OPTIMUM PROTEIN AND ENERGY LEVELS FOR FINISHING BROILER CHICKENS IN A TROPICAL ENVIRONMENT

By

Olomu, M. J.,
National Animal Production Research Institute,
Shika, Zaria,
Nigeria.

SUMMARY

Three experiments were conducted to determine the optimum protein and energy levels for finishing broiler chickens in a tropical environment. Dietary protein levels (20, 23 and 26 percent) and energy levels (2800, 3000 and 3200 Kcal/kg diet) tested had no significant effects on performance of finishing chickens fed fishmeal-containing rations. Rations based on cereals and groundnut meal, without fishmeal, did not support maximum liveweight gain and feed efficiency at dietary protein levels below 26 percent. Dietary treatments had no significant effects on carcass dressing percentages.

Based on the present results, a protein level of 20 percent(for fishmeal-containing rations) and 23 or 26 percent (for rations based on groundnut meal without fishmeal) and energy levels of 2800 to 3000 Kcal/Kg diet are tentatively recommended for finishing broiler chickens raised in a tropical country like Nigeria.

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INTRODUCTION

Based on information obtained in temperate countries, the National Research Council (NRC, 1971) recommended optimum protein level of 20 percent and metabolisable energy (ME) level of 3200 Kcal/Kg diet for finishing broiler chickens (6-9 weeks). Corresponding information on finishing broiler chickens, raised in a tropical environment like Nigeria, is limiting although for starting broiler chicks (0-6 weeks), a protein level of 23 percent and ME of 2800 to 3000 Kcal/Kg diet have been recommended (Olomu, 1976a).

Although groundnut is relatively cheaper and more easily available than fishmeal, it is deficient in lysine and methionine, the two most limiting amino acids in practical poultry rations. A recent report (Wethli, Morris and Shresta, 1975) indicate that groundnut meal based rations support maximum growth if the deficiencies were corrected. There are very few reports, however, that indicate the levels of protein and energy at which maximum growth rate of broiler chickens could be obtained using high levels of groundnut meal without supplementation with lysine or methionine or addition of fishmeal. It was thought useful to seek better evidence about this aspect of the use of groundnut meal.

One other aspect of broiler production that is often neglected is the effect of variation in dietary energy and protein on the dressing out percentages of broiler

chickens. Recently, however, Farrell, Cunning and Hardarker (1973) and Olomu (1976b) reported some data in this respect.

The present studies were designed to determine the optimum protein and energy levels needed for finishing broiler chickens in the tropics and to study the effects of variation in calorie: protein ratios on the dressing out percentages of broiler chickens. A comparative evaluation of rations with or without fishmeal was also carried out.

MATERIALS AND METHODS

Indian River broiler-type day old chicks of mixed sexes were raised for 6 weeks on a ration containing 23 percent protein and ME of 3000 Kcal/Kg diet. At 6 weeks of age, the chicks were fasted overnight, individually weighed and assigned to similar lots of 40 birds each. Two lots were randomly assigned to each treatment. All chicks were fed and watered ad libitum under identical environmental and management conditions on cement floored pens covered with wood shavings as the bedding material. The experiments were terminated when the birds were 10 weeks old.

Three experiments were conducted. The compositions of the experimental rations used are shown in Tables 1 and 2. In Experiments 1 and 2, three protein

Table 1. Composition of Rations Used in Experiment 1.

Ingredients	1	2	3	4	5	6	7	8	9
Yellow maize	55.85	58.70	61.55	49.55	50.25	50.95	43.30	41.75	40.20
Groundnut meal	22.80	24.30	25.80	31.70	33.10	34.50	40.60	41.95	43.30
Fishmeal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Palmoil	0.10	1.75	3.40	0.50	2.90	5.30	0.85	4.05	7.25
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Premix[1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Common salt (Nacl)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Wheat bran	12.00	6.00	-	9.00	4.50	-	6.00	3.00	-
Cost/kg ration (₦)	0.184	0.191	0.198	0.180	0.187	0.194	0.177	0.184	0.190
Calculated composition:									
Crude protein (%)	20	20	20	23	23	23	26	26	26
ME (Kcal/Kg diet)	2800	3000	3200	2800	3000	3200	2800	3000	3200
Lysine (%)	0.85	0.85	0.84	0.95	0.95	0.94	1.05	1.05	1.05
Methionine (%)	0.64	0.64	0.64	0.70	0.70	0.70	0.76	0.76	0.76

1 Supplied per Kg ration: Vitamin A, 10,000 I.U; Vitamin D_3, 2000 I.C.U; Vitamin E, 5 I.U; Vitamin K, 2.24 mg; Riboflavin, 5.5 mg; Vitamin B_{12}, 10 ug; Calcium pantothenate, 10 mg; Niacin, 25 mg; Choline chloride, 350 mg; Folic acid, 1 mg; Manganese, 56 mg; Zinc, 50 mg; Copper, 10 mg; Iron, 20 mg; Cobalt, 1.25 mg; Amprolium, 125 mg; Terramycin, 100 mg.

