

PROTEIN AND ENERGY REQUIREMENTS OF BROILER CHICKENS IN THE TROPICS

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SUMMARY

An experimental design consisting of four or three protein levels and three energy levels were used to determine the optimum protein and energy requirements for starting broilers (0—6) weeks of age and finishing broilers (6—10) weeks of age. For the starting phase, four protein levels (20, 23, 24 and 26%) and three energy levels (2800, 3000 and 3200 Kcal ME/kg) were employed, while in the finishing phase three protein levels (18, 20 and 22%) and the same three energy levels as in the starting phase were used. In the two experiments growth rate and feed efficiency improved as protein level increased. The 3000 Kcal ME/kg energy level appeared to be the best for maximal growth. Of the four protein levels used for the starting phase, the minimum required for growth was clearly shown to be 23% while 20% was minimum required for the finishing phase. The results of the present studies indicate that the following minimal protein and metabolizable energy levels were required for broiler chicks in the tropics: 23—24% protein with energy level of 2800 — 3000 Kcal ME/kg for the starting phase and 20% protein and energy level of 2800 — 3000 Kcal ME/kg for the finishing phase.

INTRODUCTION

Limited research work has been carried out in the tropics in the area of nutrient requirements of chicks. Lack of this information has forced feed compounders in the tropics to rely on NRC or ARC recommended allowances for their feed formulations. A large body of reports has shown that environment has definite effects on feed efficiency, growth rate and on egg production (Joiner and Huston, 1959; Prince *et al*, 1961; and Howes *et al*, 1964). It has also been stressed that the nutrient requirements established in temperate environment may not be entirely satisfactory under tropical conditions (Agudu, 1971; Babatunde and Fetuga, 1976; Olomu, 1976; Njike, 1979;

Olomu and Offiong, 1980). The few trials on energy and protein requirements of broilers carried out under tropical conditions show some inconsistencies. For instance, Gowda (1973) in India found that the protein requirement of broiler starters is above 21% and probably around 24% at an energy concentration of 3000 Kcal/ME/kg. Rao *et al*. (1973) examined the performance of pure-bred broiler chicks from 0—10 weeks with C/P ratio of 136 during the starting phase and 160 in the finishing phase; their results indicate that 22% and 19% protein levels were respectively adequate for starting and finishing phases.

The results of Prasad *et al* (1973) appear to indicate that 23% protein level with an energy concentration of 2840 to 3100 Kcal/ME diet was adequate. These authors found methionine supplementation to the diets ineffective in improving the responses of chicks over the unsupplemented diets. Desai (1974) tested three protein levels at a constant energy level of 2800 Kcal ME/kg diet. He found the crude protein requirement to be 24%. The latter result was confirmed by the work of Rao *et al* (1974) who obtained maximum body weight on broiler chicks fed 24% protein level with 2860 Kcal ME/kg diet. Olomu (1976) in Nigeria investigated the performance of Indian River broiler type chicks at four protein levels (17, 20, 23 and 26%) and energy levels of 2800, 3000 and 3200 Kcal/kg diet. The data showed the protein requirement of broiler chicks to be 23% or 26% with the energy level of 2800 or 3000 Kcal/kg diet. In another experiment, Olomu and Offiong (1980)

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tested the performance of Ross-type broiler chicks on a two — phase feeding regimen. Four protein levels (17, 20, 23 and 26%) and three energy levels (2800, 3000 and 3200 Kcal/kg diet) were used for the starting phase and similar protein and energy levels for the finishing phase. The results confirmed the earlier findings of Olomu (1976). Their results also showed that 20% protein level with the energy level of 3000 Kcal/kg diet to be adequate for the finishing period. The above findings differ from NRC (1977) recommendations of 23% protein for chicks 0—3 weeks of age, 20% for chicks 3—6 weeks and 18% for chicks 6—9 weeks of age and energy of 3200 Kcal/kg diet at each protein level.

Recognising that reduced intake of feed in hot weather is one of the severe problems which face poultry farmers in the tropics, it would seem advisable for countries in the tropics attempting to use a rational feeding policy for their progressive poultry industry, to pursue some specific and local research on this subject. The purpose of the present studies therefore is to determine the requirements of the two nutrients between 0—6 weeks and 6—10 weeks of age for which little work has been done in the tropics.

