Trop. J. Anim. Sci. 1 (2): 63-72 (1999)
ISSN: 1119-4308

CRUDE PROTEIN REQUIREMENT OF GROWING COCKERELS BY DIET DILUTION TECHNIQUE

R.I. SALAMI[1] AND K.N. BOORMAN[2]
Animal Science Division
Department of Agricultural Education,
ST. Andrew's College of Education, Oyo, Nigeria.

Target Audience: Animal scientists, animal nutritionists, poultry farmers

ABSTRACT

An improved method called diet dilution technique was used (in place of the orthodox method) to design treatment diets to measure the crude protein (CP) requirement of the growing Isa Brown cockerels during 9 to 13 weeks of age. A 280g/kg CP summit diet was serially diluted with an isoenergetic 25.6g/kg CP dilution mixture to produce treatment diets containing 120, 140, 160, 180 and 200g/kg CP on as-fed basis with 2600 kcal/kg metabolisable energy content in diets A,B,C,D and E respectively. The diets were fed *ad libitum* to a total of 75 birds.

Mean daily weight gain and feed conversion ratio (FCR) were improved significantly (P<0.05) as dietary CP content increased up to the level of 180g/kg CP diet beyond which there was no significant improvement. This diet (D) supported daily growth rate of about 20g/bird/day and FCR of 4.41. Feed cost per unit of gain on 180 and 200g/kg CP diets were the same (*ca* 10 kobo) and lower than on the rest diets, with the highest feed cost (*ca* 17 kobo) per unit of gain recorded for diet A. Conclusively, 180g/kg CP diet would satisfy the protein requirement of the growing cockerels for optimal growth rate and FCR and at minimal cost of feeding per unit of gain.

Key words: Cockerel, feed cost, protein requirement, summit diet, diet dilution technique, performance characteristics.

DESCRIPTION OF PROBLEM

The method commonly used in protein requirement studies to design experimental diets is to adjust the proportion of the energy or protein concentrates or both in order to produce graded levels of dietary protein for determining "requirement" (1,2,3). This approach does not allow for

[1]Corresponding author

[2] Department of Applied Biochemistry Food and Nutrition, University of Nottingham Sutton Bonnington, L.Borough, United Kingdom

computing the cost of feed or nutrient under test without bias in view of different proportions of the concentrates used in the treatment diets. Furthermore, this procedure may also introduce different proportions of the essential amino acids due to the proportions of the concentrates used thereby altering not only the amino acid balance but also the energy content of some of the treatment diets.

A method has since been described which eliminates the shortcomings inherent in the orthodox method. It is called "diet dilution technique" (4,5). Although the method was originally developed and applied to determine the methionine requirement of laying pullets, it has since been applied to measure the amino acid requirements of different classes of poultry birds (5,6,7). In its application for determining amino acid requirement of birds, it entails the serial dilution of a high-protein "summit" diet with a protein-free or low-protein dilution mixture of similar energy, vitamin and mineral (supplemental) contents to produce a series of diets containing increased concentration of the test amino acid. The test amino acid is made first - limiting in the summit diet by keeping it usually at a relatively lower level of 145 to 150% of its required value while those in greater excess may be at 185 to 200% of the assumed or recommended requirement value. It is pertinent to mention that the treatment diets resulting from the serial dilution of the summit diet have varying protein contents with constant amino acid balance, a feature which the present study utilises for designing treatment diets of varying crude protein levels to determine "requirement".

Despite the preference for tougher table meat which is provided by intensively managed culled layers and culled scavenging birds notably cocks and hens in some quarters in Nigeria (8,9), commerical cock/cockerel production and their nutrition have been neglected until recently (10). The present study was, therefore, carried out to modify and apply diet dilution technique to measure the crude protein requirement of growing cockerels during 9 to 13 weeks of age.

