CRUDE PROTEIN REQUIREMENTS OF GROWING CHICKENS UNDER NIGERIAN ENVIRONMENT

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SUMMARY

A FEEDING trial was carried out with Warren cockerels to determine the minimum crude protein requirements of growing chickens (6 — 14 weeks) under the Nigerian (tropical) environment. Three series of diets with protein levels ranging from 13 to 22 percent were used for this study. The first series consisted of unsupplemented all-plant protein diets, the second and third series were the all-plant protein diets supplemented with methionine or methionine plus fishmeal respectively.

Satisfactory growth and feed conversion efficiency were observed with increasing concentration of protein, changes in body weight being similar to the pattern observed with the baby chicks fed the same protein levels (Njike 1978a).

Maximum weight gain was achieved by chicks on unsupplemented rations containing 20 and 22 percent protein and on 18% protein diets supplemented with methionine or methionine plus fishmeal.

The result clearly showed that there is no advantage in supplementing grower rations with fishmeal; the most economic ration is unsupplemented 18% protein diet.

The performance of chicks on unsupplemented 18% protein diet or 16% protein diet supplemented with methionine or methionine plus fishmeal are comparable and are protein levels of choice for growing chickens under tropical conditions like Nigeria.

INTRODUCTION

THERE is dearth of information on nutrient requirements of chicks under tropical conditions. It is well-known that chicks possess very efficient regulatory mechanisms to adjust the feed intake as per energy demand within certain range of caloric density. Hence any slight change in environment does not affect either growth or egg production provided other nutrients are not limiting. On the other hand chickens do not consume the feed to meet their protein requirement. The sub-optimal level of dietary protein in relation to energy may become the limiting factor for growth and egg production.

Environment has definite effect on feed conversion efficiency, growth and on egg production (Wilson 1969). Joiner and Huston (1957) found that bird grown under variable temperatures weighed 18.64kg more at 10 weeks of age than those held at constant temperature of 32°C. There was also a difference in temperature tolerance between breeds with high temperature affecting the New Hampshires and White Rocks more than White Leghorns. Prince, Potter and Irish (1961) using temperature ranges from 7.5°C to 24°C, found slightly greater gains at the higher temperatures. There was also a slight significant negative linear effect of temperature on feed conversion efficiency attributed to increasing the temperature from 7.5°C to 24°C. Howes, Grub and Rollo (1962) using 5 temperature levels between 13°C and 35°C found that body weight were heavier in the lower temperatures, but the best feed conversion was obtained at the warmer temperatures. Winchester and Kleiber (1938) found that food consumption was approximately a linear negative function of environmental temperature and that environmental temperature had marked effect on the compositions of the body substance formed. The results of Squibb (1959) contrasted with the above reports. This author studied the effect of environment on the production and size of eggs, feed efficiency and mortality of New Hampshire hens in five areas of Guatemala having temperatures covering a range of 0–45°C, with variable humidities. He found that there were no significant differences in egg size, production, feed consumption, mortality and body weight between areas or groups within areas. He explained this inconsistency

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with the published reports on the basis of the observed extremely wide diurnal range for temperatures and humidities in the areas studied. He also hypothesised that the greatest condition of stress will occur when the highest or lowest temperature is associated with the narrowest diurnal range. In addition, the apparent ability of poultry to adapt to environmental stress conditions (Weiss and Borbely 1957 cited by Squibb 1959) must be considered. Despite this discrepancy, most published data tend to indicate that feed consumption is higher in cooler environmental conditions.

For a long time, feed compounders in this country have relied on NRC or ARC recommended allowances for their feed formulations. It has been stressed on several occasions (Agudu, 1971; Babatunde and Fetuga 1976; Olomu, 1976; Njike, 1978^a) that these nutrient requirements established under temperate conditions may not be entirely satisfactory under tropical environment. For efficient feed formulation, it is desirable to provide information on feed composition based on actual requirements derived from experimentally determined levels found adequate for normal growth, health and productivity under tropical conditions. So far little work has been conducted in this direction in this country. An attempt was therefore made to study the crude protein requirements of growing cockerels (6-14 weeks) under Nigerian conditions.

