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ENERGY AND PROTEIN REQUIREMENTS OF BROILER CHICKS IN THE HUMID TROPICS

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A study was carried out to investigate the affects of different protein and energy combinations on the performance of broiler chicks. The experiment consisted of all combinations of 4 levels of protein (20, 22, 24 and 26%) with 3 levels of energy (2800, 3000 and 3200 kcal/kg).

There was a significant interaction effect between protein and energy levels with respect to average daily gain and feed efficiency. At the 2,800 kcal/kg energy level, daily gain significantly ($P < 0.05$) increased as the level of protein fed increased from 20 to 22%. At the 3000 and 3200 kcal/kg energy levels the highest daily gains were obtained with the 22% protein level. These values were, however, not significantly different from those obtained with the 20% protein level.

Daily feed intake dropped significantly as the energy fed increased beyond the 2800 kcal/kg level. Feed efficiency significantly improved as the protein level was increased from 20 to 22 and 24%, while an increase to 26% caused a drop in efficiency of feed utlization. Increasing the energy fed beyond the 2800 kcal/kg level significantly improved feed efficiency. The amount of carcass fat decreased as the level of protein fed increased, while it increased as the energy level fed increased.

From the results it appears that under the conditions of this study, a ration containing 22% protein and an energy level of 3000 kcal/kg would be adequate for broiler production in the tropics.

Key words: poultry, broilers, energy, protein, tropics

The continued reliance on protein and energy values established in the temperate world for the raising of broilers in the tropics stems from the fact that there is a paucity of information in this direction in the tropical regions of the world. Data developed in the temperate regions of the world cannot be used indiscriminately in the tropical areas since it is known that the warm and humid environment can modify these values. The effects of environmental conditions have been shown by Ichhponani et al (1978) and Ahmad and Mather (1976) who conducted studies during winter and summer temperatures.

This study was therefore conducted to investigate the effects of different protein and energy level combinations on the performance of broiler chicks in the tropics.

Materials and Methods

Some 432 broiler chicks of the Ross breed used in this study were reared in an oil-heated brooder for the first three weeks of life. During this period medicated mash and water were provided. At 3 weeks of age the birds were wing-banded and allocated at random to 12 equal treatment groups of 3 birds each. These were further sub-divided into 3 subgroups, each of 12 birds and placed in cages. The sub-groups were similar in weight. In a factorially designed experiment consisting of 4 levels of protein (20, 22, 24 and 26%) and 3 levels of energy (2800,3000 and 3200 kcal/kg), all possible combinations of the protein and energy levels were used, thus giving a total of 12 experimental diets (Table 1) each of which was fed to 3 groups of birds (replicas).

Table 1:

Percentage composition of experimental rations (air-dry basis)

Energy levels:	2800 kcal/kg				3000 kcal/kg				3200 kcal/kg			
Protein %	20	22	24	26	20	22	24	26	20	22	24	26
Ingredients												
Yellow corn	52.50	49.50	46.00	40.50	55.00	57.00	50.00	43.00	52.00	51.50	44.00	41.00
Groundnut cake	24.50	25.00	27.00	32.00	24.80	23.00	26.50	34.00	26.20	24.50	31.00	34.00
Fish meal	7.00	10.00	13.00	14.00	7.00	12.00	14.00	14.00	7.00	12.00	12.00	14.00
Rice bran	11.95	11.95	10.45	9.65	7.45	3.95	4.45	3.15	5.50	3.95	3.95	1.95
Palm oil	0.50	0.50	0.50	0.80	2.20	1.00	2.00	2.80	5.75	5.00	6.00	6.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bone meal	1.50	1.00	1.00	1.00	1.50	1.00	1.00	1.00	1.50	1.00	1.00	1.00
Vitamin-mix[1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Amprolium (a coccidiostat)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis												
Crude protein (%)	20.10	22.04	24.10	26.06	20.04	22.00	24.08	26.28	20.08	22.15	24.07	25.94
Crude fibre (%)	8.31	8.20	7.89	7.88	7.61	6.91	6.91	6.95	7.16	6.70	6.86	6.58
ME (kcal/kg), calculated	2830	2828	2825	2805	3003	3010	3013	3011	3217	3212	3207	3206
Calcium %	1.07	1.01	1.10	1.14	1.07	1.07	1.13	1.14	1.07	1.07	1.08	1.14
Phosphorus, available (%)	0.51	0.51	0.57	0.59	0.57	0.51	0.56	0.56	0.57	0.51	0.52	0.55

1 Pfizer product supplying the following per kilogramme of diet: vitamin A, 10,000 I.U; D_3, 2000 I.U; E, 5 I.U; K, 2.24 mg; riboflavin, 5.5 mg; B_{12}, 0.01 mg; pantothenic acid, 10.0 mg; nicotinic acid, 25.0 mg; choline, 350.0 mg; folic acid, 1.0 mg; methionine, 450.0 mg; Mn, 56.0 mg; I_2, 1.0 mg; Fe, 20.0 mg; Cu, 10.0 mg; Zn, 50.0 mg; and Co, 1.25 mg.

