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RESPONSE OF CHICKEN BROILERS TO EARLY GRADED LEVELS DIETARY PROTEIN AND ENERGY

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ABSTRACT

270 day old Arbor Acre broilers of a mixed sex were used to investigate the effects of different dietary protein and energy levels on performance, nutrient absorption capability and gut morphology of broilers from 0 – 14 days of age. Birds were fed diets containing 20, 23, or 25% protein and 3000, 3200 or 3400kcal/kg metabolisable energy using a 3 x 3 factorial design from 0 – 14 days of age. From 15 – 28 days all the birds in the experimental units were fed a standard diet to investigate the residual effects of the early protein and energy levels. There were significant interactions (P<0.01) between dietary protein and energy content in feed intake, weight gain and feed/gain ratio (P<0.01). At 20 and 25% protein level, increase in dietary energy levels above 3200kcal/kg resulted in a significant decrease in feed intake (P<0.01). At 23% protein, feed intake at 3200kcal/kg was significantly lower than those of birds fed with either 3000 or 3400kcal/kg. At 20, 23 and 25% protein levels, increase in energy content above 3000kcal/kg resulted in a significant increase in weight gain (P<0.01). At 20 and 25% protein levels, increase in energy above 3000kcal/kg resulted in a significant decrease in feed to weight ratio (P<0.01). Significant interaction (P<0.01) also occurred on the residual effect of the dietary levels of protein and energy earlier fed to the birds on feed intake, weight gain and feed conversion ratio. At 20% protein level, increase in energy above 3200kcal/kg resulted in a significant decrease in feed intake, weight gain and feed conversion ratio. At 23% protein level, the feed intake and feed to gain ratio at 3400kcal/kg were significantly higher than those of birds earlier fed diets with either 3000 or 3200kcal/kg. 20% dietary protein level combined with energy content of 3400kcal/kg gave the lowest cost of feed cost/kg and cost of producing 1kg of the bird compare to dietary level of 25% protein and energy content of 3000kcal/kg which had the highest cost of feed/1kg and cost of producing 1kg of the bird. The diet of lower nutrient density (20% of protein level and 3400kcal/kg) showed a better cost – effectiveness when express as per kilogramme live weight.

Keywords: *Broilers, Dietary Energy and Protein, Performance, Residual Effect.*

INTRODUCTION

Broiler chicks increase their body weight approximately 50 fold within 40 days of age. Due to the short life cycle, growth during the first week is important. This is also reflected in the positive relation between body weights in the first week and body weights at Marketing (Nir and Levanon, 1993; Gonzales *et al*., 2003). It has been an interesting exercise to follow the development of Broiler production over this time, and to encapsulate ideas of associated changes in nutrition and feeding management. For example, in 1991, the emphasis in broiler nutrition was

on maximizing growth rate, together with the new approach of considering breast meat yield. In 1997, the concept of compensatory growth was emphasized, as a necessary management tool to control metabolic disorders. In the intervening, eight years, poultry geneticists have obviously reduced the incidence of these disorders, and so we are once again considering rapid growth throughout the entire grow – out period. It is such evolving circumstances within the industry that dictate the need for periodic reappraisal of our feeding programs. (Steven and Summers, 2005)

Genetic selection for fast growth in the broiler industry continues at a rapid pace, with chicks weighing only 40-45g at day – old now reaching some 2-2.2kg by 40days of age. The magnitude of this growth indicates that every day in the broilers life is important in reaching target weight. (Noy and Sklan, 2001). The higher the genetic potential of a bird, the greater the challenges faced by the nutritionists to develop a diet that fully exploits that potential. When formulating diets to optimize production, several areas should be considered. Of these, early chick nutrition is one of the most important, as the first seven of fourteen days of life account for 20-30% of the bird's total lifespan (marketable age 35days). This importance is likely to increase with further improvement in genetic potentials (54g improvement in weight per year), it can be expected that the marketable age will be reduced by one day per year, and thus the initial seven – fourteen days will account for 35 - 40% of lifespan (Noy and Sklan, 2001).