MATERIALS AND METHODS

Allocation of chicks

Day-old Warren breed cockerels were reared up to 6 weeks of age on a conventional starting ration. Dietary treatments were introduced at the end of the 6th week. Four hundred and forty cockerels were used in the feeding trials involving 22 pens of 20 birds each. Two groups of 20 chicks were randomly assigned to each treatment. Feed and water were provided *ad lib*. Chicks were weighed at weekly intervals but feed remnants (and therefore feed intake) were weighed daily.

Diets

Eleven treatment diets were formulated (Table 1). The first series of diets containing 16, 18, 20 or 22 percent protein levels (Diets 1, 2, 3 and 4) were designed to compare responses to increasing concentrations of protein in an unsupplemented all - plant protein diet. The second series consisted of 14, 16 or 18 percent (Diets 5, 6 and 7) all - plant protein diets supplemented with methionine to meet NRC (1971) requirement. The last set of diets with protein levels of 13, 14, 16 or 18 percent protein and containing 3% fishmeal (FM) supplemented with methionine to meet NRC (1971) requirement were tested. All data were analysed by the analysis of variance followed by Duncan's multiple range test as outlined by Steel and Torrie (1960).

RESULTS

The protein and amino acid contents of the protein sources used in the formulation of the rations are presented in Table 2. Table 3 shows the amino acid profile of the test diets, while Table 4 summarizes values for mean weekly body weights, weight gains, feed intake and feed conversion ratios.

Mean body weights

In series 1 diets (Diets 1 to 4) the mean body weights increased significantly ($P < 0.05$) with increasing concentration of protein up to 20% protein level. The mean differences between the liveweight values for 20% and 22% were small but not significant. Supplementation with methionine (Diets 5, 6 and 7) resulted in improvement in total liveweight. The chicks on 16 and 18% protein levels supplemented with methionine (Diets 6 and 7) performed significantly better than the values obtained with those on identical unsupplemented protein levels (Diets 1 and 2). Similarly, the 16 and 18% protein diets with FM (Diets 10 and 11) were significantly better than the unsupplemented diets with similar protein levels (Diets 1 and 2) but were not better

TABLE 1

Percentage Composition of test diets

Ingredients	Ratios											N/kg ingredient
	1	2	3	4	5	6	7	8	9	10	11	
Maize	71.60	65.2	58.8	52.5	77.9	71.6	65.2	84.7	80.7	74.5	68.5	0.200
Groundnut cake	22.30	28.7	35.1	41.4	16.0	22.3	28.7	6.2	10.2	16.4	22.75	0.275
Fishmeal	—	—	—	—	—	—	—	3.0	3.0	3.0	3.0	0.878
Brewers dried grain	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.072
Methionine	—	—	—	—	0.24	0.2	0.15	0.23	0.2	0.16	0.11	3.50
DCP	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.128
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.60
Oyster shell	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.128
Vt/min mix*	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3.87
Calculated protein (%)	16.05	18.02	19.98	21.92	14.1	16.1	18.0	12.99	14.2	16.2	16.07	
Analysed protein (%)	15.8	18.3	20.50	21.9	13.9	15.8	18.4	12.3	14.2	16.2	18.1	
Cost (₹/1000kg feed)	223.5	228.3	233.1	237.9	227.2	230.5	233.6	237.8	239.8	243.0	246.0	

*Provided per kg of complete final ration: Vitamin A, 1500 I.U.; Vitamin D₃ 3000 I.C.U.; Vitamin E, 5mg; Vitamin B₂ 5.5mg; Vitamin B₁₂ 0.01mg; d — calcium pathothenate, 10mg; niacin, 2.5 mg; choline chloride, 120 mg; Vitamin B₁₁ 2mg; BHT; 10 mg; manganese oxide, 32.26mg; ferrous sulphate, 40.65mg; zinc oxide, 25mg; copper oxide, 2.57mg; potassium iodide, 0.706; cobalt; sulphate, 0.572; milcorn ad, 2g.