levels (20, 23 and 26 percent) and three ME levels (2800, 3000 and 3200 Kcal/Kg diets) were evaluated. Rations used in Experiment 2 contained no fishmeal. Experiment 3 involved a comparative evaluation of groundnut-meal based rations with or without fishmeal. In this experiment, Rations 1, 2, 4, 5, 7 and 8 from Table 1 were compared with the corresponding rations in Table 2. The average starting weights of chicks used in Expts. 1 and 2 were 600 grams while those used in Expt. 3 were 650 grams.

Table 2. Composition of Rations Used in Experiment 2.

Ingredients	1	2	3	4	5	6	7	8	9
Yellow maize	55.40	56.35	57.30	49.15	47.85	46.55	42.80	39.50	36.20
Groundnut meal	30.45	31.85	33.35	39.35	40.70	42.05	48.30	49.45	50.60
Palm oil	0.10	2.40	4.70	0.45	3.55	6.65	0.85	4.65	8.45
Bone meal	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Premix[1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Wheat bran	9.30	4.65	-	6.30	3.15	-	3.30	1.65	-
Cost/Kg ration (₦)	0.147	0.154	0.161	0.143	0.150	0.157	0.140	0.146	0.153
Calculated composition:									
Crude protein (%)	20	20	20	23	23	23	26	26	26
ME (Kcal/Kg diet)	2800	3000	3200	2800	3000	3200	2800	3000	3200
Lysine (%)	0.69	0.68	0.68	0.79	0.79	0.78	0.89	0.89	0.89
Methionine (%)	0.58	0.57	0.57	0.64	0.63	0.63	0.70	0.69	0.69

[1] See Table 1.

The birds were weighed at weekly intervals and feed consumption was also recorded at weekly intervals. A record of mortality was kept. At the end of Experiments 1 and 2, a final weight of all birds was taken and 20 birds from each replicate were randomly selected, slaughtered and bled individually in slaughtering cones. The carcasses were defeathered, eviscerated and cleaned. The weights of the carcass plus neck, leg, head, gizzard, liver and heart were obtained. From these weights, the dressing percentages were calculated.

All data were subjected to analyses of variance and significance of differences assessed by applying Duncan's multiple range test (Steel and Torrie, 1960) at the 5 percent level of probability.

RESULTS

Results obtained in the first experiment are summarized in Tables 3 and 4. Dietary treatments had no significant effects on the weight gains, feed efficiency, mortality and feed cost per kilogram liveweight of the birds. Feed efficiency, however, tended to improve with increase in dietary energy levels. Generally, feed consumption tended to decrease with increase in dietary energy level. The caloric intakes of the birds tended to increase with increase in dietary energy level, although in most cases not significantly so. At each energy series, the caloric intake was highest at a dietary protein level of 20%. The carcass dressing percentages were not significantly affected by dietary treatments (Table 4).

Table 2. Effects of variation in dietary protein and energy levels on the weight gain, feed consumption, feed efficiency, caloric intake, mortality and unit cost of production of finishing broiler chickens:

Experiment 1[1]

Dietary Treatment		Weight gain (g)	Feed consumption (g/bird)	Feed efficiency (g feed/ g gain)	Caloric intake[2] (Kcal/bird)	Mortality (%)	Feed Cost/Kg liveweight (₦)
ME (Kcal/Kg diet)	Protein (%)						
2800	20	995.7	2765.1^{a1}	2.83	7742.4^{bc}	2.5	0.52
3000	20	1017.0	2717.1^{a}	2.66	8136.3^{ab}	5.0	0.51
3200	20	1033.7	2644.8^{bc}	2.54	8463.4^{a}	2.5	0.50
2800	23	1000.2	2728.8^{ab}	2.73	7640.5^{bc}	2.5	0.49
3000	23	975.8	2600.0^{bc}	2.67	7800.1^{bc}	2.5	0.50
3200	23	999.9	2476.3^{bc}	2.51	7924.0^{b}	2.5	0.49
2800	26	940.5	2613.3^{bc}	2.87	7317.3^{c}	2.5	0.51
3000	26	1001.1	2591.0^{bc}	2.59	7772.9^{bc}	5.0	0.48
3200	26	988.0	2489.5^{c}	2.53	7966.3^{b}	2.5	0.48

1 Column values followed by the same superscripts or no superscripts are not significantly different (P 0.05).

2 Values were obtained by multiplying feed consumed by metabolisable energy (ME) of the rations.

Table 4. Effects of variation in dietary protein and energy levels on the carcass dressing percentages of broiler chickens -