The gastro intestinal tract of the neonate animals is immature with limited ability to handle complex feed materials. Atteh (2002), recommend high level of protein of high biological value for creeps. Although neonate chicks have enzyme profile that is close to that of the adult bird, but their capability for optimal digestibility is not reached until several weeks of age. It is therefore conceivable that neonate chicks should be able to benefit from high quality and quantity protein and energy that will ameliorate the immune system.
Broiler birds are usually fed on a controlled basis to maintain body weight within recommended guidelines. Daily energy consumption will vary with age, stage of production and environmental temperature, but will usually range from 2800 – 3200 kcal ME per bird daily (Waldroup *et al*., 2005; Bornstein *et al*., 1979; Atteh, 2002).

This trial will be justifiable if the result of this trial enable nutritionist to improve on early nutrient digestibility and growth through the manipulation of dietary protein and energy. Research has shown that any reduction in time needed to get broilers to the market is likely to be saved during the neonate period (0 -14days). Hopefully the result of this trial may help to ameliorate the problem associated with this stage of production. The research study was designed to investigate the histology of the Gastrointestinal Tract (GIT), nutrient digestibility and performance responses to variable protein and energy content of the diets during 14 days post hatch and the residual effect of such a treatment during subsequent brooding period.

MATERIALS AND METHODS

The experiment was conducted in the animal pavilion in the Department of Animal production, University of Ilorin. A total of 270 day-old Arbor Acre broiler chicks (mixed sex) were reared in electrically heated battery cages and used for this trial. The birds were fed the experimental diets shown in Table 1. The experimental diet consisted of a 3x3 factorial combination of protein and energy contents. Birds were fed diets with a low (20%), recommended (NRC, 1994) (23%) or

High (25%) protein. Each of these protein levels were combined with low (3000), recommended (3200) or high (3400) Kcal/kg of ME. Thus, there were 9 experimental diets, each with 3 replicates of 10 birds. The experimental diets and water were fed *ad libitum* for the first 14 days of life. Birds were weighed at day old and randomly assigned to the treatments. From 14 to 28 days of age, all the birds were fed a standard diet (Table 2) to investigate the residual effects of the dietary treatments during the first two weeks of life.

Data Collection and Analysis

Feed intake and weight gain were recorded at the end of each phase by subtracting the left over feed from the initial quantity of feed given, also by subtracting the final weight at the end of the week from initial weight of the bird. That is, 14 days and 28 days of age. Feed conservation ratio FCR was calculated by dividing feed intake by the bird's weight gain. Cost benefit ratio was also calculated for each phases. The cost benefit ratio was calculated as grams of weight gain per cost of diet fed. Also, at 14 days of age, 2 birds from each replicate (with no visible abnormalities) were randomly selected and slaughtered by neck dislocation. The birds were dissected and the GIT removed. The duodenum, jejunum and ileum were subjected to histological analysis. Sections of these samples were collected, fixed to the slides and dyed according to procedure described by Harris *et al*., (1994) hemotoxylin – eosin (HE) technique. From each slides, villus height and crypt depth were measured using an image analyzer system[2], with 230 x amplification. A record of mortality of experimental birds was also collected during the experiment.

Nutrient Retention

Nutrient retention trials were undertaken at 14 and 28 days of broiler's age. Weighed quantities of feed were fed to the birds and fecal samples collected over a 72hours period using the total collection method. The fecal samples were weighed, oven – dried at 80^{o}c, reweighed, ground and chemical analyses of the samples were carried out in accordance to the procedure outlined by A.O.A.C. (2005).

Chemical Analysis

Feed and fecal samples were subjected to proximate analysis, N content was analysed using the Kjeldahl procedure and Crude protein was calculated as N X 6.25. The fat content was determined as ether extract using a soxhlet apparatus using petroleum ether (60^{o} – 80^{o}c). Crude fibre content was determined using the procedure described by (Atteh, 2002).