Experimental diets and water were provided ad libitum for a period of 8 weeks and feed samples were analysed for crude protein and crude fibre contents by the methods of the Association of Official Analytical Chemists (1975). Daily feed consumption was computed from weekly records and the birds were weighed weekly. At the end of the eighth week of the trial, the birds were deprived of food, but not water for 18 hours. Two birds from each group, making a total of 6 birds from each experimental diet , were randomly selected for carcass evaluation. The selected birds were weighed individually, slaughtered and scalded in hot water to facilitate plucking. After the heads and legs were cut off, the birds were dissected and the internal organs separated. The carcass was weighed and the carcass yield was calculated from the weight of the carcass expressed as a proportion of the liveweight. The gizzard, fat and liver were also weighed and each was expressed as g/100g liveweight.

The data collected were subjected to the standard analysis of vari -

ance technique (Steel and Torrie 1960), and Duncan's Multiple Range test was used to detect differences among the means.

Results and Discussion

The results of the study are presented in Tables 2, 3 and 4. Table 2 shows the energy-protein interaction effects while Table 3 and 4 show the main effects of protein and energy respectively.

Table 2:

Effects of energy and protein levels on the performance and carcass characteristics of broiler birds (INTERACTION VALUES)

Energy (kcal/kg)	Protein (%)	Daily gain (g)	Daily feed intake (g/bird/day)	Feed efficiency (g feed/g gain)	Carcass yield (%)	Fat (g/100g live-weight)	Gizzard (g/100g live-weight	Liver (g/100g live-weight)
2800	20	26.94[c]	105.74	3.93[a]	67.73	0.84	2.37	1.77
	22	32.50[ab]	108.08	3.33[bcd]	70.01	0.60	2.72	1.84
	24	33.32[ab]	105.32	3.17[cd]	66.29	0.57	2.24	1.65
	26	30.67[b]	109.66	3.58[ab]	66.78	0.42	2.45	1.92
3000	20	32.08[ab]	102.26	3.19[cd]	67.14	1.17	2.23	1.71
	22	34.35[a]	102.56	2.99[d]	67.13	1.09	2.19	1.78
	24	33.25[ab]	102.64	3.09[cd]	68.95	0.99	2.06	1.68
	26	30.00[bc]	101.53	3.41[bc]	67.02	0.42	2.09	1.90
3200	20	32.74[ab]	100.50	3.08[cd]	68.25	1.24	1.91	1.80
	22	34.58[a]	102.39	2.97[d]	67.03	1.17	2.32	1.83
	24	30.60[b]	100.62	3.30[bcd]	67.86	1.02	2.11	1.81
	26	30.02[bc]	102.49	3.43[bc]	69.03	0.47	2.25	1.72
± S.E.M		1.03	1.92	0.12	0.95	0.13	0.14	0.09

abcd Treatment means in each column with a common letter or with no letter are not significantly different at ($P < 0.05$)

There was a significant interaction effect with respect to the average daily gain and feed efficiency. With the 2800 kcal/kg energy level, the daily gain significantly ($P < 0.05$) increased as the level of protein fed increased from 20 to 22%. There was however, no significant increase when up to 24% protein was fed. With 26% protein, however, there was a significant drop in daily gain when compared to either the 22 or 24% protein level. With the 3000 and 3200 kcal/kg energy levels the highest daily gains were obtained with the 22% protein level. These values were, however, not significantly different from the values obtained with the 20% protein level.

Tables 3 and 4 on the main effects of protein and energy show that increasing the level of protein fed from 20 to 22% significantly increased gain. There was however no added advantage from feeding up to 24 % protein. In fact feeding up to 26% protein caused a significant fall in rate of gain. Even though the energy main effect showed no significant effect on the rate of gain, the birds fed the 3000 kcal/kg energy level had the highest rate of gain.

