METABOLISM AND NUTRITION

Response of Broiler Chickens to Dietary Energy and Lysine Levels in a Warm Environment

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ABSTRACT Two trials were conducted to determine the response of 23- to 47-day-old broiler chickens to dietary lysine and energy levels when reared in a 26.7 C environment. Broiler finishing diets, which contained 3100, 3175, 3250, or 3325 kcal ME/kg of feed were fed in combination with either .308 or .322% lysine/Mcal (kg) with a constant 18.7% dietary protein.

Male and female body weights were not statistically different (P<.05) among dietary energy levels when both sexes were fed .308% lysine/Mcal (kg). When the male chicks were fed .322% lysine/Mcal (kg), body weights increased with increasing dietary energy level. Feed utilization also increased with increasing dietary energy level when broilers were fed either .308 or .322% lysine/ Mcal (kg).

These data suggest that the body weight response to dietary energy level when broilers were reared in a warm environment will occur only when adequate amino acid levels are employed. The dietary energy requirement is at least 3250 kcal ME/kg of feed when 23- to 47-day-old broilers are fed .322% lysine/Mcal (kg) and reared in a hot environment but appeared to be lower when broilers were fed .308% lysine/kg of feed.

(*Key words:* lysine requirement,environmental temperature, energy, broilers)

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INTRODUCTION

Scott *et al.* (1947) was one of the first to demonstrate that rations high in energy content tended to promote more rapid growth and better feed conversion in chickens than rations of lower energy content. Chick growth improvements have also been noted by Robertson *et al.* (1948), Donaldson *et al.* (1956), Dale and Fuller (1980), Brown and McCartney (1982), and others. Brown and McCartney (1982) found that increasing dietary energy from 3100 to 3400 kcal metabolizable energy (ME)/kg of diet resulted in higher market broiler weights and improved feed conversions.

Dale and Fuller (1980) found that the incorporation of high levels of fat into balanced rations improved growth and feed conversion in both a cyclic hot temperature regimen (23 to 33 to 23 C) and a cool environment (14 to 22 C range); however, growth did not increase due to added fat when broilers were reared at a constant 31 C environment. Adams *et al.* (1962) measured the effect of two energy levels (2830 and 3300 kcal ME/kg) when broilers were reared at two temperatures (21 and 32 C). They concluded that the deleterious effects of the 32 C temperature could not be offset by increasing energy, protein, or minerals.

Reece and McNaughton (1982) found no difference in 7-week body weights due to dietary energy level when the broilers were reared at 26.7 C temperature. Rearing broilers at an 18.3 C temperature resulted in a 3.1% linear increase in body weight as dietary energy level increased from lowest to highest levels (3175 to 3325 kcal ME/kg).

The most obvious difference between the studies of Dale and Fuller (1980) and Reece and McNaughton (1982) was the amino acid levels employed. Dale and Fuller (1980) formulated diets that contained about .336% lysine/ Mcal (kg)[1] compared to .308% lysine/Mcal (kg) in the Reece and McNaughton study. Reece and McNaughton (1982) found that a decrease in energy intake at a rearing temperature of 26.7 C resulted in a corresponding decrease in lysine and methionine plus cystine intake.

Bacon *et al.* (1981) evaluated the effects of diets containing three dietary energy levels ranging from 3090 to 3310 kcal ME/kg on broilers grown in a cool (23 C) and a warm

[1]Multiple percent lysine per megacalorie (kilogram) by 2.2046 to obtain megacalorie percent – a figure that is normally used in practical feed formulations.

environment (26 C). Energy level did not significantly affect body weights at 49 days in either environment. The lysine levels employed in the finisher diets were .334%/Mcal (kg), .323%/Mcal (kg), and .312%/Mcal (kg) for dietary energy levels of 3140, 3250, and 3360 kcal ME/kg, respectively. Dietary amino acid levels decreased as dietary energy level increased. The lysine levels employed in the withdrawal diets were about 6.5% (range .292 to .312% of lysine/Mcal) lower than in the finisher diets. These lysine levels are comparable to levels fed by Reece and McNaughton (1982) where they, too, found no differences in body weight due to dietary energy level when broilers were reared in a hot environment.

