CRUDE PROTEIN REQUIREMENTS OF EGG-TYPE BABY CHICKS UNDER NIGERIAN (TROPICAL) ENVIRONMENT

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SUMMARY

TWO feeding trials were conducted with day old mixed sexes of Apollo (White Leghorn) strain. The first experiment was designed to test the effectiveness of all — vegetable protein diets to meet the requirements of baby chicks. While the second one was designed to find out whether synthetic methionine and/or fishmeal supplementation are desireable in low quality protein of groundnut cake.

Results showed that a diet based on plant proteins only, namely, those of groundnut cake and maize, is capable of stimulating rapid growth in chicks. Diets containing 24% all-vegetable protein, 22% plant protein plus 0.35% feed grade methionine or 20% plant protein containing 3% of fishmeal plus 0.37% feed grade methionine, satisfied the requirements for rapid growth and efficient feed utilization in young chicks. However, based on the prevailing prices of the ingredients used in formulating the rations, the results indicate that ration based on 24% all — plant protein diet was least expensive.

INTRODUCTION

One of the main constraints to livestock production in Nigeria is the inadequate knowledge of nutritional requirements of our domestic animals, particularly poultry and pig. Poultry nutrition research in this country has been somewhat haphazard. There has been, surprisingly, no attempt to work out systematically nutrient requirements for chicks under Nigerian conditions. Most of the feed formulations have been based on the NRC and/or ARC recommended allowances. Evidence points to the fact that nutrient requirements for chickens established in temperate zones and recommended by the NAS-NRC or the ARC may not be satisfactory in the tropics and sub-tropics (Scott, 1968). In most part of Nigeria, the temperature rises above the range of thermal neutrality (13°-31°C) (Scott, 1973). Information available indicates that climate, particularly heat stress, affects the performance of chicks. Although it is not well known how far the chicken is affected and to what extent adaptation to the environment is possible, it is generally known that heat stress occurs above the range of thermal neutrality. This range is considered to be the normal for optimal metabolism in the bird.

Heat stress coupled with high relative humidity reduces feed intake; this in turn reduces protein (amino acids), energy sources, mineral and vitamin intakes; also high temperatures exert detrimental effects on the storage and keeping quality of feed ingredients.

Any experiment aimed at determining nutrient requirements of chicks raised under the Nigerian environment and which is carried out under Vom conditions requires justification. This is because the weather conditions in this part of the country are atypical of the rest of the country. The weather conditions of Vom in Plateau State of Nigeria has been described by Knudsen and Sohael (1970). Briefly, the average daily mean minimum temperature is 17°C; average daily mean maximum temperature is 28.6°C. The average daily mean relative humidity at noon varies between 14% and 17%. The corresponding figures for Ibadan (University of Ibadan, 1969) for the same period are as follows:— Average daily mean minimum temperature is 21.6°C and average daily mean maximum temperature is 33.5°C. Plateau State therefore ap-

pears to be a distinct ecological zone.

The objective in carrying out these feeding trials is to obtain information on nutrient requirements of chicks in this zone and thus furnish data with which to compare results from other zones of Nigeria; a realistic compilation of feed requirements of livestock in Nigeria must take into account all the various ecological zones in the country and a collaborative work on this subject, sponsored by the Federal Department of Livestock, has Vom as one of its centres for the poultry trials..

Experiment 1

The first experiment was designed to test the effectiveness of all-plant protein diets to meet the requirements of baby chicks.

One day old chicks of both sexes of Apollo (White Leghorn) strain were randomly divided into seven equal treatments. Two groups of 40 chicks were randomly assigned to each treatment. Seven diets were formulated to contain 18, 20, 22, 24, 26, 28 and 30% protein (on dry matter basis). The chicks were fed their respective experimental diets *ad libitum* for 6 weeks. They were weighed in groups at weekly interval and feed consumption was also recorded weekly. A commercial starter diet was included in the experiment for comparison.

Experiment 2

Experiment 2 was designed to test the effect of supplementing low quality protein of groundnut cake with synthetic methionine and to find out whether FM as an additive is desirable in starter diets.

