package SPSS for windows, version 11.0 (2000). Results showed that birds on low protein-high energy diet (T7) had the least values in most of these parameters measured. Birds on low protein-medium energy (T8) and high protein-low energy (T3) diets performed best in these parameters. Diets T8 and T3 were therefore recommended as the best to be used under the single phase feeding system.
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INTRODUCTION

Diets with varying protein and energy levels have been recommended for the starter and finisher stages in broiler growth by many researchers. These varying protein and energy levels are however not in consonance among the various researchers. The National Research Council (1971) recommended 23% crude protein and 3,200Kcal/kg metabolizable energy (ME) for broiler chicken at the starter stage, while the Agricultural Research Council (1973) recommended 18.8% crude protein and energy level of 3,100Kcal/kg metabolizable energy. Babatunde and Fetuga (1976) recommended 18% crude protein level for finisher broilers. Olomu and Offiong (1980) recommended a diet of 20% protein and 3,000Kcal/kg energy for finisher broilers. This apparent lack of agreement calls for the need for further research work in this area. This experiment is therefore to compare the growth performance of broiler chicks fed single phase diets from 0 to 8 weeks of age with those on double phase feeding system.

MATERIALS AND METHODS

240 day- old chicks were used in this experiment. Birds were randomly distributed into 10 treatment groups with each group having 2 replicates comprising of 12 birds per replicate. Nine of the experimental diets were formulated to comprise 20%, 22% and 24% crude protein levels. Within each protein level, there were 3 diets providing 2,600, 2,900 and 3,200Kcal/kg metabolizable energy. These 9 diets were fed single phase *ad libitum* to 9 out of the 10 groups of birds. The 10^{th} diet which was the control was formulated to comprise 22% crude protein and 3, 000Kcal/kg ME and fed as starter stage diet to the 10^{th} group of birds from 0-5 weeks (Table 1). The finisher phase birds were fed a diet comprising 20% crude protein and 2,800Kcal/kg ME from 6-8 weeks (Table 2). Weekly data collection on body weight gain and feed intake were carried out for 8 weeks. The other parameter determined was feed conversion ratio. A 3 x 4 -2 factorial design was adopted for this experiment. Feed and water were supplied *ad libitum* throughout the duration (0-8 weeks) of the experimental period. All necessary vaccinations and preventive medication were carried out at various periods of the experiment. Data were subjected to analysis of variance, while differences between means were carried out using Duncan's multiple range test with the aid of a computer package SPSS for windows, version 11.0 (2000).

RESULTS AND DISCUSSION

Table 3 shows the proximate composition of the experimental diets. T1 to T10 fed at the starter phase

of 0 to 5 weeks of age. The dry matter ranged from 82.40 to 92.10%, crude protein from 19.90 to 24.20% while crude fibre ranged from 6.30 to 8.10%. Other nutrients are ether extract which ranged from 4.60 to 10.50%, ash from 4.60 to 11.30%, nitrogen free extract from 49.8 0to 60.00% and metabolizable energy which ranged from 3052 to 3367 kilocalories per kilogram.

The proximate composition of the experimental diets T1 to T10 fed during the finisher phase of 6 to 8 weeks of age are shown in Table 4. The diets were the same and had similar proximate composition as stated for treatments 1 to 9 in Table 3, except for the control diet (T10) which is the finisher stage diet for the double phase feeding system.

The dry matter content of the diet ranged from 82.40 to 92.10%, the crude protein ranged from 19.90 to 24.75% while the crude firbre ranged from 6.30 to 8.10%. Others include ether extract with a range of 4.60 to 10.74%, ash with a range of 4.60 to 11.30% and nitrogen free extract with a range of 49.80 to 60.00%. Metabolizable energy on the other hand had a range of 3052 to 3407 kilocalories per kilogram metabolizable energy.