Statistical Analysis

The data collected were subjected to Analysis of variance by Genstat 5 program (Pane *et al*., 1987) using the model for factorial design (Steel *et al.,* 1980). The interaction and mean values between treatments were evaluated and separated using the Duncan multiple range test (Duncan, 1955).

RESULTS

Table 1: Experimental Diet (100%)

Ingredients	T1	T2	T3	T4	T5	T6	T7	T8	T9
Basal ingredients*	28.62	28.62	28.62	28.62	28.62	28.62	28.62	28.62	28.62
Maize	45.00	45.00	45.00	45.00	40.00	40.00	40.00	37.00	34.00
Soybean meal (48%)	14.69	14.69	14.69	20.94	21.84	21.84	25.94	26.28	26.98
Palm oil	6.21	8.71	11.21	4.33	9.54	9.54	4.92	8.10	10.40
Sand(filler)	5.48	2.98	0.48	1.11	-	-	0.52	-	-
Total	100	100	100	100	100	100	100	100	100
Analysed Nutrient Content									
Dry Matter (%)	84.22	87.70	87.76	86.49	87.68	85.75	86.24	88.13	90.01
Crude Protein (%)	20.25	20.16	12.40	22.20	22.66	23.14	23.96	24.06	24.13
Crude Fat (%)	7.25	8.05	5.17	8.45	7.20	9.25	8.40	9.72	9.40
Crude Fibre(%)	7.55	6.87	9.25	7.25	6.55	7.05	7.40	7.40	6.55
Calculated Protein (%)	20.00	20.00	20.00	23.00	23.00	23.00	25.00	25.00	25.00
Calculated Energy(kg/cal)	3000	3200	3400	3000	3200	3400	3000	3200	3400
Calculated Calorie:Protein	150:1	160:1	170:1	130.4:1	139.1:1	147.8:1	120:1	128:1	136:1

*** Made up of:**

Soybeans (full fat): 5%, Blood meal: 4%, Oyster shell: 0.02%, DL Methionine 0.01%,
Wheat offal: 5% Fish meal: 1.5% salt: 0.25%
BDG: 10%, Bone meal: 2.5%, Premix: 0.25% providing per kg of diet; Vitamin A, D, E and K

Experimental diets	Protein %	ME Kg/cal
T1	20	3000
T2	20	3200
T3	20	3400
T4	23	3000
T5	23	3200
T6	23	3400
T7	25	3000
T8	25	3200
T9	25	3400

Analysed Nutrient Content of the Experimental Diets

Treatments	Dry Matter (%)	Crude Protein (%)	Crude Fat (%)	Total Fibre (%)	Ash (%)
T1	84.22	20.25	7.25	7.55	8.59
T2	87.70	20.16	8.05	6.87	10.85
T3	87.76	21.40	5.17	9.25	10.45
T4	86.49	22.20	8.45	7.25	8.82
T5	87.68	22.66	7.20	6.55	9.21
T6	85.75	23.14	9.25	7.05	10.76
T7	86.24	23.96	8.40	7.40	9.60
T8	88.13	24.06	9.72	7.40	11.05
T9	90.01	24.13	9.40	6.55	10.45

Table 2: Composition of the Standard Diet (100%) (15- 28 Days of Age).

Ingredient	% Composition
Basal	
Maize	45.00
Soyabeans meal (48%)	14.69
Soyabeans (full fat)	5.00
Wheat offal	5.00
Brewer's Dried Grain (BDG)	10.00
Blood meal	4.00
Fish meal	1.50
Bone meal	2.50
Oyster shell	0.02
Salt	0.25
Premix	0.25
DL methionine	0.10
Palm oil	6.21
Sand (filler)	5.48
Total	100.00

Analysed Nutrient Content of the Standard Diet (%)

Dry Matter	-	84.22
Moisture content	-	15.78
Crude protein	-	20.25
Crude fat	-	7.25
Crude fibre	-	7.55
Total Ash	-	8.59