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TABLE 2

Amino acid composition (% protein) of different protein sources used for the experiment

Amino acid	Yellow maize ¹					Brewers dried grain ¹		Groundnut cake ¹	Fishmeal ²
Arg	..	..	..	..	..	0.45	1.04	4.20	4.50
His	..	..	..	..	..	0.27	0.40	0.95	1.72
Ile	..	..	..	..	..	0.45	1.24	1.70	3.36
Lys	..	..	..	..	..	0.25	0.72	1.50	5.21
Leu	..	..	..	..	..	1.24	1.84	2.70	5.69
Met	..	..	..	..	..	0.11	0.32	0.38	2.10
Cys	..	..	..	..	..	0.13	0.24	0.60	0.86
Phe	..	..	..	..	..	0.57	1.04	2.10	3.02
Tyr	..	..	..	..	..	0.52	0.06	1.50	2.60
Thr	..	..	..	..	..	0.41	0.72	1.10	3.59
Try	..	..	..	..	..	0.11	0.32	0.41	0.86
Val	..	..	..	..	..	0.40	1.28	1.80	3.80
Gly	..	..	..	..	..	0.45	0.80	2.10	4.73
(g/kg) % protein	..	..	..	..	..	9.14	20.80	39.84	71.80

¹Values from Scott *et al* (1969)

²Values from Mba *et al* (1974)

TABLE 3

Amino acid composition (% protein) of various rations

Series 1													Series 2				Series 3			NRC (1975)
Amino acids	1	2	3	4	5	6	7	8	9	10	11									
Arg ..	1.29	1.53	1.77	0.20	0.154	1.29	1.53	0.080	0.958	1.191	1.429	0.95								
His ..	0.417	0.461	0.504	0.545	0.374	0.417	0.461	0.351	0.378	0.421	0.452	0.32								
Ile ..	0.737	0.817	0.897	0.976	0.659	0.737	0.817	0.623	0.673	0.751	0.83	.06								
Lys ..	0.535	0.615	0.695	0.774	0.461	0.535	0.615	0.486	0.536	0.613	0.693	.09								
Leu ..	1.545	1.639	1.732	1.824	1.453	1.545	1.639	1.444	1.502	1.593	1.685	1.10								
Met ..	0.73	0.19	0.208	0.225	—	—	—	—	—	—	—	—								
Met + Cys	0.407	0.454	0.502	0.549	0.601	0.607	0.607	0.06	0.619	0.605	0.602	.0								
Phe ..	0.908	0.106	1.104	0.120	0.811	0.908	0.106	0.735	0.796	0.891	0.988	0.10								
Tyr ..	0.736	0.798	0.861	0.923	0.674	0.736	0.798	0.643	0.682	0.743	0.805	—								
Thr ..	0.561	0.605	0.649	0.692	0.517	0.561	0.605	0.545	0.572	0.615	0.659	0.55								
Try ..	0.180	0.199	0.218	0.237	0.161	0.180	0.199	0.154	0.166	0.185	0.204	0.16								
Val ..	0.726	0.816	0.905	0.994	0.638	0.726	0.816	0.603	0.659	0.746	0.835	.07								
Gly ..	0.815	0.920	0.126	0.130	0.711	0.815	0.920	0.677	0.743	0.846	0.950	.08								
Protein (%)	16.05	18.02	19.98	21.92	14.12	16.05	18.02	12.99	14.22	16.12	18.07	16.00								

TABLE 4

Mean weight (g), weight gain (g), feed intake (g), feed conversion efficiency (g feed/g gain), cost ₦/kg gain and mortality (%)