Table 5 shows the result for the growth performance of the broiler birds fed the various diets. Birds on high protein-low energy (T3= 24%CP, 2,600 ME) diet had the highest final body weight of 2117.50g. Birds on low protein-medium energy and high protein-medium energy diets (T8=20%CP, 2,900ME and T2=24%CP,2,900ME) followed closely to the value of T3 with final body weight of 2117.50g and 2083.63g respectively. Birds on low protein-high energy (T7=20%CP, 3,200ME) diet had the least final bodyweight of 1638.00g. The variations in the final body weight of birds on the various diets were significant ($P<0.05$). However, except for birds on T7 and T3 mentioned earlier, final body weights for birds on the various diets were not significantly different ($P>0.05$) from those on the control (T10=20% CP, 2,800 ME) diet.

Similar trend of result was obtained for body weight gain in birds, when compared to those of final body weight of birds. Water intake per bird in litres, among the diets were significant ($P<0.05$). Values for high protein-low energy (T3), low-protein medium energy (T8) and low protein-high energy (T7) diets were significantly different ($P<0.05$) from values from other diets and the control. Diets T3 and T8 had the highest water intake of 12.66 and 12.67 litres respectively, while diet T7 had the least water intake value of 8.79 litres.

This experiment showed that the key growth parameters such as body weight, body weight gain and feed intake were affected by the variations in the protein and energy levels of the various diets. High protein-low energy diet (T3) favoured growth parameters most in this study and was followed in rank by low protein-medium energy diet (T8). Feed intake was also appreciably high for these diets (T3 and T8).

Dietary energy and protein levels are very important due to their associative effect in the diets most especially energy, as it determines the extent of the uptake of other nutrients. The finding of this work agrees with that of Umar (2001) who worked on broilers fed single phase *ad libitum* diet with graded levels of protein and energy and reported that energy levels affect the growth pattern of broilers. This is in respect of birds being able to adjust intake of feed to satisfy their energy requirement. He further stated that intake of both protein and energy between three and six weeks by birds influenced their final body weight more than intake at other ages. The result was also in consonance with that of Jackson *et al.* (1982a, b) who monitored the effect of dietary protein and energy on the performance of broilers and observed that body weight and feed efficiency improved with increasing level of protein and energy in broiler diet.

The result was also in conformity with the works of Jackson *et al.* (1982c) who reported that body weight was depressed in low protein diet having higher energy, while high protein diet had the reverse opposite effect. The result of this study was however not in agreement with the findings of *Tion et al.* (2005) who monitored the effect of caloric to protein ratio of pratical diets on performance and carcass quality of broiler chicken. Their findings showed that calorie -protein ratio had no significant effect ($P>0.05$) on feed intake, weight gain and feed to gain ratio. Although their finding was on starter diet only, the result of this work was for both starter and finisher diets combined. Tion *et al* .(2005) used calorie- protein ratios varying from 140:1 to 160:1, while the ratios in this study varied from 108:1 to 160:1. Feed intake of birds that were fed diet T5 which contains 22%CP and 2,900 metabolizable energy was higher and closely followed by those fed diets T8 and T3 containing 20%CP and 2,900MEand 24% CP and 2,600 ME respectively. Their calorie-protein ratios were 132:1, 145:1 and 108:1 respectively. Feed intake values of diets T5, T8 and T3 were significantly higher than those of other diets in this study. This observation was also reported in the work with finisher diets by Tion *et al.* (2005) for T8 diet, although the value was not significant.

In nearly all the parameters measured for growth, birds on low protein-high energy diet (T7 with calorie-protein ratio of 160:1) recorded the least

feed intake. This may be as a result of the fact that birds eat to satisfy their energy requirements. Once the energy requirement is satisfied, feed intake is reduced. Also because of reduced intake for the low protein high energy diet, intake of other nutrients in the diet are reduced. Hence the poor performance in most of the growth parameters observed for birds on this diet. This observation agreed with the findings of Ahmad (2001) who worked on low energy-low protein diets in broilers and reported that the need for energy varies from one environment to another and that energy requirement sets the base for the quantitative requirements for all other nutrients.

CONCLUSION

Considering some key performance index of poultry birds which include, the final body weight, average body weight gain and total feed intake, diets T8 and T3 emerged the best.

Diet T8 (=20% CP, 2,900 ME with a calorie - protein ratio of 145:1) was second best in final body weight (2083.63g), average body weight gain (2045.33g) and in total feed intake (7042.98g).