The rations containing 18, 20, 22, 24 and 26% protein in experiment 1 were supplemented with feed grade methionine to meet 100% of the recommended ARC (1975) levels. Another set of rations containing 3% FM were tested in the same experiment at 18, 20, 24 and 26% protein levels. The experimental design and the conduct of the experiment were as in experiment 1.

All the data were analysed by the analysis of variance and Duncan's multiple range test as outlined by Steel and Torrie (1960). The 0.05 level of probability was accepted as the criterion for statistical evaluation of significances.

RESULTS

Experiment 1

Tables 1 and 2 show, respectively, the composition of the rations and the amino acid profile of the diets used in experiment 1. Included in Table 2 is a column showing ARC (1975) amino acid requirements of chicks. Shown in Table 3 are the more pertinent data from the experiment 1.

TABLE 1

Composition (g/kg) and calculated analysis of the diets containing cereal and groundnut cake as principal protein source given to chicks in experiment 1

RATIONS

Components	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Yellow Maize	722.3	673.1	623.9	574.7	525.4	476.22	427.0
Groundnut Meal	209.6	258.8	308.03	357.3	406.47	455.68	504.9
Brewer's Dried Grain	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Dicalcium Phosphate	25.5	25.5	25.5	25.5	25.5	25.5	25.5
Oyster Shell	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Socium Chloride	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Vitamin/Mineral Mix*	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Calculated Protein (6.25 x N)(g/kg)	180.3	200.3	220.1	240.0	259.9	279.8	299.7
Determined Protein (6.25 x N)(g/kg)	181.5	198.9	221.6	239.8	261.8	281.2	300.8

**Supplied per Kilogram of idet: Vitamin A, 15000 I.U.; Vitamin D_3, 3000 I.C.U.; Vitamin E, 5 mg. Vitamin B_2 5.5 mg; Vitamine B_{12} 0.01 mg; D-calcium pantothenate 10 mg; niacin, 25 mg; choline choline chloride 120 mg; Vitamin B_1 2 mg; B.H.T., 10 mg; maganese oxide 32.26 mg; ferrous sulphate 40.65; zinc oxide 25 mg; copper oxide 2.57 mg; potassium iodide 0.706 mg; cobalt sulphate 0.572, milocorn ad 2g.*

TABLE 2

Amino acid composition (g/kg) of diets used for experiment 1

RATIONS

Amino Acids	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*ARC (1975 Requirements)*
Arg	14.46	16.80	119.14	21.48	23.48	27.15	28.48	10.3
Ais	4.38	4.79	5.19	5.60	6.07	6.42	6.83	4.3
Ile	8.22	9.08	9.94	10.81	11.67	12.53	13.39	8.5
Leu	16.22	17.18	18.14	19.11	20.07	21.04	22.00	14.5
Lys	5.80	6.56	7.32	8.08	8.85	9.61	10.37	11.0
Met	1.94	2.13	2.32	2.51	2.71	2.90	3.09	4.8
Met + Cys	4.63	5.15	5.67	6.19	6.71	7.23	7.76	9.2
Phe	9.67	10.62	11.57	12.52	13.47	14.42	15.37	9.2
Tyr	8.75	9.38	10.01	10.64	11.27	11.30	12.53	7.3
Thr	6.11	6.60	7.09	7.57	8.06	8.55	9.03	7.4
Try	1.94	2.13	2.32	2.51	2.71	2.90	3.09	2.1
Val	7.88	8.77	9.66	10.54	11.43	12.31	13.20	9.8
Gly	8.94	10.00	11.06	12.12	13.17	14.23	15.29	14.0 (glycine + serine)
Protein (N x 6.25) (g/kg)	180.3	200.3	220.1	140.0	159.9	279.8	299.7	
First limiting amino acid	met	met	met	met	met	met	met	
Second limiting amino acid	lys	lys	lys	lys	lys	lys	lys	
Amount of met added in expt. 2	4.57	4.05	3.53	3.01	2.49	1.97	1.44	

Mortality Rate

Data on mortality are not shown but the results from the two experiments, considered collectively, indicate that different diets had no effect on mortality rate. Generally the mortality rate was low and in no treatment diet did the number of birds that died exceed 7% of the total number.