Mickelberry *et al.* (1966) increased the dietary energy from 2935 kcal ME/kg of feed to contain 3500 kcal ME/kg by substituting corn oil, lard, or hydrogenated coconut oil for cellulose and feed the rations to broilers in either a 21 or 29 C environmental temperature. The lysine was maintained at .326%/Mcal (kg). Incorporation of fat into the diet improved both growth and feed conversion in all cases. Comparable lysine levels were used by Dale and Fuller (1980) with similar improvements in growth responses by increasing dietary energy in both warm and cool environments.

The literature indicates that when adequate lysine levels are fed to broilers in a hot environment, a growth response to dietary energy level occurs; however, when inadequate levels of lysine are fed, the growth response does not occur. The objective of this study is to determine the effect of different lysine and methionine plus cystine levels on the response of broiler chickens fed different dietary energy levels. The environment temperatures used represent the hot summer conditions normally experienced in the Southeastern United States.

MATERIALS AND METHODS

A total of 2560 male and 2560 female 1-day-old chicks (Arbor Acre × Peterson) in two trials were obtained from a commercial hatchery and placed in an electrically-controlled broiler house. Softwood shavings provided litter for broilers reared at 695 cm^2 per bird. Temperatures were maintained at 29.4 C during the first week; 26.7 C during the second week; 23.9 C during the third week; and 26.7 C from 23 to 47 days of age. Ventilation rate was adjusted on a daily basis to balance outside conditions with latent heat production of the birds so that relative humidity in the house was maintained in the 55 to 65% range. Feed containing 3200 kcal ME/kg of feed, 22.3% crude protein, 1.25% dietary lysine, and 1.04% dietary sulfur-containing amino acids provided adequate nutrients in meeting the National Research Council (1977) requirements for chicks fed 1 to 22 days of age.

At 23 days of age, four lots of 40 males and 40 females in each of two trials were placed on finishing diets (Table 1), which contained 3100, 3175, 3250, or 3325 kcal ME/kg of feed. Lysine was adjusted to maintain .308 or .322% lysine/Mcal (kg). The same experimental design was used in both trials. The highest dietary lysine level employed corresponded to the suggested lysine intakes required to produce potentially maximum growth response in a hot environment when broilers are fed high energy diets. Diets containing .308% lysine/Mcal (kg) are similar to diets reported by Reece and McNaughton (1982). Sulfur-containing amino acids (methionine plus cystine) were maintained at 83% of the lysine level. Prior to the computer assisted formulation of each diet, crude protein of soybean meal was determined by using total Kjeldahl nitrogen. At the time each of the two experiments began, the mean 23-day body weights of the experimental treatment groups did not differ significantly. In each experiment, birds were individually weighed and feed consumption determined when broilers were 47 days of age.

A 2 × 4 factorially arranged randomized complete block design was used in each experiment. Data were examined statistically by the analysis of variance (Steel and Torrie, 1960). Duncan's new multiple range test (Duncan, 1955) was used to determine significant differences between means. All statements of significance refer to the 5% level of probability.

RESULTS AND DISCUSSION

The 47-day body weights for the four dietary energy levels and two lysine levels are shown in Figures 1 and 2. Body weights were statistically equal ($P>.05$) when both males (Fig. 1) and females (Fig. 2) were fed different

TABLE 1. *Composition of the diets used to determine the response of broiler chickens to dietary energy and lysine levels in a hot environment*

Ingredient	Diet number 1	2	3	4	5	6	7	8
	(%)							
Yellow corn	72.711	70.009	67.336	65.009	71.798	69.467	67.133	64.798
Soybean meal (48.5% protein)	18.027	19.209	20.328	20.741	19.537	19.950	20.364	20.778
Animal fat (7716 kcal/kg)	.372	2.439	4.490	6.363	.819	2.693	4.569	6.445
Dicalcium phosphate (22% Ca 18.5% P)	1.079	1.085	1.091	1.098	1.077	1.084	1.091	1.098
Limestone	.808	.792	.775	.763	.788	.776	.763	.750
Salt	.408	.408	.409	.409	.408	.409	.409	.410
Broiler trace element premix[1]	.250	.250	.250	.250	.250	.250	.250	.250
MHA – Ca, 93%	.155	.187	.219	.245	.209	.236	.264	.291
Coban (50 g/ton)	.100	.100	.100	.100	.100	.100	.100	.100
Animal protein pack[2]	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Corn gluten meal (61% protein)	1.090	.521	...	...	...	...	...	...
L-Lysine-HCl	...	...	.002	.022	.014	.035	.057	.080
Total	100	100	100	100	100	100	100	100
Calculated analysis								
Protein, %	18.70	18.70	18.70	18.70	18.70	18.70	18.70	18.70
Metabolizable energy, kcal/kg	3100	3175	3250	3325	3100	3175	3250	3325
Lysine, %/Mcal (kg)	.308	.308	.308	.308	.322	.322	.322	.322
Methionine + cyst., %/Mcal (kg)	.256	.256	.256	.256	.267	.267	.267	.267
Lysine, %	.96	.98	1.00	1.02	1.00	1.02	1.05	1.07
Methionine + cystine, %	.80	.81	.83	.85	.83	.85	.87	.89
Calcium, %	.90	.90	.90	.90	.90	.90	.90	.90
Available phosphorus, %	.45	.45	.45	.45	.45	.45	.45	.45
Sodium, %	.20	.20	.20	.20	.20	.20	.20	.20
Calorie:protein	165.8	169.8	173.8	177.8	165.8	169.8	173.8	177.8

