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The Effects of Variation in Dietary Protein and Energy Concentrations on Broiler Performance in the Tropics

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RINGKASAN

Dalam dua percubaan ayam daging, enam linear program ransum kos-termurah telah dirumuskan berasaskan dua kepekatan energi (12.6 dan 24.2 MJ energi ungkaibina (ME) kg^{-1} dan tiga kandungan protein (73, 63 dan 52 MJ ME kg protein kadar^{-1}). Dalam percubaan pertama, empat kelompok mengandungi lapan ekor ayam daging jantan dialokasi kepada setiap ransum dan dipercubaan kedua, empat kelompok mengandungi sepuluh jantan dan sepuluh betina dialokasi kepada setiap ransum.

Kecenderungan yang sama diamati dalam dua percubaan tersebut. Penambahan kepekatan energi sangat membaiki kadar pertumbuhan dan daya penukaran makanan ayam.

Ayam-ayam tersebut cenderung untuk lebih cepat membesar pada tiga ransum energi-rendah dengan peningkatan kandungan protein ransum, dan daya penukaran makanan juga bertambah baik. Pada ketiga-tiga ransum energi-tinggi, kadar tumbesaran terbaik diamati pada ransum dengan kandungan protein terendah, walaupun daya penukaran makanan cenderung lebih baik bila kandungan protein ransum ditingkatkan. Sebagai kesimpulan, penambahan minyak sawit ke ransum energi tinggi membaiki kandungan net energi dan mungkin meninggikan kesediaan asid-asid amino yang dapat dilihat dari pembaikan perlakuan dari jayaguna ransum-ransum ini, terutama sekali pada ransum berkadar protein terendah.

SUMMARY

In two broiler experiments, six linearly programmed least-cost diets were formulated at two dietary energy concentrations (12.6 and 24.2 MJ metabolizable energy (ME) kg^{-1} and three protein contents (73, 63 and 52 MJ ME kg crude protein^{-1}). In the first experiment, four groups each of eight broiler cockerels were allocated to each diet, and in the second, four groups of ten males and of ten females were allocated to each diet.

Similar trends were observed in both experiments. Increasing the dietary energy concentration improved, substantially, the growth rate and feed conversion ratio of chickens.

Birds tended to grow faster on the three low-energy diets with increasing dietary protein content; feed conversion ratio also improved. On the three high-energy diets, the best growth rate was observed on the diet with the lowest protein content although feed conversion ratio tended to improve as dietary protein content increased. It was concluded that the addition of palm oil to the three high-energy diets improved their net energy content and may have increased availability of amino acids in order to account for the improved performance on these diets, particularly that with the lowest crude protein content.

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INTRODUCTION

In warm, but particularly in humid climates, poultry production is characterized by a depression in performance such that production of improved breeds and strains does not match that in temperate regions (Anon, 1965). There are numerous experiments with broilers from three weeks of age onwards to support this generalization (Milligan and Winn, 1964; Harris, Dodgen and Nelson, 1974; Cowan and Mitchie, 1978).It has been shown in Malaysia that by increasing the dietary protein and energy contents of broiler diets, birds grew at a minimum rate and feed intake per unit of gain was reduced (Khoo, 1972, 1974; Wolf *et al.*, 1976; Raghavan *et al.*, 1978).

The object of this study was to examine the extent to which growth rate and food utilization could be improved by manipulating the energy and protein concentrations of broiler diets in the tropics.

MATERIALS AND METHODS

There were two experiments. In both, six least-cost diets were formulated using the linear programming package (Duncan, 1977). There were two energy concentrations, and at each concentration there were three protein levels such that the ratios of energy to protein for both energy levels were 73, 63 and 52 MJ metabolizable energy (ME) kg crude protein^{-1}. The ingredient composition of the six diets and their calculated chemical analysis are given in Table 1. The diets were mixed separately for each experiment.

TABLE 1

Ingredient and calculated chemical composition of the experimental diets (%) on an 'as is' basis

Ingredient	Diet No. 1	2	3	4	5	6
Maize	62.3	58.6	42.8	62.9	52.3	42.0
Soybean meal	22.0	30.3	38.8	26.9	35.4	37.2
Fish meal	–	–	4.1	3.1	3.7	12.1
Rice bran (defatted)	12.8	8.2	–	–	–	–
Cassava root meal	–	–	12.3	–	–	–
Palm oil	–	–	–	4.2	5.9	7.2
Salt	0.26	0.26	0.26	0.30	0.30	0.30
Tricalcium phosphate	1.98	1.96	1.47	2.08	1.97	0.83
Limestone	0.35	0.39	0.02	–	–	–
Choline chloride	0.06	0.04	–	0.24	0.15	0.09
Vit and Min Premix[1]	0.25	0.25	0.25	0.28	0.28	0.28
Cost (M$/ton)	406.59	432.74	479.29	491.32	541.42	612.23
Dry matter (%)	87.6	88.0	88.4	88.0	88.8	89.4
Metabolizable energy (MJ kg^{-1})	12.6	12.6	12.6	14.2	14.2	14.2
Protein (N x 6.25, %)	17.21	20.06	24.09	19.40	22.61	27.15
MJ ME kg protein^{-1}	73.2	62.8	52.3	73.2	62.8	52.3
(Kcal ME kg protein^{-1})	(17.5)	(15.0)	(12.5)	(17.5)	(15.0)	(12.5)
Ether extract (%)	3.3	3.1	2.8	7.1	8.5	10.0
Crude fibre (%)	5.1	5.0	4.8	4.4	4.4	4.3
Calcium (%)	0.80	0.80	0.80	0.92	0.92	1.1
Phosphorus (%)	0.82	0.78	0.68	0.72	0.74	0.73