	R A T I O N S										
	1	2	3	4	5	6	7	8	9	10	11
Starting weights	658.5	664.2	659.5	647.6	636.9	696.9	677.5	687.3	653.9	667.5	676.8
Weight at 10 weeks	1150.8	1250.2	1284.1	1277.1	1123.4	1286.6	1282.8	1063.1	1145.3	1276.8	1298.8
Weight gain at 10 weeks	492.3	586.6	622.6	630.0	486.5	591.7	615.3	375.9	491.1	608.8	623.5
Feed intake at 10 weeks	2353.2	2414.3	2297.4	2343.6	2189.3	2431.9	2399.7	1729.1	2170.6	2508.3	2369.3
FE	4.78	4.12	3.69	3.72	4.50	4.11	3.90	4.6	4.42	4.12	3.80
Weight at 14 weeks ¹	1611.5 ^{cd} *	1691.8 ^b	1836.9 ^a	1837.3 ^a	1568.3 ^d	1721.3 ^b	1850.3 ^a	1552.1 ^d	1640.3 ^c	1736.3 ^b	1890.7 ^a
Weight gain at 14 weeks ²	953.0 ^{fg}	1027.6 ^c	1177.4 ^b	1189.6 ^{ab}	941.4 ^{gh}	1044.4 ^{cd}	1172.8 ^b	815.0 ^{hi}	986.4 ^{ef}	1070.8 ^c	1213.8 ^a
Feed intake at 14 weeks ³	5355.9 ^{bc}	5456.6 ^b	6004.7 ^a	5710.1 ^{ab}	4707.9 ^e	4960.9 ^{cde}	4902.3 ^{de}	4278.8 ^f	4715.0 ^e	4925.7 ^{cde}	4976.6 ^{cd}
FE ⁴	5.62 ^a	5.31 ^a	5.10 ^a	4.80 ^{bc}	5.0 ^{bc}	4.75 ^{bc}	4.18 ^d	5.25 ^{ab}	4.78 ^{bc}	4.60 ^{cd}	4.1 ^d
Percentage mortality	1.0	0.0	2.2	3.0	0.0	4.0	0.0	0.0	5.0	2.2	1.8
Feed cost/kg gain, ₦	1.26	1.21	1.19	1.14	1.14	1.09	0.98	1.25	1.15	1.12	1.0
1SEM	—	—	64.49; CV 1.7%; F	—	33.17***	—	—	—	—	—	—
2SEM	—	—	30.07; CV 1.29%; F	—	146.62***	—	—	—	—	—	—
3SEM	—	—	414.43; CV 3.7%; F	—	13.5***	—	—	—	—	—	—
4SEM	—	—	0.53; CV 4.99 ± F	—	8.54***	—	—	—	—	—	—

* Figures on same horizontal line followed by the same superscript letters are not significantly different (P 0.05).
 *** Very highly significant (P < 0.001)

SEM — standard error of means
 LSD — least significant difference
 CV — coefficient of variation
 F — variance ratio

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than either the unsupplemented 20 and 22% protein level (Diets 3 and 4) or 16 and 18% protein diets supplemented with methionine alone (Diets 6 and 7).

Mortality

Percentage mortality varied from zero to five percentage but there was no apparent relationship between the rations and mortality.

Feed intake and feed efficiency

For each series of diets, the feed intake increased with increasing concentration of the protein in the diet, conversely, the feed efficiency ratio decreased as the protein level increased. These two tendencies tend to suggest more efficient utilization of feed at the higher protein levels.

Feed costs

Table 1 shows the cost per ton of the various diets while Table 4 shows the feed cost per kilogram liveweight gain of the birds. The costs were based on the local prices in 1978. For each series of diets there is an inverse relationship between the feed costs per ton of feed and costs per kilogram liveweight gain.

DISCUSSION

The usual decline in the feed efficiency as the chick ages are evident at all protein levels. Contrary to the results of Pathak and Barsaul (1973) and those of Smith (1967), figures obtained in this study showed that protein levels have significant effect on body weight gain. Smith (1967) indicated that 11 to 19% dietary protein rations did not depress body weight gain.

The data obtained from this trial once more confirm the earlier results (Babatunde *et al.*, 1976; Njike 1978^a) that all-plant protein diets based on groundnut cake and maize meal is capable of supporting economic growth in chicks by formulations at higher protein levels. It is clear from the amino acid composition

of the rations (Table 3) that the first limiting amino acid in the diets is lysine; this is followed by methionine. The good growth rate and feed efficiency obtained in this study would appear not to justify the high level of lysine requirements recommended for growing pullets as indicated in the publication of NRC (1971). This idea is supported by the lower figure 6.3g/kg diet recommended for growing pullets by ARC (1975). The ARC (1975) figure was nearly met by most diets used for this study except diets 5, 8 and 9. This means that diet of 16% (Diet 6) without lysine supplementation was quite adequate.