Table 3:

Effects of protein levels on the performance and carcass characteristics of broiler birds (PROTEIN MAIN EFFECT)

Protein (%)	Daily gain g/day	Daily feed intake g/bird/day	Feed efficiency g feed/ g gain	Carcass yield (%)	Fat g/100g liveweight	Gizzard g/100g liveweight	Liver g/100g liveweight
20	30.59[b]	102.84	3.40[a]	67.71	1.08[a]	2.17	1.76
22	33.81[a]	104.34	3.09[b]	68.06	0.95[a]	2.41	1.82
24	32.39[a]	102.86	3.18[b]	67.70	0.86[a]	2.14	1.72
26	30.23[b]	104.56	3.47[a]	67.61	0.44[b]	2.26	1.84
± S.E.M.	0.60	1.11	0.07	0.55	0.07	0.08	0.05

a, b Treatment means in each column with a common letter or with no letter are not significantly different at ($P < 0.05$)

Table 4:

Effects of energy levels on the performance and carcass characteristics of broiler birds (ENERGY MAIN EFFECT)

Energy (kcal/kg)	Daily gain (g/day)	Daily feed intake (g/bird/day)	Feed efficiency (g feed/ g gain)	Carcass yield (%)	Fat (g/100g liveweight)	Gizzard (g/100g liveweight)	Liver (g/100g liveweight)
2800	30.86	107.20[a]	3.50[a]	67.70	0.61[a]	2.44[a]	1.80
3000	32.42	102.25[b]	3.17[b]	67.56	0.92[b]	2.14[b]	1.77
3200	31.98	101.50[b]	3.19[b]	68.04	0.97[b]	2.15[b]	1.79
± S.E.M.	0.52	0.96	0.06	0.48	0.06	0.07	0.04

a,b, Treatment means in each column with a common letter or with no letter are not significantly different at ($P < 0.05$).

It may be postulated that some of the protein was converted to energy to meet the energy requirement. At the lowest protein level of 20% such a conversion to energy would mean that the protein level of 20% was inadequate to meet the needs of the birds. This probably explains why the lowest protein level of 20% was not adequate when combined with an energy level of 2800 kcal/kg but was adequate with the energy level of 3000 kcal/kg. As the energy level increased from 2800 to 3000 and then to 3200 kcal/kg the requirement for energy was probably exceeded and increased protein fed made no further impact. O'Neil et al (1962) reported that increasing protein from 18 to 22% improved weight gain of broilers but that there was no extra benefits from increasing the protein fed beyond 26%. The daily feed intake significantly ($P < 0.05$) dropped as the energy level fed increased (Table 3). Similar trends have been reported by other workers ; Labadan and Abilay (1969) and Griffiths et al (1977). This is understandable since chickens increase feed intake in order to increase the energy intake when given feed low in energy(Hill et al 1954). Feed efficiency was affected both by the protein and energy levels of the feed. Increasing the protein level from 20 to 22 and 24% significantly ($P < 0.05$) improved efficiency of feed utilization while an increase to 26% caused a drop in efficiency of feed utilization. It may be that at 26% protein level, there was metabolic strain in dealing with the extra protein and this therefore brought about the decreased efficiency. Increasing the energy fed from 2800 to 3000 kcal/kg also significantly improved feed efficiency. No extra benefit was however, obtained by feeding up to 3200kcal/kg. Such improved feed efficiency has been reported by Griffiths et al (1977). The amount of carcass fat significantly ($P < 0.05$) decreased as the level of protein fed was increased from 20 to 26%. On the other hand, increasing the energy level fed significantly ($P < 0.05$) increased the amount of carcass fat. The reduction in amount of carcass fat with increasing dietary protein level has been reported by a number of workers (Summers et al 1965; Petersen 1976). These workers noted that with more dietary protein, carcass protein and moisture increased while fat was reduced. The increased carcass fat at higher dietary energy levels has also been reported (Farrell 1974: Jeroch et al 1978) and Han (1972) has reported that the fat content of the carcass is a direct reflection of the energy value of the diet.

The results also show a significant ($P < 0.05$) increase in the size of the gizzard from birds fed the lower energy of 2800 kcal/kg when compared to those fed 3000 or 3200 kcal/kg. Since with a lower energy level the feed containing 2800 kcal/kg will be more bulky (less dense) than the feed containing 3000 and 3200 kcal/kg, there will probably be a greater volume for the lower energy feed per unit weight of the feed than for the high energy feeds.

That means that the birds on the lower energy level of 2800 kcal/kg. will have to handle a greater volume of feed for each unit of weight when compared to birds on the 3000 and 3200 kcal/kg. Since the gizzard is an organ involved in digestion, it may be that there was some enlargement of the gizzard in these birds to cope with the increased volume of feed. From all the results it appears that under the conditions of this study, a ration containing 22% protein and an energy level of 3000 kcal/kg will be adequate for efficient broiler production in the tropics.

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