Diet T3 (= 24% CP, 2,600ME with a calorie protein ratio of 108:1) also had favourable result. It recorded the best final body weight (2117.50g), average weight gain (2082.55g) and third best in total feed intake (7032.54g).

Table 1. Composition of the experimental diets fed at the starter phase (0-5 weeks)

	Treatment diets (%)									
Ingredients	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Maize	35.37	44.67	41.11	41.24	50.17	44.10	47.12	55.73	41.67	50.17
Groundnut	40.93	39.13	38.69	38.06	34.63	38.70	32.18	29.07	31.63	34.63
Fish Meal	3.00	3.00	2.00	1.50	2.00	0.50	1.50	2.00	1.00	2.00
Corn Offal	3.00	4.00	10.00	2.00	4.00	7.70	2.00	4.00	15.00	4.00
Bone meal	3.95	3.00	4.60	4.00	3.00	4.90	4.50	4.00	5.60	2.70
Oystershell	2.00	1.95	2.35	1.95	1.95	2.85	2.15	1.95	3.85	1.45
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vit/Min Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Palm Oil	10.50	3.00	0.00	10.00	3.00	0.00	9.30	2.00	0.00	3.80
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Protein & Energy Levels	HH	HM	HL	MH	MM	ML	LH	LM	LL	MH
Calculated Analysis Calorie (Protein %)	24.00	24.18	23.91	22.12	22.00	22.84	20.00	20.00	20.00	20.00
Energy (Kcal/ Kg ME)	3207	2900	2690	3216	2941	2676	3207	2906	2659	3005
Calorie Protein Ratio	133:1	121:1	108:1	145:1	132:1	118:1	160:1	145:1	130:1	136:1
Calcium	2.19	1.88	2.46	2.10	1.81	2.64	2.31	2.11	3.22	1.55
Phosphorus	1.05	0.91	1.13	1.01	0.88	1.14	1.07	1.01	1.24	0.84
Ether Extract	4.05	4.33	4.32	3.99	4.22	4.29	3.86	4.09	4.06	4.22
Crude Fibre	3.10	3.29	3.80	2.95	3.16	3.62	2.78	2.99	3.97	3.16
Methionine	0.56	0.32	0.56	0.53	0.55	0.54	0.51	0.51	0.52	0.55
Lysine	1.33	1.07	1.25	1.19	1.18	1.18	1.08	1.08	1.08	1.18

H = High, M = Medium, L = Low

- To provide the following per kg of feed, Vitamin A, 5,500 I.U; Vitamin D_3, 800 I.U; Vitamin E, 12.00 mg; Vitamin K_3, 1.50 mg; VitaminB_1, 1.00 mg; Vitamin B_2, 2.0 mg; Vitamin B_6, 1.50 mg; Niacin, 12.0 mg; Pantothenic acid, 5.0 mg; Biotin, 0.20 mg; Vitamin B_{12}, 0.01 mg; Folic acid, 0.30 mg; Cholinechloride, 150.00mg; Manganese, 60.00mg; Iron, 10.00mg; Zinc, 15.00mg; Copper, 0.80mg, Iodine 0.40mg; Cobalt, 0.08mg; Selenium, 0.04mg; Growth promoter, 8.00mg; Anti-oxidant, 40.00mg.
  Recommended inclusion 2.5 kg per ton of feed.

Table 2. Composition of the experiment diets fed at the finisher phase (6-8 weeks)