MATERIALS AND METHODS

Treatment Diets: A 280g/kg crude protein (CP) summit diet (SD) in greater excess of the recommended requirement of the growing chickens (2,8,11) and a low-protein (25.6g/kg CP) dilution mixture (DM) were formulated according to the principles of diet dilution technique. Both the SD and DM (Table 1) contained same contents of metabolisable energy (ME), supplemental vitamins and mineral elements. As a modification of an aspect of the technique, Pearson Square Method (9) was used to serially dilute SD with DM (on the basis of their calculated CP and ME contents) to produce five treatment diets containing 120, 140, 160, 180 and 200g/kg graded levels of CP in diet, A,B,C,D and E respectively (Table 2). The treatment diets were also similar in some calculated proximate fractions while crude fibre varied slightly but was within the range required for normal functioning of the alimentary tract in the class of birds used (11).

Table 1: *Composition of Summit Diet and Dilution Mixture (g/kg)*

Feed Ingredient	N/kg	Summit diet	Dilution Mixture
Maize (9% protein)	25.00	310	-
[1]Lafun (2% protein)	26.00	-	620
Groundnut cake (45% protein)	26.00	290	-
Palm Kernel cake (18% protein)	4.00	120	-
[2]Rice offal (4% protein)	3.00	120	330
Blood meal (80% protein)	18.50	70	-
Fish meal (65% protein)	130.00	60	-
Palm oil	55.00	-	20
Bone meal	14.00	15	15
Oyster shell	5.00	10	10
[3]Premix	360.00	2.5	2.5
Salt	14.00	2.5	2.5
Total	-	1000	1000
N/kg		26.42	19.05
Calculated fractions:			
Crude protein(g/kg)		280.00	25.60
Crude fibre (g/kg)		68.20	112.80
Ether extract (g/kg)		49.50	50.25
Metabolisable energy Kcal/kg)		2609.24	2606.00
Determined fractions:			
Crude protein (g/kg)		279.50	24.86
Crude fibre (g/kg0		70.45	114.35
Ether extract (g/kg)		50.65	49.20
Moisture (g/kg)		103.50	97.50

[1]*See (20) for production technology*
[3]*See (12) for composition.*

Birds and their management: From a flock of one hundred 9 weeks-old Isa Brown cockerels previously managed on deep litter, 75 birds were selected. After weighing individually, the birds were allotted into 15 groups of 5 birds each and of uniform initial mean body weight. The treatment diets were randomly applied to the groups and each diet was fed *ad libitum* to three replicates. The housing, feeding and watering of experimental birds used in the previous work [12] were followed presently.

Table 2: Composition of Treatment Diets Produced From Summit Diet and Dilution Mixture by Pearson Square Method (g/kg)

Treatment Diet Code	Dietary Level		Proportion (g/kg)		
	CP(g/kg)	ME(kcal/Kg)	[1]SD	[1]DM	[2]N/kg diet
A	120	2607.11	371.00	629.00	21.78
B	140	2607.34	449.70	550.30	22.36
C	160	2607.58	528.30	471.70	22.94
D	180	2607.82	606.90	393.10	23.52
E	200	2608.05	685.50	314.50	24.10

[1]See Table 1 for composition.
[2]Computed from Table 1

Measurements: Live body weight and feed intake of the replicates per treatment diet were measured on weekly basis from which the mean weight gains, feed intake and feed conversion ratio (FCR) on weekly basis and entire four-week period of study were subsequently computed for the respective treatment diets.

Feed Cost Analysis: The cost of the treatment diets was computed using the current market prices of the feedstuffs at the time of experiment and the calculated cost of SD and DM used to produce the treatment diets (Table 1&2).

Chemical and Statistical Analyses: Samples of SD and DM were analysed for their proximate fractions (Table 1) according to the standard methods of AOAC (13). Live performance data were subjected to analysis of variance and Duncan's Multiple Range Test was also used to compare the treatment means (14).