MATERIALS AND METHODS

Two experiments were carried out with unsexed Ross broiler — type chicks, one on broiler starters and the other on broiler finishers.

Experiment 1:

This experiment was carried out to determine the optimum protein and energy levels for broiler starter. In this trial four protein levels (20, 23, 24 and 26%) and three metabolizable energy (ME) levels (2800, 3000 and 3200 Kcal/kg diet) were used. The ME was calculated using NRC (1977) values of the individual

ingredients used for formulating the rations. The experiment involved 1200 day-old chicks purchased from a local commercial hatchery. All the chicks were vaccinated intranasally against Newcastle disease. They were fed on our Farm broiler starter ration for one week after which they were randomly allocated into the treatment diets in duplicate lots of 50 chicks each. The chicks were provided with water and feed at all times. Both chicks and feed remnants were weighed at weekly intervals; chicks were weighed in groups. The experiment was terminated at the end of a 5—week feeding period. Table 1 shows the composition and origins of the ingredients used in formulating the rations, while Table 2 shows the composition of the diets used in Experiment 1

Experiment 2:

The experiment was conducted to determine the optimum protein and energy levels for broiler finishers. Three protein levels (18, 20 and 22%) and three ME levels (2800, 3000 and 3200 Kcal/kg diet) were used. Nine hundred day-old broiler chicks of the Ross broiler breed were fed on our Farm broiler starter ration for six weeks and thereafter were assigned to the experimental rations (Table 3) in duplicate lots of 50 birds each. They were fed to 10 weeks of age, water and rations being given *ad libitum*. Chicks were weighed in groups weekly while feed remnants were weighed daily.

The data collected in the two experiments were subjected to analysis of variance followed by Duncan's multiple range test as outlined by Steel and Torrie (1960).

RESULTS

Experiment 1:

The ranges of protein and energy levels chosen in each experiment were expected

TABLE I
Percentage composition of ingredients used in ration formulation (on as-fed basis).

	Dry matter	Protein	Fibre	Fat	Ash	NFE	Ca	P	Met	Cys	ME ¹ (Kcal/kg)
Guinea corn ² (Sorghum var)	90.6	9.8	2.5	2.4	2.1	73.8	—	0.2	0.14	0.15	3,370
Groundnut cake ³	93.7	44.5	1.7	3.2	6.0	38.3	0.15	0.55	0.43	0.7	2,200
Wheat middlings ³	87.9	15.5	13.0	2.9	5.5	51.0	0.1	1.2	0.21	0.25	1,800
Fishmeal ³	93.8	66.0	0.00	5.4	16.1	6.3	3.7	2.1	2.22	0.56	2,880
Meat and bone meal ³	94.7	49.5	2.4	7.6	24.3	10.9	9.6	4.5	0.58	0.25	1,960
Perwinkle shell ²	98.5	—	—	—	—	—	38.1	—	—	—	—

¹Taken from NRC (1977).

²Purchased from local market

³Imported from Overseas

TABLE 2
Composition of diets for broiler starters — Experiment 1

Diet No.	Protein ¹ (%)	ME (Kcal/kg)	Ground guinea corn (%)	Groundnut meal (%)	Wheat Middlings (%)	Palm Oil	Constant Ingredients ² (%)	Total
1.	20	2800	63.50	16.00	8.5	—	12.00	100
2.		3000	60.50	16.00	8.5	3.0	12.00	100
3.		3200	54.00	18.00	8.5	7.5	12.00	100
4.	23	2800	53.00	26.0	5.5	0.5	12.00	100
5.		3000	51.25	27.5	8.5	3.75	12.00	100
6.		3200	44.00	30.0	5.5	8.5	12.00	100
7.	24	2800	49.75	29.25	8.5	1.0	12.00	100
8.		3000	42.75	31.00	8.5	5.75	12.00	100
9.		3200	40.50	33.0	5.5	9.00	12.00	100
10.	26	2800	44.75	36.5	5.5	1.25	12.00	100
11.		3000	38.75	28.15	5.5	5.6	12.00	100
12.		3200	38.00	40.00	1.5	8.5	12.00	100

¹Calculated values from Table 1

²Supplied the following ingredients: Fishmeal, 5%; meat and bone meal, 4%; methionine, 0.25%; salt, 0.25%; periwinkle shell, 1%; minovit 1.5%; (as recommended by suppliers).