It has been demonstrated earlier (Njike, 1978a & b) that chick starter rations properly blended with methionine alone performed as efficiently as those supplemented with methionine and fishmeal. But it will appear from the results of Olomu (1976) that the broiler starter rations based on groundnut cake and maize meal would require fishmeal supplementations.

From the performance of chicks on various rations, it would appear that 18% unsupplemented all-plant protein diet, 16% all-plant protein diet supplemented with methionine alone or methionine plus fishmeal will be adequate for growing chickens under the conditions of this experiment.

REFERENCES

- AGRICULTURAL RESEARCH COUNCIL LONDON. 1975. The Nutrient Requirements of Farm Livestock No. 1 Poultry.
- AGUDU, E. W., 1971. Protein requirements for chickens *Ghana Jnl. Agric. Sci.* 4, 13-19
- BABATUNDE, G. M. and FETUGA, B. L. 1976. Determination of the minimum crude protein requirements of broiler starters and finishers in the tropics *Nig. J. Anim. Prod.* Vol. 3, 126-138.
- BABATUNDE, G. M., FETUGA, B. L. and KASSIM, E. 1976. Methionine supplementation of low protein diets for broiler chicks in the tropics. *Brit. Poultry Sci.* 17, 463-469.
- HOWES, J. R., GRUB, W. and ROLLO, C. A. 1962. The effects of constant high temperature regimes upon broiler growth, feed efficiency, body composition and carcass quality. *Poultry Sci.* 41, 1652.

- JOINER, W. P., and HUSTON, T. M. 1975. The influence of high Environmental temperature on immature domestic fowl. *Poultry Sci.* 36, 973-978.
- MBA, A. U., NJIKE, M. C. and OYENUGA, V. A. 1974. The proximate chemical composition and the amino acid content of some Nigerian oil seeds. *J. Sci. Fd. Agric.* 25, 1547-1553.
- N. R. C. 1971. Nutrient Requirement of Domestic Animals. No. 1 Nutrient Requirements of Poultry, 6th ed. Washington D.C. National Academy of Sciences — National Research Council.
- NJIKE, M. C. 1978^a) Nutrient requirements of chicks under Nigeria environment. A paper presented before the meeting organised for Practising Professional Veterinarians at N.V.R.I., Vom, Jan. 1978.
- NJIKE, M. C. 1978b. Cottonseed meals as a substitute for groundnut cake in the diet of baby chicks. In breeds and nutrition of poultry in Nigeria. P. 59 (Pub. by Wld Poult. Sci. Ass. (Nigeria branch).
- OLOMU, J. M. 1976. Determination of optimum protein and energy levels for broiler chicks in the tropics. *Nig. Jnl. Anim. Prod.* 3, 177-183.
- PRINCE, R. P., POTTER, C. M. and IRISH, W. W. 1961. Response of chickens to temperature and ventilation environments. *Poultry Sci.* 40, 102-108.
- PATHAK, V. P., and BARSAUC C. S. 1973. Studies on growth and meat production in White Leghorn and Cross-bred chicks. *Indian J. Anim. Sci.* 43, 1006-1009.
- SCOTT, M. L., NESHEIM, M. C. and YOUNG, R. J. 1969. Nutrition of the chicken. M.L. Scott and Associates, Publishers; Ithaca, New York and London.
- SMITH, R. F. 1967. The utilization of poultry diets of protein of identical amino acid pattern. *Poultry Sci.* 46, 730.
- SQUIBB, R. L. 1959. Relation of diurnal temperature and humidity ranges to egg production and feed efficiency of New Hampshire hens. *J. Agric. Sci.* 52, 217-222.
- STEEL, R. G. D. and TORRIE, J. A. 1960. *Principles and provedures of statistics.* New York, McGraw-Hil Book Company Inc.
- WILSON, S. P., 1969. Genetic aspects of feed efficiency in broilers. *Poultry Sci.* 48, 487-495.
- WINCHESTER, C. F. and KIEBER, M. 1938. The effect of environment on mortality, rate of growth, and utilization of food energy in White Leghorn chicks. *J. Agric. Research,* 57, 529-544.