RESULTS AND DISCUSSION

The effects of dietary treatments on weekly basis and for the entire 4-week period of the experiment are summarized in Tables 3 and 4 respectively. Birds receiving diets D and E consistently had similar ($P>0.05$) growth rates which were also better ($P<0.05$) than those of birds on diets A and B during 9 to 13 weeks of age. Mean daily weight gain of the birds for the entire period of study revealed that increasing dietary crude protein content caused significant ($P<0.05$) improvement in this parameter up to 18% CP level beyond which there was no significant improvement.

Table 3: **Weekly live Performance Characteristics of the Cockerels Fed Different Levels of Crude Protein at Met. Energy of 2600 kcal/kg Diet During 9 to 13 Weeks of Age**

Performance Parameters	Treatment Diets					
	A	B	C	D	E	±SEM
Initial mean body weight (g/bird)	630.00	630.00	630.00	625.00	620.00	10.00NS
[1]ADG, g/bird d(9-10 weeks of age)	7.85^{b}	8.42^{b}	12.85^{b}	18.57^{ab}	19.57^{a}	1.20*
ADG, g/bird d(10-11 weeks of age)	8.51^{c}	17.04^{b}	18.66^{ab}	19.07^{ab}	21.17^{a}	0.77*
ADG, g/bird d(11-12 weeks of age)	11.42^{c}	15.17^{bc}	19.99^{a}	18.57^{ab}	19.42^{a}	1.20*
ADG, g/bird d(12-13 weeks of age)	12.85^{c}	17.67^{b}	19.42^{b}	23.56^{a}	22.71^{a}	0.88*
[2]ADFI, g/bird d(9-10 weeks of age)	69.43	71.48	71.14	79.99	75.71	2.90NS
ADFI, g/bird d(10-11 weeks of age)	70.28^{c}	76.39^{b}	80.42^{a}	76.82^{b}	77.60^{ab}	0.86*
ADFI, g/bird d(11-12 weeks of age)	75.82	86.42	90.13	90.28	88.89	18.89NS
ADFI, g/bird d(12-13 weeks of age)	84.99^{c}	95.28^{a}	99.28^{a}	104.28^{a}	101.42^{a}	2.13*
[3]AFCR, (9-10 weeks of age)	8.91^{c}	8.48^{c}	6.13^{b}	4.33^{ab}	3.92^{a}	0.53*
AFCR, (10-11 weeks of age)	8.25^{c}	4.48^{b}	4.30^{ab}	4.02^{a}	4.07^{ab}	0.11*
AFCR, (11-12 weeks of age)	6.71^{d}	5.71^{c}	4.51^{b}	4.89^{ab}	4.63^{a}	0.28*
AFCR, (12-13 weeks of age)	6.57^{d}	5.45^{c}	5.12^{b}	4.42^{a}	4.47^{a}	0.05*

[1,2 & 3] Refer to average daily weight gain, average daily feed intake and average feed conversion ratio respectively.

[a,b,c,d] Means bearing identical or no superscripts are similar while those with unidentical sueperscripts differ at the levels of probabilities indicated as follows:

NS = Not Significant (P 0.05)

* = Significant ($P<0.05$)

There was no significant effect of treatment on feed intake during the first and third weeks of the study whereas there was a significant effect (P<0.05) during the second and fourth weeks. The lowest feed intake was recorded for birds on diet A during 10-11 and 12-13 weeks of age respectively. However, feed intake for the entire study period showed that intake of diet A was lower (P<0.05) than intake of diets C and D but similar (P>0.05) to intake of diets B and E.

As for weight gain, feed conversion ratio (FCR) was also improved (P<0.05) with increasing dietary CP concentration up to 18% CP level.

Feed cost analysis (Table 4) showed a gradual increase in the cost per gramme of the diets as dietary CP level increased. However, feed cost per unit weight gain (kobo) decreased towards diet E. It was lower on diets D and E (about 10 kobo) than on diet A (about 17 kobo).