[1] Tasmix 22 (I.C.I Pte. Ltd.) contains the following per kg of diet; vit. A, 12,000 IU; vit. D_3, 2,000 IU; vit E, 16.5 IU; vit K, 2.5 mg; thiamine, 2.5 mg; riboflavin, 5 mg; pyridoxine 4.5 mg; vit. B_{12}, 10 mcg; pantothenic acid 14.5 mg; biotin 25 mcg; niacin, 33 mg; choline chloride, 250 mg; Fe, 80 mg; Zn, 45 mg; Mn, 80 mg; Cu, 10 mg; I 0.85 mg; Se, 0.15 mg; 3-nitro, 50 mg; bacitracin, 10 mg; DL-methionine, 300 mg.

One-day-old broiler chickens were grown to either four weeks (Experiment 1), or three weeks (Experiment 2) and then weighed; eight birds were allocated to each cage (Oh, 1978) with wire-mesh floors. The cages were out-of-doors but under cover. The mean and range of initial liveweights were similar for all groups.

In the first experiment there were four groups of eight males on each diet; in the second experiment there were four groups of ten males and four groups of ten females on each diet. Diets had previously been allocated to treatments at random. Feed and water were provided *ad libitum.* A nylon mesh screen over the cages and feeders prevented wild birds from consuming any feed. Feed intake and liveweight were recorded at two week intervals. Both experiments were terminated when the birds were eight weeks old. In Experiment 2 each group was examined for numbers of each sex present. Maximum and minimum temperatures and humidity were recorded at noon each day.

Results were analysed using analysis of variance and differences between treatment means were tested using the least Significant Difference test. Covariance analysis was used in Experiment 2 to adjust data for imbalance of sexes in each group due to incorrect sexing.

RESULTS

Experiment 1

There was a significant effect ($P < 0.01$) of dietary energy concentration as well as in protein/energy interaction for both growth rate and feed conversion ratio (Table 2). For the latter, protein level also had a significant effect ($P < 0.01$). Mean growth rate on the low-energy diets was 965 g 4 weeks^{-1}, which was lower ($P < 0.01$) than 1066 g observed on the high-energy diets. Feed conversion ratio was also better ($P < 0.01$) on the high-energy diets. Although overall growth rate was not influenced by protein content of the diet, diet 1 supported the lowest growth rate and had the poorest feed conversion, while diets 4 and 6 had the highest growth rate and best feed conversion.

TABLE 2

Mean growth rate and feed conversion ratio of 4 groups of 8 male chickens from 4 to 8 weeks on each of six diets with 2 levels of energy and 3 levels of protein. Values in parentheses refer to diet no.

	Energy : protein ration (MJ ME kg^{-1})			
Energy concentration (MJ ME kg^{-1})	73.2	62.8	52.3	LSD
	Mean weight gain (g 4 weeks^{-1})			
12.6	909^{a*} (1)	999^{b} (2)	986^{b} (3)	75.0
14.2	1146^{c} (4)	977^{b} (5)	1074^{c} (4)	
	Feed conversion (g g^{-1})			
12.6	2.92^{a} (1)	2.66^{b} (2)	2.38^{c} (3)	0.099
14.2	2.18^{d} (4)	2.45^{e} (5)	2.19^{d} (6)	

* Values with different superscripts (a–d) are significantly different ($P < 0.05$)

Experiment 2

The adjusted feed conversion ratios and growth rates for males and females are shown in Fig. 1 and 2. There was a significant ($P < 0.05$) effect of energy, protein and a protein/energy interaction for mean growth rate (g 5 weeks^{-1}) and feed conversion ratio in both sexes. It was observed that among the low-energy diets the highest growth rate for both sexes correlated with diet 3 which contained the highest amount of protein. Performance of broilers fed the high-energy diets was not improved by the addition of protein; in the case of males, diet 4 containing the lowest protein level, gave better ($P < 0.05$) growth than diets 5 and 6. In both sexes feed conversion ratio improved ($P < 0.05$) on the low-energy diets with increasing protein content. In the high-energy diets feed conversion ratio was fairly similar in all three diets (4, 5 and 6). It was observed that males, in particular, showed a positive response to increasing protein content of the diet.