Experiment 1[1]

Dietary Treatment					Giblets		
ME (Kcal/Kg diet)	Protein (%)	Carcass + neck (%)	Leg (%)	Head (%)	Gizzard (%)	Liver (%)	Heart (%)
2800	20	66.5	5.14	3.79	2.55	1.96	0.37
3000	20	66.8	4.65	3.70	2.53	1.99	0.36
3200	20	65.9	4.77	3.61	2.36	2.07	0.38
2800	23	65.7	4.64	3.55	2.62	1.94	0.34
3000	23	64.1	5.10	3.56	2.53	2.06	0.37
3200	23	65.8	4.90	3.53	2.44	1.93	0.34
2800	26	64.8	4.96	3.74	2.57	1.84	0.33
3000	26	64.4	4.89	3.57	2.54	1.96	0.34
3200	26	65.8	5.26	3.86	2.60	1.78	0.35

[1] No signfficant differences were detected in each of the parameters measured.

Protein and Energy Levels for Broilers.

Results of experiment 2 (Table 5) showed that weight gains of the birds increased with increase in dietary protein level, results different from those obtained in Experiment 1. Variation in dietary energy level had no predictable effects on the weight gains. The best feed efficiency was obtained on the ration containing 26 percent protein and ME of 3200 Kcal/Kg diet. Feed consumption and caloric intake were not significantly affected by dietary treatment. Mortality was not significantly affected although in one case (Ration 1), a relatively high mortality (15 percent) was observed. The feed costs per kilogram liveweight were not significantly affected by dietary treatment and were lower than those obtained in Experiment 1. Dietary treatments had no significant effects on carcass dressing percentages (Table 6). In Experiment 3, the two types of rations (with or without fishmeal) were compared. The results of this experiment are presented in Table 7. The results followed similar trends as in the first and second experiments. Generally, the weight gains and feed consumption of birds given rations with fishmeal were higher than those of birds fed rations without fishmeal. The maximum liveweight gain obtained with unsupplemented groundnut protein (Ration 12) was about 93 to 95 percent of the maximum reached by chickens given a lower level of protein from cereals, groundnut meal and fishmeal (Rations 1 and 2). This particular ration (Ration 12) also gave similar feed consumption, feed efficiency and caloric intake

Table 5. Effects of different protein and energy levels on the weight gain, feed consumption, feed efficiency, caloric intake, mortality and unit cost of production of finishing broiler chickens:

Experiment 2[1]

Dietary Treatment							
ME (Kcal/Kg diet)	Protein (%)	Weight gain (g)	Feed consumption (g/bird)	Feed efficiency (g feed/ g gain)	Caloric intake[2] (Kcal/bird)	Mortality (%)	Cost/ kg liveweight (₦)
2800	20	829.8^{bc}	2508.1	3.03^{a}	7022.7	15.0	0.44
3000	20	814.8^{bc}	2405.4	2.95^{ab}	7216.2	2.5	0.45
3200	20	760.8^{c}	2368.4	3.12^{a}	7578.9	2.5	0.50
2800	23	842.0^{bc}	2539.8	3.02^{a}	7111.3	5.0	0.43
3000	23	857.3^{b}	2547.5	2.97^{ab}	7642.5	0.0	0.45
3200	23	825.0^{bc}	2372.5	2.89^{ab}	7592.0	0.0	0.45
2800	26	858.8^{b}	2553.9	2.98^{ab}	7150.8	2.5	0.42
3000	26	941.4^{a}	2569.5	2.73^{ab}	7708.4	2.5	0.40
3200	26	950.7^{a}	2455.3	2.59^{b}	7858.4	7.5	0.40

1 Column values followed by the same superscripts or no superscripts are not significantly different (P 0.05).

2 Values were obtained by multiplying feed consumed by metabolisable energy (ME) of the rations.

Protein and Energy Levels for Broilers.

Table 6. Effects of variation in dietary protein and energy levels on the carcass dressing percentages of broiler chickens - Experiment 2[1]

Dietary Treatment					Giblets		
ME (Kcal/Kg diet)	Protein (%)	Carcass + neck (%)	Leg (%)	Head (%)	Gizzard (%)	Liver (%)	Heart (%)
2800	20	65.9	4.89	3.66	2.53	1.83	0.37
3000	20	67.1	4.67	3.47	2.60	2.04	0.38
3200	20	66.1	4.69	3.60	2.47	1.86	0.36
2800	23	66.2	4.71	3.56	2.32	1.80	0.34
3000	23	66.2	4.57	3.38	2.24	1.95	0.35
3200	23	65.8	4.58	3.42	2.16	1.76	0.34
2800	26	65.9	4.67	3.49	2.48	1.91	0.33
3000	26	64.4	4.64	3.33	2.26	1.92	0.34
3200	26	66.7	4.90	3.30	2.33	1.95	0.34

[1] No significant differences were detected in each of the parameters measured.