There were significant interactions ($P<0.01$) between dietary levels of protein and energy on feed intake, weight gain and feed/gain ratio (Table 3). For broilers fed diets containing 20% and 25% protein levels, increase in energy content above 3200 kcal/kg resulted in a significant decrease in feed intake ($P<0.01$). however, for broilers fed diet containing 23% protein, feed intake at 3200 kcal/kg was significantly ($P<0.01$) lower than those of birds fed diets with either 3000 or 3400 kcal/kg. In the same vein, for broilers fed diets containing 20, 23 and 25% protein levels, increase in energy content above 3000kcal/kg resulted in a significant increase in weight gain ($P<0.01$). At 25% protein level, there were no significant differences in weight gain at 3200 and 3400kcal/kg of energy. At 20, and 25% protein levels, increase in energy above 3000kcal/kg resulted in a significant decrease in feed to weight gain ratio ($P<0.01$). Whereas, at 23% protein level, feed to weight gain at 3200 kcal/kg of energy was significantly lower than those of birds fed diets with either 3000 or 3400kcal/kg.

Table 3: Effects of Dietary Levels of Protein and Energy on Performance of Broiler Chicks from 0 -14 days of Age

Dietary Treatments	Feed Intake (g/bird)	Weight Gain (g/bird)	Feed Gain Ratio
Main Factors			
A. Protein(CP %)			
	*	*	*
20%	284.3[a]	170.0[a]	1.68[a]
23%	325.1[b]	177.7[b]	1.83[b]
25%	379.0[c]	200.0[c]	1.86[c]
SEM	3.48	0.915	0.0054
B. Energy Kcal/Kg (ME)			
	*	*	*
3000	351.8[a]	171.8[a]	1.98[c]
3200	323.4[b]	188.7[b]	1.70[b]
3400	313.2[b]	187.1[b]	1.67[a]
SEM	3.48	0.915	0.00544
CP × ME	*	*	*

***** - Significant at P<0.01
SEM - Standard error of the means

Table 4: Effect of Early (0 – 14days) Dietary Levels of Protein and Energy on Residual (15 – 28 days) Performance of Broilers

Dietary Treatments	Feed Intake (g/bird)	Weight Gain (g/bird)	Feed Gain Ratio
Main Factors			
A. Protein(CP %)			
	*	*	*
20%	726.5[a]	444.1[a]	1.63[c]
23%	733.5[a]	473.3[b]	1.55[b]
25%	799.2[b]	545.2[c]	1.47[a]
SEM	3.75	0.532	0.00577
B. Energy Kcal/Kg (ME)			
	*	*	*
3000	761.2[b]	485.2[b]	1.57[b]
3200	760.8[b]	508.9[c]	1.50[a]
3400	737.1[a]	468.5[a]	1.59[b]
SEM	3.75	0.532	0.00577
CP × ME	*	*	*

***** - Significant at P<0.01
SEM - Standard error of the means

Response of Chicken Broilers to Early Graded Levels Dietary Protein and Energy

Table 4 indicates that there were significant interactions (P<0.01) between early of the dietary levels of protein and energy on subsequent/residual feed intake, weight gain and feed to gain ratio. At 20% protein level, increase in energy above 3200kcal/kg resulted in a significant decrease in feed intake, weight gain and feed/gain ratio. At 23% protein level, the feed intake and feed/gain ratio at 3400kcal/kg were significantly higher than those of birds earlier fed diets with either 3000 or 3200kcal/kg. Whereas, at the same level lower energy of 3000kcal/kg resulted in a significant increase in weight gain (P<0.01).
Also, at 25% protein level, increase in energy content above 3000kcal/kg had no significant effects on feed intake. Whereas, at the same protein level, increase in energy content above 3000kcal/kg resulted in a significant increase in weight but a decrease in feed to gain ratio (P<0.01).

Table 5: Effects of Dietary Levels of Protein and Energy on Nutrient Retention of Broiler Chicks from 0 – 14 Days of Age.