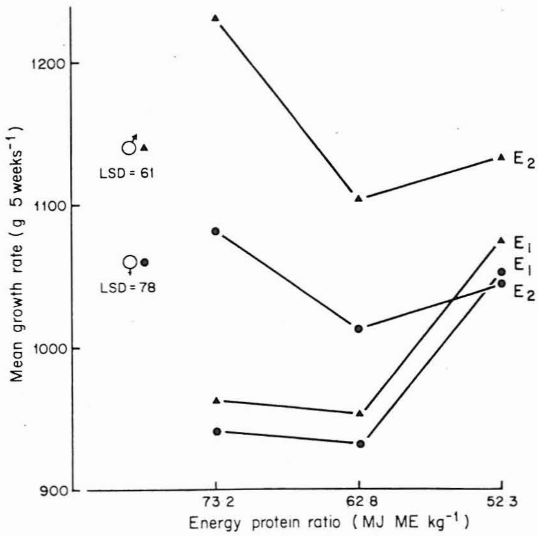

Fig. 1. The relationship between growth rate and the energy : protein ratio of broiler diets fed to 4 groups of males and 4 groups of females on high (E2) – and low (E1) – energy diets from 3 to 8 weeks.

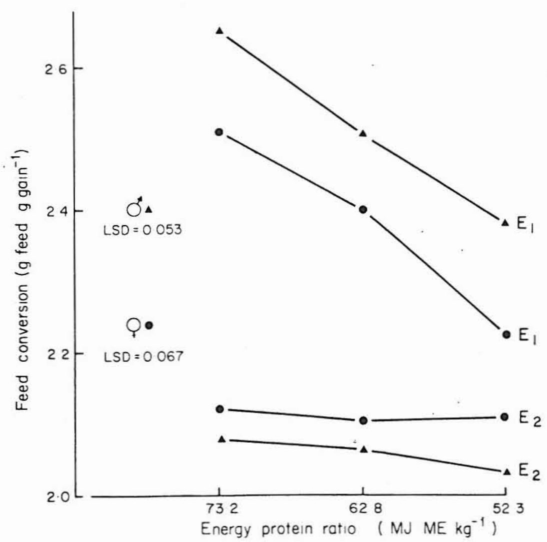

Fig. 2. The relationship between feed conversion and the energy : protein ratio of broiler diets fed to 4 groups of males and 4 groups of females on high (E2) – and low (E1) energy diets from 3 to 8 weeks.

DISCUSSION

The results of both experiments (Table 2 and *Fig. 1* and *2*) indicated that a marked response by broilers to protein was observed only on the low-energy diets, containing 12.6 MJ ME kg^{-1}. In contrast a significant depression was observed when the protein content of the high-energy diets was increased above 19.4% (diet 4). This trend was more apparent in Experiment 2 than in Experiment 1. Diet 5, containing 22.7% crude protein, did not support the growth performance predicted for diets 4 and 6. Feed conversion ratio, on the other hand, responded favourably to the increase in dietary protein on this diet (Table 2, *Fig. 1*). These findings are in agreement with those of MacAlpine (personal communication) who observed that broiler chickens grown from four to eight weeks at 30°C on high (13.6 MJ ME kg^{-1}) and low (11.5 MJ ME kg^{-1}) energy diets with different protein contents grew equally well on the high-energy diets when the protein contents were 22.0 and 24.5%, but declined significantly thereafter. In contrast, MacAlpine found that growth rate on the low-energy diet was highest when the protein content was 20.6% and declined significantly as protein decreased.

The major difference between the high-and-low energy diets used in the present study was the inclusion of palm oil in the former diets (4, 5, 6). It is known that the availability of ME of fats and oils is higher than that of carbohydrate sources due to a low heat increment (Farrell, 1978). Thus oil-based diets would allow chickens to take in larger amounts of dietary energy at high temperature before intake start to decline due to heat stress. The apparent negative growth response, however, to protein on the high but not on the low-energy diets suggested that dietary protein may have been more efficiently utilized in the presence of palm oil than in its absence, as both energy level diets contained corresponding amounts of protein in the computation MJ ME kg^{-1} (Table 1). In the case of high-energy diets, the response in growth may have been due to excess of amino-acid caused by the increased protein content; under these circumstances the net energy of the diets would be expected to decline.

The average maximum and minimum temperatures were 22.5°C (range: 20–25°C) and 33.7°C (range: 28.3–36.1°C), respectively, throughout the experimental period. The mean for relative humidity was 57.67% (range: 34.0–96.5%). Cowan and Mitchie (1978) were unable to detect a response to increased amounts of protein (18 to 29%) in broiler diets (11.6 MJ ME kg^{-1}) at temperatures of 26 and 31°C. The diets were comparable to the low-energy diets used here where there was definite response to increasing dietary protein for feed conversion, and a response for growth rate. It is possible that poultry experiments undertaken in climate rooms at constant high temperatures, or by cycling high temperature do not simulate, sufficiently closely, the daily changes in temperature and humidity of a tropical environment for differences to be detected in broiler performance due to the interaction of environment and nutrition.

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