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Effect of Varying Levels of Leucine and Energy on Performance and Carcass Characteristics of Broiler Chickens

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Abstract: The experiment was conducted to evaluate the influence of excess leucine, in broiler diets containing varying levels of energy. In a 2 x 2 factorial arrangement, the effects of leucine levels and dietary energy on performance and carcass characteristics of Cobb broiler chickens from 3 to 6 weeks of age were tested. Dietary treatments consisted of two levels of leucine i.e. 0 and 0.5% with two of metabolizable energy (ME) i.e. 3200 and 3000 kcal/kg, respectively. Reducing dietary energy decreased weight gain up to 7.4% (P<0.05). Decreasing dietary energy had no significant effect on feed consumption and feed to gain ratio and carcass characteristics. Increasing dietary leucine had no significant effect on feed consumption, weight gain and feed to gain ratio and carcass characteristics, but significantly increased carcass weight up to 9% (P<0.05). Dietary treatments had no significantly effect on mortality. Further research is needed to evaluate the potential impact of excess leucine in diets with reduced levels of crude protein.

Key words: Leucine, broiler diets, dietary energy, crude protein

Introduction

Many factors can influence amino acid (AA) requirements of chicks and others animals at any given growth stage (Baker, 1997), i.e. dietary factors (e.g. energy level, protein level and presence of protease inhibitors), environmental factors (e.g. disease, crowding, feeder space and heat or cold stress) and genetic factors (e.g., sex and capacity for lean vs fat growth). Several studies have investigated the effects of excess of leucine content in the diet during starter period of broiler chickens (Edmonds and Baker, 1987; Smith and Austic, 1977; Farran and Thomas, 1990; Panz *et al.*, 1984). D'Mello and Lewis (1970) showed that excessive dietary leucine resulted retarded growth rate and increased feed conversion (FC) for 3-week-old, male broiler. Understanding less limiting amino acids needs will allow the nutritionists to minimize excess of essential amino acids (Kidd *et al.*, 2000; Baker *et al.*, 2002) and the reduce of costs.

Moreover, energy is one of the most important factors in broiler rations and plays an important role in determining the performance of the birds. Energy levels suitable for raising broiler in temperate zones need revision as compared to tropical zone as environmental conditions modify these values. The main reason is that birds will eat sufficient feed to satisfy their energy requirements and this is one of the main factors limiting intake. If the energy intake (feed intake) of the bird changes, so does the intake of protein (amino acids), vitamins and minerals. This means that the ratio in which these are supplied in relation to the energy content of the diet is absolutely critical if so as to ensure that the bird receives adequate amounts of nutrients for any phase of its growth (Plumstead, 1997; Sainsbury, 2000). High energy broiler starter diets result in extra deposition of fat (Holsheimer and Jensen, 1991) pointing the wastage of dietary energy. To ensure the maximum utilization of each and every nutrient of the diet, a right proportion of these nutrients is necessary to optimum the growth of the birds and to minimize the surplus use of vital dietary component.

The challenge for a nutritionist is to make formulation economically viable diets, which provide as closely as possible the amino acids and energy requirement of chickens. But to our knowledge studies regarding excesses of leucine content in the diet have not been conducted in grower broiler chickens. The objectives of our study were: To determine the effect of L-leucine supplementation on growth performance and carcass characteristics of grower broiler chickens fed two levels of energy.

Materials and Methods

A total of 80 straight run one-day broiler chicks (Cobb) were randomized into four plicate groups of five chicks each for four treatments with varying amount of L-leucine and energy added to basal diet. All birds consumed feed and water at will and reared and continous lighting. From 1 to 21 d of age, all chicks were fed a nutritionally complete broiler starter. common diet through d 21. Birds received dietary treatments from 21 to 42 days of age. Fishmeal, soybean meal and corn were analyzed

Table 1: Composition (%) and nutrient content of diets with different level of leucine and energy in experiment