As stated in several reports (8,11,15) protein is an essential nutrient in poultry diets. This is also confirmed presently by significant improvement in the performance parameters measured as dietary protein increased up to the level which satisfied requirement (Table 3 & 4). From the results of the present study, the protein requirement of the growing cockerels during 9 to 13 weeks of age would be satisfied with 180g crude protein/kg diet in contrast to 200g CP/kg diet recommended for broiler finishers by several authors (10,11,16).

Table 4: Live Performance Characteristics of Cockerels Fed Treatment Diets and Bioeconomics of Production During 9 to 13 Weeks of Age

Performance Parameters	Treatment Diets					
	A	B	C	D	E	±SEM
[1]ADG, (g/bd)	10.16^{d}	14.57^{c}	17.73^{b}	19.94^{a}	20.64^{a}	0.36
[2]ADFI(g/bd)	51.17^{b}	79.23^{ab}	85.35^{a}	87.85^{a}	82.67^{ab}	8.50
[3]FCR	7.64^{d}	6.04^{c}	5.02^{b}	4.41^{a}	4.27^{a}	0.05
[4]Cost per g diet (kobo)	2.18	2.24	2.29	2.35	2.41	-
[5]Feed cost per g. weight gain (kobo)	16.66	13.53	11.50	10.36	10.29	-

[1,2 & 3]See footnote to Table 3 for full meaning.

[a,b,c,d]Means bearing idenical superscripts are similar (P>0.05) while those with unidentical superscripts differ (P<0.05).

[4]Computed from Table 2, 100 Kobo = NI.

[5]Obtained as prduct of FCR and cost per gramme diet.

It is interesting to note that the mean daily weight gain on diet D is superior to the values given for cockerels and pullets (8) of similar age as those used presently. However, their FCR are comparable with those observed herein, especially for diets C,D, and E.

Birds fed diet A could not eat as much as the birds on other diets on account of the effect of the relationship between energy and protein (15) otherwise known as energy: protein ratio (E:P). The E:P was wider in diet A (217:1) and it became narrower in favour of better performance in the birds as dietary CP level increased. This coupled with similarity in the energy content of the treatment diets, explains why feed intake tended to be uniform at higher dietary CP levels. This disparate E:P phenomenon in the treatment diets might have been responsible for the poorer ($P<0.05$) weight gain and FCR on diets whose CP contents were below the requirement level in this study which is in line with an earlier observation (1). However, this effect (E:P) was not noticed in the feed intake during the first and third weeks of the study and no explanation (other than chance) can be given for it.

The higher feed cost per unit of weight gain at the lower dietary protein levels is an indication of poorer efficiency of utilisation of these diets. This result suggests that protein malnutrition would increase cost of feeding per unit of weight gain without corresponding increase in the output (weight gain) of the malnourished animal. This result agrees with the finding in an earlier study (17).

As noted earlier in this report, published information in the local literature on the protein requirement of the growing cockerels is limited. However, the present recommendation (180g C.P/kg diet) agrees with the 18% dietary crude protein quoted elesewhere (18) and disagrees with 16% CP (8,10) for the tropics and the temperate regions (11,15). The lower nutrient requirements of birds under temperate condition may be explained largely on account of higher feed consumption of the birds (11,15,18). On the other hand, the disparity in the recommended protein requirement values for the tropics may be attributable to differences in animal and dietary factors such as gender and energy content among others. On the strength of the findings in this study, method of desgning experimental diets used for measuring "requirement" may also be implicated for the disparate recommendations of the authors both in the temperate and tropical regions.

CONCLUSIONS AND APPLICATIONS

1. In this study, weight gain and FCR were optimised at minimal cost of feeding in the birds that were fed with 18% crude protein diet D beyond which there was no significant benefit for increasing dietary CP level.

2. Adoption of any dietary protein level lower than the present recommendation (usually for the grower pullets in which slower rather than faster growth rate is desired to delay sexual maturity) for the grower cockerels is fraught with management error. This is because the cockerels eat more and grow bigger that the pullets under the same dietary and management regimens (8,15).