[1] The broiler premix furnished the following amounts of other ingredients per kilogram of feed: vitamin A, retinyl acetate form, gelatin coated, 6614 IU; vitamin D_3, 2205 ICU; vitamin E, DL-alpha tocopherol acetate, 3.31 IU; riboflavin, 4.96 mg; niacin, 27.6 mg; d-pantothenic acid, 8.82 mg; folic acid, 276 μg; vitamin B_{12}, 11 μg; choline chloride, 496 mg; ethoxyquin, 55 mg; menadione dimethylpyrimidinol bisulfite, 1.65 mg; pyridoxine, 1.10 mg; selenium, 10 mg; manganese (oxide form), 55 gm; zinc (oxide form), 50 mg; iodine, 1.25 mg; iron (sulfate form), 40 mg; copper (sulfate form), 4.0 mg.

[2] The animal protein pack purchased commercially was composed of a combination of fish meal, poultry by-product meal, and poultry offal meal.

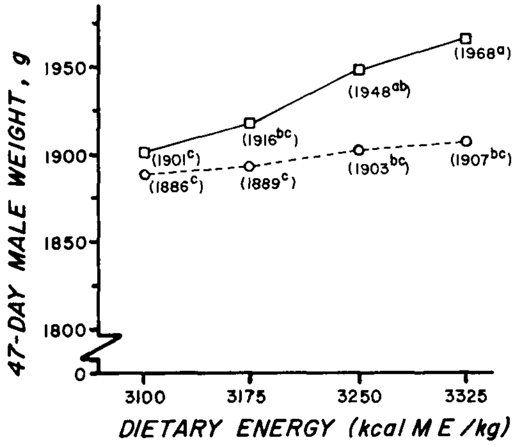

FIG. 1. Influence of dietary energy level in the broiler finishing diets on the lysine requirement of 23- to 47-day male weights. Values in parentheses show mean of each treatment. Means followed by different small letters are significantly different (P<.05). Lysine at .308 (- - -) or .322 (——) %/Mcal (kg).

dietary energy levels and .308% lysine/Mcal (kg). When the males were fed .322% lysine/Mcal (kg), body weights increased with increasing energy. Using the energy levels employed in these studies, male body weights were statistically maximized by feeding 3250 kcal ME/kg of diet and .322% lysine/Mcal (kg). No significant differences (P<.05) were found in male body weights when the males were fed 3250 or 3325 kcal ME/kg and .322% lysine/Mcal (kg). Female body weights were optimum for the energy and lysine levels employed in this study at 3175 kcal ME/kg and .322% lysine/Mcal (kg).

Feed:gain was not statistically different when the broilers were fed different amino acid levels. Feed:gain curves were similar when either lysine level was fed in diets with increasing energy levels. Feed:gain decreased with increasing energy levels (Fig. 3).

These results confirm work by Mickelberry *et al.* (1966), Dale and Fuller (1980), Bacon *et al.* (1981), and Reece and McNaughton (1982). When broilers were subjected to a warm environment and fed more than .322% lysine/Mcal (kg), 47-day body weights increased as dietary energy increased. Similar results were reported by Dale and Fuller (1980) and Mickelberry *et al.* (1966). With .308% lysine/Mcal (kg) fed to broilers 23 to 47 days of age, a growth response did not occur in this study when broilers were reared in a constant 26.7 C temperature-controlled environment. This situation was corrected with diets containing .322% lysine/Mcal (kg) or .71% lysine/Mcal (lb). Maximum body weight response occurred by feeding .322% lysine/Mcal (kg) for 3250 kcal ME/kg of diet for males and 3175 kcal ME/kg of diet for females.