TABLE 3
Composition of diets for broiler finishers — Experiment 2

Diet No.	Protein ¹ (%)	ME ¹ (Kcal/kg)	Ground guinea corn (%)	Groundnut meal (%)	Wheat middlings	Palm oil (%)	Constant ingredients ²	Total (%)
1.	18	2800	64.75	12.5	14.5	—	8.25	100
2.		3000	64.75	12.5	12.25	2.25	8.25	100
3.		3200	60.50	14.75	10.0	6.5	8.25	100
4.	20	2800	63.75	19.0	9.0	—	8.25	100
5.		3000	60.75	19.5	9.0	2.5	8.25	100
6.		3200	55.75	22.0	6.5	7.5	8.25	100
7.	22	2800	57.75	26.0	8.0	—	8.25	100
8.		3000	55.25	28.0	5.0	3.5	8.25	100
9.		3200	50.25	29.5	4.0	8.0	8.25	100

¹Calculated values from Table 1

²Supplied the following ingredients: fishmeal, 3%; Meat and bone meal, 3%; Salt, 0.25%; periwinkle shell, 1%; Minovit 1% (as recommended by the sup pliers).

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to include minimal levels required for maximal growth and feed efficiency. The effects of different levels of protein and energy on the average weekly feed consumption, liveweight gain and feed efficiency (g feed eaten/g weight gain) are shown in Table 4. Data indicate that feed efficiency improved as the protein level increased. At three dietary energy levels (2800, 3000 and 3200 Kcal ME/kg) there was a significant depression of liveweight gain and feed efficiency when the ration contained 20% protein. The differences in feed consumption, liveweight gain and feed efficiency of birds on 23, 24 and 26% protein diets (Diets 4—12) were not significant. Of the four protein levels used the minimum required for maximal growth was clearly shown to be 23%. For best feed efficiency the level varied between the last two levels, that is 3000 and 3200 Kcal ME/kg. The 3000 Kcal ME/kg was clearly shown to be the best for maximal growth. Depression of growth was

indicated when ME was increased from 3000 to 3200 Kcal ME/kg.

Experiment 2:

The results of this experiment are summarized in Table 5. Growth was equally good for all three protein levels but the protein effect on feed efficiency again varied. There was some indications of improvement in feed efficiency with increasing protein level. The 3000 Kcal ME/kg energy level continued to be the best for maximal growth but it appears the higher energy level, 3200 Kcal ME/kg, was required for maximal feed efficiency. Again, slight depression of growth was noted at the highest energy level but the differences were small and not statistically significant.

DISCUSSION

The data obtained in this study clearly indicate that there is a general improve-

TABLE 4

Effect of different levels of protein and energy on the feed consumption Liveweight gain and feed efficiency of broiler starters (1—6 weeks) — experiment 1

Diet No.	Protein (%)	ME (Kcal/kg)	Average		Feed efficiency g	
			Weekly feed Consumption*	Average weekly weight gain(g)	Feed eaten/g	Weight gain
1.	20	2800	1795.7 ^{cd}	704.2 ^c	2.55 ^a	
2.		3000	1827.1 ^{cd}	716.5 ^c	2.55 ^a	
3.		3200	1786.9 ^{cd}	714.9 ^c	2.495 ^{ab}	
4.	23	2800	1896.4 ^{abc}	787.6 ^{ab}	2.41 ^{bc}	
5.		3000	1888.9 ^{abdc}	806.5 ^a	2.345 ^c	
6.		3200	1880.7 ^{abcd}	800.3 ^a	2.35 ^c	
7.	24	2800	1873.8 ^{abcd}	790.3 ^{ab}	2.368 ^c	
8.		3000	1935.9 ^a	818.3 ^a	2.365 ^c	
9.		3200	1908.6 ^{ab}	813.2 ^a	2.345 ^c	
10.	26	2800	1906.8 ^{ab}	811.3 ^a	2.35 ^c	
11.		3000	1896.2 ^{abc}	808.6 ^a	2.345 ^a	
12.		3200	1834.5 ^{abcd}	799.0 ^a	2.325 ^c	
Standard error of Means			30.7	11.8	0.0273	

**Means bearing the same superscript do not differ significantly ($P < 0.05$)

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TABLE 5

Effect of different levels of protein and energy on the feed consumption, liveweight gain and feed efficiency of broiler finishers — experiment 2