	Treatments diets (%)									
Ingredients	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Maize	35.37	44.67	41.11	41.24	50.17	44.10	47.12	55.73	41.67	55.73
Groundnut Cake	40.93	39.13	38.69	38.06	34.63	38.70	32.18	29.07	31.63	29.07
Fish Meal	3.00	3.00	2.00	1.50	2.00	0.50	1.50	2.00	1.00	2.00
Corn Offal	3.00	4.00	10.00	2.00	4.00	7.70	2.00	4.00	15.00	4.00
Bone Meal	3.95	3.00	4.60	4.00	3.00	4.90	4.50	4.00	5.60	4.55
Oystershell	2.00	1.95	2.35	1.95	1.95	2.85	2.15	1.95	3.85	2.75
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
*Vit/Min Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Palm Oil	10.50	3.00	0.00	10.00	3.00	0.00	9.30	2.00	0.00	0.75
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Protein and energy levels	HH	HM	HL	MH	MM	ML	LH	LM	LL	LM
Calculated Analysis										
Crude protein %	24.00	24.18	23.91	22.42	22.00	22.84	20.00	20.00	20.00	20.00
Energy (Kcal/kg ME)	3207	2900	2690	3216	2941	2676	3207	2906	2659	2802
Calorie protein ratio	133:1	121:1	108:1	145:1	132:1	118:1	160:1	145:1	130:1	140:1
Calcium	2.19	1.88	2.46	2.10	1.81	2.64	2.31	2.11	3.22	2.54
Phosphorus	1.05	0.91	1.13	1.01	0.88	1.14	1.07	1.01	1.24	1.09
Ether extract	4.05	4.33	4.32	3.99	4.22	4.29	3.86	4.09	4.06	4.09
Crude fibre	3.10	3.29	3.80	2.95	3.16	3.62	2.78	2.99	3.97	2.99
Methionine	0.56	0.32	0.56	0.55	0.55	0.54	0.51	0.51	0.52	0.53
Lysine	1.33	1.07	1.25	1.19	1.18	1.18	1.08	1.08	1.08	1.08

H = High, M = Medium, L = Low

*To provide the following per kg of feed

Vitamin A, 5.500 I.U; vitamin D_3, 800 I.U; Vitamin E, 12.00mg; Vitamin K_3, 1.50mg; Vitamin B_1, 1.0mg; Vitamin B_2, 2.0mg; Vitamin B_6, 1.50mg; Niacin, 12.0mg; Panthothenic acid, 5.0mg; Biotin, 0.20mg; Vitamin B_{12}, 0.01mg; Folic acid, 0.30mg; choline chloride, 150.00mg; manganese, 60.00mg; Iron, 10.00mg; Zinc, 15.00mg; Copper, 0.80mg; Iodine, 0.40mg; Cobalt, 0.08mg; Selenium, 0.04mg; Growth Promoter, 8.00mg; Anti-oxidant, 40.00mg. Recommended inclusion rate 2.5kg per ton of feed.

Table 3. Proximate composition of experimental diets fed at the starter phase (0-5 weeks)

	Treatments diets (%)									
Nutrients	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Dry Matter	89.50	85.10	88.00	86.00	85.90	90.50	89.90	92.10	82.40	85.50
Moisture	10.50	14.90	12.00	14.00	14.10	9.50	10.30	7.90	17.60	14.50
Crude Protein	24.20	23.90	24.10	22.10	22.10	22.20	19.90	20.10	20.20	22.10
Crude Fibre	6.30	6.50	6.40	8.10	7.50	7.00	7.90	6.50	8.00	8.00
Ether Extract	10.50	9.80	8.30	4.60	9.00	6.20	6.40	8.20	9.50	9.20
Ash	9.20	7.50	6.80	5.90	11.30	4.60	5.80	8.10	6.50	6.10
Nitrogen Free Extract	49.80	52.30	54.40	59.30	50.10	60.00	60.00	57.10	55.80	54.60
Metabolizable Kcal/kg DM	3367	3345	3360	3213	3213	3220	3052	3066	3074	3213

T_1 = 24% CP, 3200Kcals/kg ME, T_2 = 24% CP, 2900Kcals/kg ME, T_3 = 24% CP, 2600Kcals/kg ME
T_4 = 22% CP, 3200Kcals/kg/ME, T_5 = 22% CP, 2900Kcals/kg ME, T_6 = 22% CP, 2600Kcals/kg ME
T_7 = 20% CP, 3200Kcals/kg ME, T_8 = 20% CP, 2900Kcals/kg ME, T_9 = 20% CP, 2600Kcals/kg ME
T_{10} = 20% CP, 2800Kcals/kg ME.