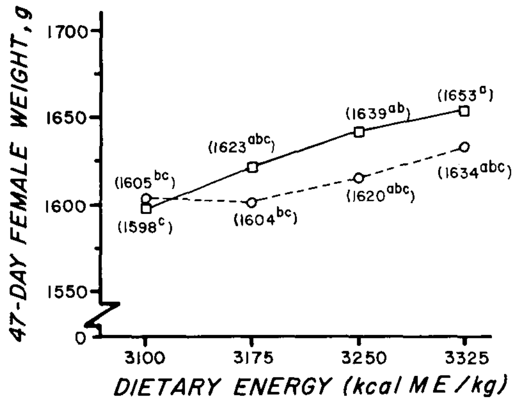

FIG. 2. Influence of dietary energy level in the broiler finishing diets on the lysine requirement of 23- to 47-day female weights. Values in parentheses show the mean of each treatment. Means followed by different small letters are significantly different (P<.05). Lysine at .308 (- - -) or .322 (——) %/Mcal (kg).

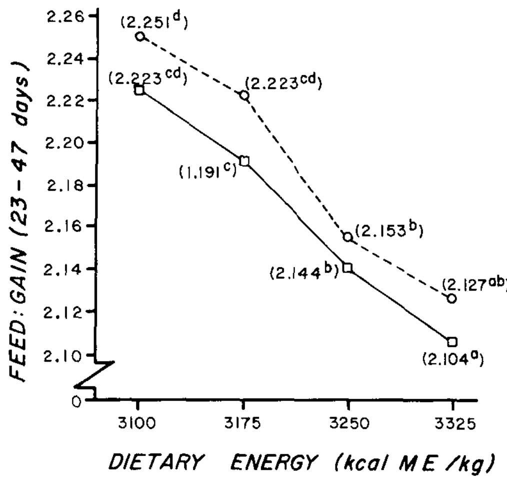

FIG. 3. Feed:gain of 23- to 47-day mixed sexed broilers fed various dietary energy and lysine levels. Lysine at .308 (- - -) or .322 (——) %/Mcal (kg).

REFERENCES

Adams, R. L., F. N. Andrews, E. E. Gardiner, W. E. Fontaine, and C. W. Carrick, 1962. The effects of environmental temperature on the growth and nutritional requirements of the chick. Poultry Sci. 41:588–594.

Bacon, W. L., A. H. Cantor, and M. A. Coleman, 1981. Effect of dietary energy environmental, and sex of market broilers on lipoprotein composition. Poultry Sci. 60:1282–1286.

Brown, H. B., and M. G. McCartney, 1982. Effects of dietary energy and protein and feeding time on broiler performance. Poultry Sci. 61:304–310.

Dale, N. M., and H. L. Fuller, 1980. Effect of diet composition on feed intake and growth of chicks under heat stress. II. Constant *vs.* cycling temperatures. Poultry Sci. 59:1434–1441.

Donaldson, W. E., G. F. Combs, and G. L. Romoser, 1956. Studies on energy levels in poultry rations. 1. The effect of calorie-protein ratio of the ration on growth, nutrient utilization and body composition of chicks. Poultry Sci. 35:1100–1105.

Duncan, D. B., 1955. Multiple range and multiple F tests. Biometrics 11:1–42.

Mickelberry, W. C., J. C. Rogler, and W. J. Stadelman, 1966. The influence of dietary fat and environmental temperature upon chick growth and carcass composition. Poultry Sci. 45:313–321.

National Research Council, 1977. Nutrient Requirements of Domestic Animals. No. 1. Nutrient Requirements of Poultry. Natl. Acad. Sci., Washington, DC.

Reece, F. N., and J. L. McNaughton, 1982. Effects of dietary nutrient density on broiler performance at low and moderate environmental temperatures. Poultry Sci. 61:2208–2211.

Robertson, E. I., R. F. Miller, and G. F. Heuser, 1948. The relation of energy to fiber in chick rations. Poultry Sci. 27:736–741.

Scott, H. M., L. D. Matterson, and E. P. Singsen, 1947. Nutritional factors influencing growth and efficiency of feed utilization. 1. The effect of the source of carbohydrate. Poultry Sci. 26:554.

Steel, T.G.D., and J. H. Torrie, 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., Inc., New York, NY.