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4
Corn	61.00	64.17	60.00	64.27
SBM (44%)	24.00	23.80	23.34	24.00
Fishmeal (57%)	6.99	6.70	6.99	5.9
Palm Oil	5.42	2.00	5.70	2.00
Limestone	1.26	1.30	1.27	1.30
Salt	0.28	0.28	0.25	0.28
DCP	0.10	0.80	1	0.80
Mineral Mix	0.25	0.25	0.25	0.25
Vitamin Mix	0.25	0.25	0.25	0.25
L-Lysine	0.20	0.20	0.20	0.20
DL-Methionine	0.15	0.15	0.15	0.15
L-Leucine	0	0	0.50	0.50
Choline cloride	0.10	0.10	0.10	0.10
Calculated analysis				
ME Kcal/kg	3,204	3,031	3,195	3,053
CP, %	20.000	20.00	19.92	19.95
Ca, %	0.92	1.07	1.12	1.03
Available P, %	0.33	0.44	0.48	0.42
Fiber %	3.140	3.19	3.07	3.20
Mehionine + Cystine, %	0.840	0.84	0.83	0.83
Lysine, %	1.281	1.27	1.26	1.21
Leucine, %[1]	1.707	1.71	2.16	2.19

[1]The NRC (1994) recommends minimum levels of 1.09% Leucine for diets with 3200 ME kcal/kg and 20% crude protein on broiler from 21 to 42 days of age.

for CP prior to diet formulation to assure accurate treatment crude protein content. Crude protein was determined using Kjedahl procedure (AOAC, 1980). Four dietary treatments were replicated 4 times (20 birds/ treatment) in a factorial arrangement. Two level of L-leucine (0.0, 0.5 g/kg) were added to the to the control (ME 3200 kcal/kg) and low- energy (ME 3000 kcal/kg) in the growing periods, respectively). Dietary treatments were formulated according to NRC (1994). One diet (Diet 1, Table 1) was considered as the positive control and calculated to contain 23% CP and 3200 kcal/kg of ME. Pen body weight and feed consumption were recorded weekly throughout the experiment. Feed consumption was corrected for body weight of mortality. Feed consumption was calculated as a difference between the amount of feed supplied to the birds and the amount of feed that remained at the end of each feeding period. Body weigh gain was calculated as a difference between the final and initial birds weight during each of the weighing periods. Feed intake and weight gain was recorded at 21 to 42 day and feed conversion ratio (FCR) was calculated. On 42nd day of the experiment, six birds from each treatment were randomly selected, slaughtered and defeathered to get the carcass responses to the dietary treatments. Feed conversion (feed: gain ratio) was calculated as a ratio between feed consumption and weight gain for each period. The data on carcass weight, abdominal fat and organ weight i.e. heart, liver and gizzard were also recorded at this stage. Carcass weight measurements were done after defeathering and removal of feet, head and viscera. Abdominal fat comprised leaf fat surrounding the cloaca and abdominal muscles excluding fat surrounding the gizzard. The factorial arrangement of 4 treatments consisting of two level energy and two level of leucine with CRD design were analyzed using the General Linear Models procedure of SAS (SAS Institute, 1997). When differences among means were found, means were separated using Duncan's new multiple range test (Steel and Torrie, 1980).

Results and Discussion

Feed intake, weight gain and feed conversion ratio of broiler chickens are presented in Table 2. Supplementation of leucine had no significant effect on cumulative feed consumption, weight gain and feed conversion ratio. Our observations that Leu excess had no effect on growth agree with the comprehensive study by others author. Edmonds and Baker (1987) found that the excess 4% leucine on diet contained 23% protein and 3,130 kcal ME/kg diet had no significant effect on weight gain, feed intake and gain/feed of broiler chicks. Moreover, addition of 4% leucine to a 20% protein (C-SBM) diet for pig also had been found to exert no deleterious effects on growth (Edmonds and Baker, 1987). Penz *et al.* (1984) reported that addition of 1.6% L-leucine to make a total of 3.23% in 22.9% protein diet was not enough to cause a significant reduction in growth whereas D'Mello and Lewis (1970) found that 2.9% leucine in a 20% protein diet was not growth depressing weight gain but addition 4.8% L-leucine caused a significant reduction on broiler chicks (Penz *et al.*, 1984).