Dietary Treatments	Nutrient Retention Crude protein (%)	Crude fat (EE%)	Crude Fibre (%)
Main Factors			
A. Protein(CP %)			
	NS	*	NS
20%	71.70	86.50[a]	16.50
23%	64.30	80.00[b]	21.80
25%	70.20	84.40[c]	22.50
SEM	3.58	2.70	2.64
B. Energy Kcal/Kg (ME)			
	NS	*	NS
3000	76.20	92.40[a]	24.00
3200	63.20	81.50[b]	18.90
3400	66.70	77.00[c]	17.90
SEM	3.58	2.70	2.64
CP × ME	NS	*	NS

***** - Significant at (P<0.01)
NS - Not significant at (P> 0.01)
SEM - Standard error of the means

There was no significant effect of dietary protein and energy levels on crude fibre retention (P>0.01, Table 5). There was also no significant interaction between dietary levels of protein and energy on these parameters (P>0.01). However, there were significant interaction (P<0.01) between dietary levels of protein and energy on crude protein and crude fat digestibility, as shown in table 5. Hence, at 23% and 25% protein levels, there was a significant increase in crude fat digestibility at low energy of 3000kcal/kg compare to 3200 and 3400 kcal/kg (P<0.01).Whereas, at 20% protein levels, there were no significant difference in fat digestibility at 3000 and 3400kcal/kg of energy, but better fat retention at energy level of 3200kcal/kg.

There was no significant effects of early dietary protein and energy levels on residual/subsequent protein, fat or crude fibre retention (P>0.01, Table 6). There was also no significant interaction between early dietary protein and energy level on nutrient retention at 4 weeks of age (P>0.01).
The effects of early dietary protein and energy levels of duodenal, jejunal, and ileal morphology are shown in Tables 7, 8, and 9. Increase in dietary levels of protein above 20% increases the jejunal and duodenal villus height and crypt depths (P<0.01). Increase in dietary energy content caused a significant increase in both duodenal and jejunal villus length and crypt depths (P<0.01). There were no significant interaction between early dietary levels protein and energy in duodenal and jejunal villus height and crypt depths (P<0.01, Tables 7 and 8).
There were significant interactions (P<0.01) between dietary levels of protein and energy on ileum villus height and crypt depth, details of which are shown in Table 9. Thus, at 20% and 25% protein levels, increase in energy content above 3000kcal/kg resulted in a significant decrease in ileum villus height and crypt depth. Whereas, at 23% protein level, ileum villus height and crypt depth at 3200kcal/kg was significantly higher than those of birds fed diets with either 3000 or 3400kcal/kg.

Table 10 shows that the physical and financial performance of neonate broilers grown to 14 days of age on dietary protein and energy levels. The dietary treatments have different nutrient density and balanced protein levels relative to NRC recommended levels 23% CP and 3200kcal/kg of ME. The term "balanced protein" refers to the practical application of the ideal amino acid profile to supply broilers with the correct minimum levels of essential and non-essential amino acids. Table 11 shows the physical and financial performance of the residual effect on the experimental diets earlier fed to the birds.

Table 6: Effects of Early Dietary Levels of Protein and Energy on Residual Nutrient Retention of Broiler Chicks from 15 – 28 Days of Age

Dietary Treatments	Nutrient Retention Crude protein (%)	Crude fat (EE%)	Crude Fibre (%)
Main Factors			
A. Protein(CP %)			
	NS	NS	NS
20%	77.12	89.98	60.80
23%	67.00	86.42	52.50
25%	70.79	84.52	57.70
SEM	1.24	1.88	1.94
B. Energy Kcal/Kg (ME)			
	NS	NS	NS
3000	73.85	87.97	52.40
3200	71.34	86.88	59.20
3400	69.73	86.07	59.30
SEM	1.24	1.88	1.94
CP × ME	NS	NS	NS

NS - Not significant at (P> 0.01)
SEM - Standard error of the means

Table 7: Effects of Early Dietary Levels of Protein and Energy on Duodenal Morphology of Broilers (0 – 14 Days of Age)