Table 4. Proximate composition of experimental diets fed at the finisher phase (6 – 8 weeks)

Nutrients	Treatments diets (%)									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Dry Matter	89.50	85.10	88.00	86.00	85.90	90.50	89.90	92.10	82.40	91.53
Moisture	10.50	14.90	12.00	14.00	14.10	9.50	10.30	7.90	17.60	8.47
Crude Protein	24.20	23.90	24.10	22.10	22.10	22.20	19.90	20.10	20.20	24.75
Crude Fibre	6.30	6.50	6.40	8.10	7.50	7.00	7.90	6.50	8.00	6.44
Ether Extract	10.50	9.80	8.30	4.60	9.00	6.20	6.40	8.20	9.50	10.74
Ash	9.20	7.50	6.80	5.90	11.30	4.60	5.80	8.10	6.50	9.44
Nitrogen Free Extract	49.80	52.30	54.40	59.30	50.10	60.00	60.00	57.10	55.80	50.93
Metabolizable Energy Kcal/kg DM	3367	3345	3360	3213	3213	3220	3052	3066	3074	3407

T_1 = 24% CP, 3200Kcals.kg ME, T_2 = 24% CP, 2900Kcals/kg ME, T_3 = 24% CP, 2600Kcals/kg ME
T_4 = 22% CP, 3200Kcals/kg ME, T_5 = 22% CP, 2900Kcals/kg ME, T_6 = 22% CP, 2600Kcals/kg ME
T_7 = 20% CP, 3200Kcals/kg ME, T_8 = 20% CP, 2900Kcals/kg ME, T_9 = 20% CP, 2600Kcals/kg ME
T_{10} = 20% CP, 2800Kcals/kg ME.

Table 5. Growth performance of broiler birds fed from 0 to 8 weeks on single phase versus double stage feeding system

Parameters	Treatments diets (%)										
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	SEM
Average initial body weight/birds (g)	33.05^{a}	33.00^{a}	34.95^{ab}	34.40^{a}	32.45^{a}	33.30^{a}	39.20^{c}	38.30^{bc}	38.35^{bc}	31.55^{a}	0.61
Final body weight/bird (g)	1964.67^{ab}	2028.39^{ab}	2117.50^{c}	1873.93^{ab}	1958.10^{ab}	1882.06^{ab}	1638.00^{a}	2083.63^{ab}	1873.33^{ab}	1679.00^{ab}	43.11
Body weight gain/bird (g)	1931.62^{ab}	1995.39^{ab}	2082.55^{b}	1839.53^{ab}	1925.65^{ab}	1848.76^{ab}	1598.80^{a}	2045.33^{ab}	1834.98^{ab}	1647.45^{ab}	43.11
Feed intake/birds (g)	6316.08^{ab}	6307.91^{ab}	7032.54^{ab}	5978.57^{ab}	7530.60^{b}	6282.09^{ab}	5348.59^{a}	7042.98^{ab}	6069.03^{ab}	6251.07^{ab}	158.96
Feed to gain ratio	3.26	3.17	3.44	3.26	3.91	3.40	3.35	3.45	3.31	3.81	0.08
Water intake/bird (l)	11.02^{ab}	10.20^{ab}	12.66^{b}	11.43^{ab}	11.87^{ab}	10.69^{ab}	8.79^{a}	12.67^{b}	9.93^{ab}	9.31^{ab}	0.34

a,b,c, = means not having the same alphabet along the row are significant ($P<0.05$).
SEM = Standard Error of Means
T_1 = 24% CP, 3200Kcals/kg ME, T_2 = 24% CP, 2900Kcals/kg ME, T_3 = 24% CP, 2600Kcals/kg ME
T_4 = 22% Cp, 3200Kcals/kg ME, T_5 = 22% CP, 2900Kcals/kg ME, T_6 = 22% CP, 2600Kcals/kg ME
T_7 = 20% CP, 3200Kcals/kg ME, T_8 = 20% CP, 2900Kcals/kg ME, T_9 = 20% CP, 2600Kcals/kg ME
T_{10} = 20% CP, 2800Kcals.kg ME.

RECOMMENDATION

From the result of this study, diet T8 and T3 (low protein-medium energy and high protein-low energy diets) are recommended for maximum growth of broiler birds fed single phase from 0 to 8 weeks. This recommendation is for climatic regions that fall within annual temperatures of between 18.9^{0}C minimum and 34.8^{0}C maximum, and having rainfall pattern of between 1,100mm to 1,600mm minimum and maximum respectively.

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