Table 7. Performance of finishing broiler chickens as affected by the presence or absence of fishmeal in groundnut meal-based rations[1].

Dietary Treatment								
Ration type	ME (Kcal/Kg diet)	Protein (%)	Weight gain (g)	Feed consumption (g/bird)	Feed efficiency g feed/g gain)	Caloric intake[2] (Kcal/bird)	Mortality (%)	Cost/ Kg live-weight (₦)
With 5% fishmeal								
	2800	20	1019.0^{ab}	3036.0^{a}	2.98^{abc}	8500.8^{ab}	5.0	0.55^{a}
	3000	20	1037.9^{a}	2987.1^{ab}	2.88^{bc}	8961.3^{a}	2.5	0.55^{a}
	2800	23	1024.4^{ab}	3000.6^{ab}	2.93^{abc}	8401.7^{abc}	2.5	0.53^{ab}
	3000	23	1026.0^{ab}	2868.4^{abc}	2.80^{c}	8605.2^{ab}	5.0	0.52^{ab}
	2800	26	969.7^{abc}	2882.1^{abc}	2.97^{abc}	8069.9^{bcd}	5.0	0.52^{ab}
	3000	26	1023.3^{ab}	2857.4^{abc}	2.79^{c}	8572.2^{ab}	2.5	0.51^{ab}
No fishmeal								
	2800	20	851.8^{c}	2774.2^{c}	3.26^{a}	7767.8^{cd}	5.0	0.48^{bc}
	3000	20	840.5^{c}	2660.7^{c}	3.16^{ab}	7982.1^{bcd}	2.5	0.49^{b}
	2800	23	863.4^{c}	2803.3^{bc}	3.24^{a}	7849.2^{cd}	0.0	0.46^{c}
	3000	23	884.1^{c}	2796.1^{bc}	3.16^{ab}	8388.3^{abc}	2.5	0.47^{bc}
	2800	26	980.0^{bc}	2760.3^{c}	3.04^{abc}	7728.8^{d}	5.0	0.42^{c}
	3000	26	965.5^{abc}	2828.9^{abc}	2.93^{abc}	8486.7^{ab}	5.0	0.43^{c}

1 Column values followed by the same superscripts or no superscripts are not significantly different (P 0.05).

2 Values were obtained by multiplying feed consumed by metabolisable energy (ME) of the rations.

as those obtained on the fishmeal containing rations. Mortality was not significantly affected by dietary treatments. The feed cost per kilogram liveweight was lower on the rations without fishmeal than on those rations containing fishmeal.

DISCUSSION

The present results with fishmeal containing rations indicated that beyond a protein level of 20 percent and ME level of 2800 to 3000 Kcal/kg diet, the performance of birds did not appear to improve. The optimum level of protein agrees with the level recommended for finishing broiler chickens by NRC (1971) while the optimum ME levels agree with previous findings (Olomu, 1976a) but are lower than the NRC (1971) recommendation of 3200 Kcal/Kg diet. A possible reason for the differences in recommended energy needs between the temperate and tropical regions may be that with the higher environmental temperatures in the tropics less energy is needed by these chicks to maintain basal metabolism as compared to those raised in temperate regions. For rations without fishmeal, the optimum protein level seems to be 23 or 26% while the optimum energy level was 3000 Kcal/Kg diet. The lower performance of birds fed the low protein rations without fishmeal may be due to the lower levels of lysine and methionine plus cystine as compared to those containing fishmeal (reference Tables 1 and 2). The improvement in performance with

increase in dietary protein level in the rations without fishmeal may be related to the increase in the levels of these amino acids in the essentially groundnut meal based rations as the dietary protein level was increased.

The maximum liveweight gains obtained with the unsupplemented groundnut rations was about 93-95 percent of that of rations supplemented with fishmeal. Wethli, Morris and Shresta (1975) and Olomu (1976a) had earlier reported values of 84 and 75 percent respectively. Since the earlier workers used day-old chicks while chickens used in the present report were 6 weeks old it is perhaps plausible to suggest that the older birds were more tolerant to any deficiencies existing in the unsupplemented groundnut meal based ration. More research work is needed in this direction.

Although maximum growth rate is an important objective for a feed compounder selling broiler feeds, it may not be the only important criterion for poultry production. The present results indicate that where fishmeal is expensive and not easily available, reasonable growth rate at cheaper production costs could be obtained by its elimination. The question remains as to what extent depression in performance could be accepted in relation to the cost of broiler feeds and elimination of fishmeal. Much more research information is needed in this respect.

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