	Duodenum	
Dietary treatments	**Villus height (mm)**	**Crypt depth(mm)**
Main factor		
A. Protein (CP %)		
	NS	NS
20%	1.77	0.06
23%	1.93	0.11
25%	1.88	0.10
SEM	0.013	0.006
B. Energy kcal/kg (ME)		
	NS	NS
3000	1.91	0.11
3200	1.87	0.09
3400	1.81	0.07
SEM	0.013	0.006
CP × ME	NS	NS

NS - Significant at (P> 0.01)
SEM - Standard error of the means

Table 8: Effects of Early Dietary Levels of Protein and Energy on Jejunal Morphology of Broilers (0-14 Days of Age)

	Jejunum	
Dietary treatments	**Villus height (mm)**	**Crypt depth(mm)**
Main factor		
A. Protein (CP %)		
	NS	NS
20%	1.82	0.10
23%	1.97	0.20
25%	1.98	0.18
SEM	0.012	0.005
B. Energy kcal/kg (ME)		
	NS	NS
3000	2.02	0.20
3200	1.91	0.17
3400	1.84	0.12
SEM	0.012	0.005
CP × ME	NS	NS

NS - Significant at (P> 0.01)
SEM - Standard error of the means

Table 9: Effects of Early Dietary Levels of Protein and Energy on Ileal Morphology of Broilers (0 – 14 Days of Age

Dietary treatments	Ileum Villus height (mm)	Crypt depth(mm)
Main factor		
A. Protein (CP %)		
	*	*
20%	0.43[a]	0.47[a]
23%	0.60[c]	0.66[b]
25%	0.55[b]	0.63[b]
SEM	0.006	0.006
B. Energy kcal/kg (ME)		
	*	*
3000	0.60[c]	0.68[c]
3200	0.52[b]	0.58[b]
3400	0.46[a]	0.50[a]
SEM	0.006	0.006
CP X ME	*	*

* - Significant at (P< 0.01)
SEM - Standard error of the means

Table 10: Cost Benefit Analysis of Dietary Protein and Energy on Performance of Broiler Chicks from 0 – 14 Days of Age Relative to NRC Standard (T5)

Treatment	Cost of feed ₦/kg	Savings on cost of feed	Cost of producing 1kg of bird ₦/kg	Savings comparison
T1	18.97	-1.77	38.13	-11.47
T2	18.52	-1.32	30.00	-3.34
T3	14.73	2.47	20.62	6.04
T4	20.20	-3.00	39.19	-12.53
T5	17.20	0.00	26.66	0.00
T6	23.81	-6.61	47.38	-20.72
T7	26.16	-8.96	53.10	-26.44
T8	25.44	-8.24	49.10	-22.44
T9	21.01	-3.81	33.83	-7.17

Table 11: Cost Benefit Analysis of the Residual Effects of Experimental Diets on Performance of Broiler Chicks from 15 – 28 days

Treatment	Cost of feed ₦/kg	Savings on cost of feed	Cost of producing 1kg of bird ₦/kg	Savings comparison
T1	45.26	5.95	74.68	10.09
T2	47.85	3.36	79.91	4.86
T3	40.44	10.77	63.90	20.87
T4	44.81	6.40	65.42	19.35
T5	44.61	6.60	65.13	19.64
T6	48.72	2.49	84.77	0.00
T7	50.96	0.25	81.54	3.23
T8	51.21	0.00	70.67	14.10
T9	50.91	0.30	73.31	11.46

DISCUSSIONS

The feed intake of the experimental birds from 0- 14 days of age were influenced by the dietary levels of energy and protein. The feed intake was higher for birds fed with calorie: protein ratio of 120:1. This observation was in agreement with reports by Golian and Maurice (1992) and Leeson *et al*. (2000), who reported that the birds consume feed to primarily meet their energy requirements. For an unexplained reason, birds fed with calorie: protein ratio of 147.8:1also produced higher mean value for feed intake. This is contrary to the expectation that birds fed with this diet were expected to consume less feed, since birds eat to satisfy their energy requirement first and may cease to eat or reduced feed intake drastically. NRC (1977).