Diet No.	Protein (%)	ME (Kcal/kg)	Average Weekly feed consumption* (g)	Average weekly liveweight gain (g)	Feed efficiency (g feed eaten/g weight gain)
1.	18	2800	2901.5 ^d	768.5 ^d	3.775 ^a
2.		3000	2902.2 ^d	779.7 ^d	3.72 ^{ab}
3.		3200	2768.2 ^e	757.4 ^d	3.655 ^{abc}
4.	20	2800	3083.3 ^{cd}	849.4 ^{ab}	3.63 ^{abc}
5.		3000	3009.0 ^{bc}	865.8 ^{ab}	3.475 ^{cd}
6.		3200	2995.9 ^{cd}	851.8 ^{ab}	3.435 ^{de}
7.	22	2800	3217.5 ^a	900.9 ^a	3.585 ^{bcd}
8.		3000	3118.6 ^{abc}	903.5 ^a	3.455 ^{de}
9.		3200	2770.0 ^e	836.9 ^b	3.31 ^e
Standard error of means		—	39.3	16.4	0.0454

*Means bearing the same superscript do not differ significantly ($P < 0.05$)

ment in liveweight gain and feed efficiency for broiler starters as the protein level in the diet increased from 20—26%. The result is in accord with earlier observations made by Summers *et al.* (1964), Rajaguru *et al.* (1966), Bartov *et al.* (1974), Olomu (1976), and Olomu and Offiong (1980). The 24% protein level with ME of 3000 Kcal ME/kg (Diet 8) supported the highest liveweight gain of 818.3g. This figure is, however, not significantly different for rations containing 23 and 26% protein but is significantly different for those containing 20% protein. It can be inferred that the minimum crude protein requirement for broiler starters under the conditions of this experiment is 23% protein with energy concentration of 2800 Kcal ME/kg, and the maximum may probably be around 24% with energy level of 3000 Kcal ME/kg. The requirements found here do not seem to be in any major disagreement with earlier reports. For instance, Gowda (1973) found that the protein requirement of broiler chicks was above 21% and was perhaps around 24% with an energy content of 3000 Kcal ME/kg. Desai (1974) and Rao *et al.* (1974)

found 24% protein level and energy level of 2800 Kcal ME/kg adequate. And recently, Olomu and Offiong (1980) recommended 23% protein level with energy concentration of 2800 — 3000 Kcal ME/kg broiler starters under tropical condition.

Definite requirements cannot be stated for optimal feed efficiency as they were for growth. It is well known that efficiency increases with increasing energy in the diet. The data presented here show a trend towards greater efficiency with increasing protein levels, confirming the reports of Adams *et al.* (1964) and Summers *et al.* (1964). Since the total feed consumption (Table 3) shows very little difference, the greater feed efficiency observed with increasing levels of energy appears to have been related primarily to greater weight gain.

O'Neil *et al.* (1962) and many others have shown that excess energy in relation to protein depresses growth rate and feed efficiency. This interaction was not evident here. Olomu and Offiong (1980) made similar observations when they

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found no significant protein X energy interactions from the statistical analysis of their data.

The results with the finishing broiler chickens followed the same pattern as those of the starters. As protein level increased from 18—22% an improvement in weight gain and feed efficiency was evident. Similar observations were made by Rao *et al.* (1973) and Olomu and Offiong (1980). The data showed that there is obvious improvement in growth rate and feed efficiency by increasing the energy level from 2800 to 3000 Kcal ME/kg but beyond that there is deterioration in growth rate. The ration that contained 22% protein and energy level of 3000 Kcal ME/kg supported the best growth of 903.5g. This figure however, did not differ significantly from those for Diets 4—7. It may be reasoned from our data that a ration containing 20% protein level with energy concentration of 2800 — 3000 Kcal ME/kg will be required for finishing broilers. This recommendation agrees well with 20% protein with energy concentration of 3000 Kcal ME/kg of Olomu and Offiong (1980) but differed slightly with that of Rao *et al.* (1973) who found a ration containing 19% protein with C.P. ratio of 160 adequate for finishers in India (tropics).

In conclusion, based on the experimental design and procedure used in this study the following minimal protein and metabolizable energy levels were found adequate for maximal growth.

Chicks	% protein	Kcal ME/kg
0—6 weeks	23 — 24	2800—3000
6—10 weeks	20	2800—3000

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