TABLE 3

Mean body weight, gain, feed intake and feed conversion efficiency of chicks given different protein levels

Protein level %	Mean body weight (g)	Mean weight intake (g)	Mean feed intake (g)	Feed conversion efficiency (g feed intake/g weight gain)
18	203.2[a]*	166.5[a]	503.9[a]	3.03[gh]
20	221.6[ab]	180.4[ab]	522.1[ab]	2.90[fg]
22	240.5[hc]	203.8[c]	563.5[c]	2.77[bdef]
24	324.6[a]	286.5[e]	767.2[de]	2.68[bcd]
26	372.4[f]	332.2[f]	889.9[f]	2.67[bc]
28	391.6[fg]	352.0[g]	914.6[fgh]	2.60[ab]
30	391.7[fgh]	355.6[gh]	898.5[fg]	2.53[a]
Commercial Ration	297.0[d]	266.4[d]	753.9[d]	2.83[bdef]
Standard error of means	7.49	4.73	7.85	0.04
LSD (0.05)	24.42	15.4	37.2	0.14
LSD (0.01)	35.5	22.4	37.2	0.2
Coefficient of variation	3.5%	2.5%	1.5%	2.2%
F — Value	104.7**	262.5**	485.4**	13.6**

*Means in any one column bearing the same superscript do not differ significantly ($P < 0.05$).

**Highly significant ($P < 0.01$)

Final body weight

Increasing the concentration of protein of the diet led to a significant increase in total live-weight. For the strain of chicks used the final weights of those on diets containing 24, 26, 28 and 30% protein were very satisfactory.

The groups on the 24% protein diet performed significantly better than those on commercial starter diet ($P \leq 0.05$). Up to the level of protein tested (30%), the chicks showed progressive increase in total live-weight attained, showing that protein at that level has no toxic effect on the chicks.

Rate of weight gain

This followed the same trend as the final body weight, the group on higher protein levels gaining significantly better than those on lower ones up to the level tested. Again the group on 24% protein diet gained significantly better than those on commercial rations.

Feed intake

There was progressive increase in food intake as the protein level increased. The significantly higher food intake as the protein increased might be a reflection of better dietary amino acid balance. There was no significant difference between the amount of food consumed by the group on 24% protein level and those on commercial ration.

Feed efficiency

Increasing the protein level in the diet led to a decrease in feed conversion efficiency, (g food eaten/g weight gain), the increase being statistically significant. There is thus an inverse relationship between protein level on food efficiency up to the level of protein tested. The food efficiency for the group on 24% protein and commercial ration were 2.68 and 2.83 respectively. The mean difference between them was small and just statistically significant (P < 0.05).

Experiment 2.

Tables 4 and 5 show the composition of the basal diet and amino acid composition of the diets used in this experiment respectively. The results of the experiment are shown in Table 6.

TABLE 4

Composition (g/kg) and calculated analysis of the diets containing cereal and groundnut cake as principal protein sources given to chicks in experiment 2

Components	*1*	*2*	*3*	*4*	*5*
Yellow Maize	703.7	653.7	603.7	553.7	503.7
Groundnut Meal	170.0	220.0	270.0	320.0	370.0
Brewer's Dried Grain	30.0	30.0	30.0	30.0	30.0
Fish Meal (FM)	30.0	30.0	30.0	30.0	30.0
Dicalcium Phosphate	25.5	25.5	25.5	25.5	25.5
Oyster Shell	5.0	5.0	5.0	5.0	5.0
Sodium Chloride	4.3	4.3	4.3	4.3	4.3
Vitamin/Mineral Mix	2.0	2.0	2.0	2.0	2.0
Calculated Protein (N x 6.25) (g/kg)	180.3	200.1	220.1	240.2	261.1
Determined Protein (N x 6.25) (g/kg)	179.2	200.6	221.5	239.0	261.9

TABLE 5

Amino acid composition (g/kg) of diets used for experiment 2.