Expectedly, the birds had the poorest feed intake when fed 170:1. This finding is in consistent with the revised observations of the NRC (1994). Also, from Table 4, at 20%, 23% and 25% protein levels, there were significant interactions ($P<0.01$) on the residual effect on the feed intake of the birds fed dietary energy content of 3000 and 3200kcal/kg at 20% CP, 3000 and 3400kcal/kg at 23% CP and 3000 and 3200kcal/kg at 25% CP respectively. This finding was in agreement with Golian and Maurice (1992) and Leeson *et al*. (1993) who reported that birds consumed feed to primarily meet their energy requirement.

The calorie: protein ratio of diets had been found to play an important role in the performance of broiler chicken NRC (1994), Aftab *et al*. (2006). In this study, the calorie: protein values of 160:1 and 170:1 for 0-14 days of age, gave a poor performance (weight gain) for broiler chicken fed with this diet. In contrast to the increase in weight gain of the broiler chicken fed with 25% protein levels even at various energy levels. This trend agrees with other studies which showed that weight gain during the first week increase with increasing protein levels in a balanced amino acids composition of the diet Sklan and Noy (2003); Wijtten *et al*. (2004).

Result from Table 4 shows that both at 23% and 25% protein levels, the residual effect on the weight gain of the dietary treatments earlier fed to the birds increased significantly($P<0.01$) with increase in energy content of the diets. However, at 20% protein, increase in energy content

3400kcal/kg resulted in a significant reduction in the residual effect on the final body weight gain. This is in harmony with the findings of Summers and Leeson (1984).
The study shows that 20 and 25% protein levels with moderate energy content of 3200kcal/kg resulted in significant decrease in feed to gain ratio and significant increase in fat retention.
The apparent residual effect of dietary protein and energy levels earlier fed to the birds on feed conversion ratio in the present study is in consistent with the revised observation of the NRC (1984), that modern strains of broiler chicks could not precisely adjust their feed intake to body weight gain to changes in ME density.

Results obtained on ileum and crypt depth in Table 9, indicated that at 20 and 25% protein levels, increase in energy content above 3000kcal/kg, resulted in significant reduction in ileum's villus height and crypt depth($P<0.01$) respectively. Whereas at 23% protein level, there was a significant increase in ileum villus height and crypt depth of energy content of 3200kcal/kg compared to 3000 and 3400kcal/kg of energy.

However, there were no significant differences ($P<0.01$) in the duodenum and jejunum villus height and crypt depth on birds fed with dietary levels of protein and energy at 0 – 14 days of age. The above statements were in agreement with the report of Yamauchi *et al*. (1993) which indicated that the villus is larger in broilers fed with high protein and low energy diet.
First of all, it is important to evaluate the full impact of the margin in production over feeding cost. The desire to minimize feed cost per tonne needs to be balanced against maintaining or maximizing margin.

Result obtained on economic analysis in Table 10 shows that dietary level of calorie : protein ratio of170:1 had the lowest cost of feed/kg and cost of producing 1kg of the bird compared to calorie : protein ratio of 139.1:1 (Recommended NRC value of 23% CP). This phenomenon shows that birds fed with calorie: protein ratio of 170:1 had a better efficiency in the feed to gain ratio. That is, the diet of lower density was cost-effective when expressed per kilogram live weight. Interestingly, this findings is in contrast to result obtained by Ross 308 As – Hatched; Scotland (2006) who observed that the diets of the lower nutrient density was less cost – effective when expressed per kilogramme live weight.

CONCLUSION

It is evident from the result obtained in the present research that increasing level of dietary protein had an effect on the performance of the chicken broiler. In general, the optimum performance in the present experiment was obtained by broilers fed with diet of calorie: protein ratio of 120:1 at 0 -14 days of age.

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