3. It is also evident that using broiler finisher diet which usually contains 20% crude protein (as diet E) to feed grower cockerels may not be profitable and is also a waste of the expensive protein fraction of the diet.

ACKNOWLEDGEMENTS

The authors wish to show appreciation to I.K. Tiamiyu and P.I. Farayola of St. Andrew's College, Oyo for data collection and statistical analyses respectively and to Dr. A.O. Ogunsanmi of the Department of Wild Life Management, University of Ibadan, Ibadan for chemical analyses.

REFERENCES

1. Association of Official Anaytical Chemists 1990. Official Methods of Analysis. 13th Edition. Washington. D.C.
2. D'mello, J.P.F. 1982. A comparison of two empirical methods of determining amino acid requirements. Wld's Poult. Sci. J. 38(2): 114-119.
3. Eshiett, N.O., Omole, T.A. and Adegbola A.A. 1979. Crude protein and energy requiremetns of rabbits in the tropics. Niger. J.Agric. Sci., 1(2): 113-117.
4. Fisher, C. and Morris, T.R. 1970. The determination of the methionine requirement of laying pullets by a diet dilution technique Brit. Poult. Sci., 11:67-82.
5. Gous, R.M. 1980. An improved method for measuring of an amino acid. In: 6th European Poultry Conference, Hamburg, Vol. III: 32-39.
6. Morris, T.R. and Wethli, E. 1978. The tryptophan requirements of young laying pullets. Brit. Poult. Sci., 19:455-466.
7. Njike, M.C. 1979. Crude protein requirements of growing chickens under Nigerian environments. Nig. J. Anim. Prod. 2:52-58.
8. Njike, M.C. and Ndife, I.I. 1980. Protein and energy requirements of broiler chikens in the tropics. Nig. J. Anim Prod. 7(2): 97-105.
9. Ogbonna, J.U. and Adebowale, E.A. 1993. Effects of sundried cassava peel as replacement for maize and wheat offals on performance and nutrient utilisation of cockerels. Nig. J. Anim. Prod. 20(1): 61-70.
10. Oluyemi, J.A. and Roberts, F.A. 1979. Poultry production in warm wet climates. Mcmillan Press Ltd. London.
11. Pido, P.P., Adeyanju, S.A. and Adegbola, A.A. 1979. The effects of graded levels of fermented cassva meal on broilers. Poult. Sci. 58: 427-431.
12. Sainsbury, D. 1980. Poultry health and management. First edition. Granada Publications Ltd., London. P. 33-42.
13. Salami, R.I. and Oyeole, S.O.O. 1997. Evaluation of poultry visceral offal meal as a substitute for fishmeal in grower pullets' diets. Nig. J. Anim. Prod. 24: 20-25.
14. Salami, R.I. 1985. The response of the young chickens to tryptophan. M.Phil. Thesis, University of Nottingham School of Agriculture, Sutton, Bonington,LE12 5RD, UK.

15. Scott, M.L. Nesheim, M.C. and Young, R.J. 1982. Nutrition of the chicken. 2nd Edition. McGraw-Hill Book Company Inc.N.Y.

16. Smith, A.J. 1990. Poultry. CTA Tropical Agriculturist series. Macmillan, London.

17. Steel, R.G.D. and Torrie, J.H. 1980. Principles and Procedures of Statistics 2nd Edition. McGraw-Hill Book Company, Inc. N.Y.

18. Ukachukwu, S.N. and Anugwa, F.O.I. 1995. Bioeconomics of feeding raw or heat-treated soyabeans to broilers. Nig. J. Anim. Prod. 22(2): 137-140.

19. Wethli, E. and Morris, T.R. 1978. Effects of age on the tryptophan requirement of laying hens. Brit. Poult. Sci. 19: 559-565.

20. Williamson, G. and Payne, W.J.A. 1978. An introduction to animal husbandry in the tropics. 3rd Edition. ELBS/Longman. pp. 595-606.