RATIONS

Amino acids	*1*	*2*	*3*	*4*	*5*
Arg	13.67	16.05	18.42	20.80	23.17
His	4.41	4.82	5.24	5.65	6.07
Ile	8.27	9.15	10.02	10.90	11.77
Leu	16.42	17.40	18.38	19.36	20.36
Lys	6.63	7.40	8.95	9.73	8.18
Met	2.35	2.55	2.74	2.94	3.13
Met + cys	4.95	5.48	6.01	6.54	7.07
Phe	9.48	10.14	11.41	12.37	13.34
Tyr	8.72	9.32	9.86	10.60	17.24
Thr	6.56	7.05	7.55	8.04	8.54
Try	1.98	2.17	2.37	2.56	2.76
Val	8.08	8.98	9.88	10.78	11.68
Gly	9.25	10.32	11.40	12.47	13.55
Protein (N x 6.25) (g/kg)	180.3	200.1	220.1	240.2	260.1
First limiting amino acid	met	met	met	met	met
Second limiting amino acid	lys	lys	lys	lys	lys
Met added	4.25	3.72	3.19	2.66	2.13

TABLE 6

Mean body weight, gain, feed intake and feed conversion efficiency of chicks (0 — 6 weeks) given different proteins supplemented with methionine and PH

Diets %	Mean body weight (g)	Mean weight gain (g)	Mean feed intake (g)	Feed conversion efficiency
18.0	203.2^{a*}	166.5^{a}	503.9^{a}	3.03^{mn}
18 + met	259.8^{ed}	226.1^{cd}	624.7^{d}	2.76^{hijk}
18 + met + FM	281.3^{de}	246.1^{de}	644.8^{ed}	2.62^{efgh}
20.0	221.6^{ab}	180.4^{ab}	522.1^{ab}	2.90^{klm}
20 + met	305.6^{ef}	270.1^{ef}	710.3^{f}	2.65^{efghi}
20 + met + FM	331.9^{fhg}	296.6^{gh}	762.3^{fg}	2.57^{def}
22.0	240.5^{bc}	203.8^{bc}	563.5^{bc}	2.77^{hijkl}
22 + met	347.6^{ghi}	312.5^{ghi}	812.5^{iigh}	2.60^{efg}
22 + met + FM	368.6^{ij}	330.0^{ij}	830.0^{ijk}	2.50^{abcde}
24.0	324.6^{fg}	286.5^{fg}	767.8^{fgh}	2.68^{fghij}
24 + met	373.9^{ijkl}	337.3^{ijkl}	807.4^{ghi}	2.44^{abcd}
24 + met + FM	396.4^{jklm}	362.2^{jklmm}	865.7^{klm}	2.39^{ab}
26.0	372.4^{ijk}	332.2^{ijk}	889.9^{lmno}	2.68^{fghij}
26 + met	396.9^{klmn}	361.4^{jklm}	865.0^{lk}	2.40^{abc}
26 + met + FM	406.6^{mno}	371.6^{mno}	880.7^{klmn}	2.37^{a}
Standard error of means	9.17	9.77	17.60	0.069
LSD (0.05)	27.64	28.96	37.5	0.147
LSD (0.01)	38.22	40.05	51.87	0.203
Coefficient of Variation	4.0%	4.8%	3.5%	3.8%
F — Value	53.3**	29.4**	49.3**	12.0**

* Means in any one column bearing the same superscript do not differ significantly ($P<0.05$)
**Highly significant ($P < 0.01$)

Final body weight

At all protein levels, groups on diets supplemented with FM performed best. This was followed by the group on plant proteins supplemented with methionine alone. The mean final body weights of birds on unsupplemented 24% protein diet, 22% protein supplemented with methionine alone and 20% protein containing FM and methionine are 324.6, 347.6 and 331.9% respectively. Their mean differences are not statistically different.

Rate of weight gain

Supplementation with methionine and methionine plus FM produced better rates of gain than unsupplemented diets at all protein levels. The mean differences were significant.

Feed intake and feed efficiency

Methionine and methionine plus FM supplementations of the protein levels caused statistically significant decrease in food intake. The effect of these supplementations on food intake contrasted with the apparent effect on weight gains and final body weights. At all levels, chicks receiving rations containing FM consumed less food than those on rations supplemented with methionine alone or unsupplemented protein diets on food eaten/100g body weight. Also birds on protein supplemented with methionine alone consumed less food than those receiving unsupplemented rations. As might be expected, the tendency for weight gain to increase with methionine or methionine plus FM supplementations and for food intake to decrease (g food eaten/100g body weight) was reflected in the significantly more efficient feed conversions of chicks receiving the diets adequate in methionine. It is apparent therefore that chicks offered diets adequate in methionine consume less food per unit body weight gain than those offered diets marginally limiting in methionine.

Feed costs

Table 7 shows the feed costs of rations on 24% unsupplemented protein level, 22% protein supplemented methionine and 20% protein plus FM plus methionine. Feed costs estimated either on the basis of ration compositions or on the feed required per kilogram liveweight gain showed rations with FM to be most expensive followed by the ration with methionine supplementation. The 24% protein unsupplemented ration is the cheapest. This is to be expected considering the high price of FM and methionine.

TABLE 7

Cost of various rations

Rations	*cost, N/25 kg*	*cost, N/kg weight gain*
24% protein unsupplemented ration	3.83	0.4097
22% protein + met	4.03	0.4186
20% protein + met + FM	4.35	0.4472

Cost of each ingredient (in N/kg):
Maize 0.134; groundnut cake, 0.165; fishmeal, 0.810 brewers dried grain 0.072; oyster shell, 0.128; dicalcium phosphate, 0.128; salt, 0.60; vitamin/mineral mix (Intervet), 3.87; feed grade methionine, 2.42.

Discussion

Groundnut meal is the main source of protein for poultry in Nigeria and it is well known that for growing animals groundnut meal is low in both lysine and methionine. These deficiencies are not remedied by mixing the materials with cereals (see Table 2). In the experiments reported here it is evident that in spite of these deficiencies, it is possible to arrive at a protein level consisting of groundnut meal and a cereal base which will satisfy the requirements for rapid growth. The result of this experiment (Table 3) shows that 24% plant protein diet unsupplemented with FM and methionine is capable of supporting maximum economic growth in chicks. This is in agreement with the findings of Babatunde *et al.* (1976) who reported that a high protein diet unsupplemented with methionine was more economical to feed broilers than supplemented low protein diets. It, however, contrasts with results of Wethli *et al.* (1975). These authors concluded from their data that diets based on cereals and groundnut meal were incapable of supporting maximum live-weight gain or maximum efficiency of food utilisation at any level of dietary protein. It has to be pointed out that rations that support maximum growth are not necessarily the most economic. Even though maximum growth rate is an important objective for a food compounder selling chick diets in a competitive economy, it may not be an important criterion for poultry production in some parts of the world, where groundnut meal is available and high quality protein and synthetic amino acids are expensive or unavailable. Also, compensatory growth may occur using an efficient grower ration so that differences due to the type of protein supplied may not be apparent at later stages.

The fact that there is continuing response to increasing levels sof groundnut meal up to the maximum level of protein tested showed that the critical amino acids, methionine and lysine, are limiting.

Supplementation of diets with methionine and FM (Table 6) resulted in substantial improvements in growth rate, feed effeciency and total body weight attained. The lower protein levels, however, did not support maximum growth but this is not surprising judged by the amino acid composition of these diets (Table 4). By increasing the dietary protein to 22% and supplementing with 0.353% methionine alone, and 20% protein containing 3% FM plus 0.372 methionine, a performance equivalent to the group on 24% unsupplemented protein was obtained. The final body weights were high and are consistent with values expected from this breed of chicks. Agudu (1971) working in Ghana did not find any major advantage in chicks, fed higher protein levels in their early life, during their laying period and suggested that starter rations can conveniently be reduced to 18 or 16% protein without any long-term deleterious effect. In the present experiments, chicks on 18% protein containing 3% FM and methionine did not attain body weight and live-weight gain consistent with this class of birds. The discrepancy between the two data is probably to be explained in terms of the high percentage FM (8%) used by Agudu. Such a ration must be very uneconomical in this country in view of the high cost of FM. Palafox (1965) working in Hawaii provided data showing significantly more delayed sexual maturity in pullets on 16% protein than those fed 20% in their early age. This means that the early protein malnutrition in chicks would appear to have irreparable effects on the subsequent adult performances. The differences in the protein levels arrived at as satisfying the requirements for maximum economic growth in chicks appear to be a reflection of the quality of protein used in compounding the rations. Thus in the experiments reported here 24% unsupplemented protein, 22% protein supplemented with methionine and 20% protein containing 3% FM plus methionine supplementation satisfy chick requirements.

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