Levels of leucine had little influenced on heart and liver weight (Table 3). Moreover, abdominal fat content was generally reduced as leucine levels increased. This finding agree with results of Waldroup *et al.* (2002) that dietary leucine between 1.9% and 3.83% had no significant effect on heart and liver weight as percentage body weight but had significantly higher abdominal fat as leucine level increased.

However, Increasing the leucine level increased carcass weight of the total period experiment ($P<0.05$). The values of dietary Leucine (0 and 0.5%) are higher than those of cited in the NRC (1994). These results partly agree with the result of Keer and Kidd (1999), that supplementing indispensable amino acid (IDDA) to the low-crude protein treatments had increased carcass yield of birds.

Reducing dietary energy decreased weight gain ($P<0.05$), but it had no significant effect on feed consumption and feed conversion ratio. Reducing dietary energy also had no significant effect on carcass weight, abdominal fat and organ weight i.e. heart, liver and gizzard. Same to results obtained in our study, Gaffari *et al.* (2007), reported that levels of ME had

Table 2: Weight gain, feed intake and feed conversion rate as affected by L-leucine supplementation and energy levels (21-42d)

Treatment	Energy	L-Leucine	Weight Gain (g)	Feed Intake (g)	FCR (g/g)
					Main effects Energy
3200			1378.40[a]	2591.96	1.89
3000			1276.03[b]	2516.93	1.92
SEM					
					L-Leucine (g/kg)
0.0			1311.45	2548.48	1.90
0.5			1342.98	2560.41	1.92
SEM					
					Interaction
	3200	0.0	1362.4	2584.39	1.91
	3000	0.0	1260.5	2512.56	1.89
	3200	0.5	1394.4	2599.52	1.87
	3000	0.5	1291.55	2521.3	1.96
					Significance
Energy			*	ns	ns
L-Leucine			ns	ns	ns
Energy *L-leucine			ns	ns	ns

Table 3: Final carcass caracteristics of broiler fed diets as affected by L-leucine supplementation and energy levels (42 days of age)

Treatments	L-Leucine	Energy	Carcass (g)	Abdominal Fat (g)	Gizzard (g)	Liver (g)	Heart (g)
L-Leucine (g/kg)							
0.0			70.82[a]	46.88	25.98	44.32	9.05
0.5			77.91[b]	42.18	25.93	46.10	9.03
							Energy
3200			72.58	47.94	26.38	46.64	9.11
3000			76.15	41.12	25.53	43.78	8.97
							Interactions
	0.0	3200	66.46	50.88	26.48	45.28	8.90
	0.0	3000	75.19	42.88	25.48	43.37	9.14
	0.5	3200	78.70	45.00	26.28	48.00	9.26
	0.5	3000	77.12	39.36	25.58	44.20	8.80
							Significance
L-Leucine			*	ns	ns	ns	ns
Energy			ns	ns	ns	ns	ns
L-Leucine x Energy			ns	ns	ns	ns	ns

Means in columns with different superscripts are significantly different ($P<0.05$). ns: non significant. *$P<0.05$

significant effect on weight gain; low ME diets resulted in significantly lower weight gain. These results also in agreement with those obtained by Farell *et al.*, 1999; Lesson *et al.*, 1996 and Sizemore and Sigel, 1993.

Results of these trials showed that decreasing of dietary ME not significantly followed with lowering the feed intake. These results were in agreement with Plumstead *et al.* (2007), who found that feed intake of broiler chicks was not affected when dietary ME set up from 3,000 to 3,200 kcal/kg, which resulted in a step-wise increase in the cumulative ME intake to 21 days of age. In addition, it was also similar to Gonzalev and Pesti (1993) reported that there was no optimum ratio evidence between ME and CP but both ME and CP were still important to predict broiler performance. The apparent lack of an effect of ME density on feed intake in this study was consistent with the revised observations of NRC (1994) that modern broiler strains did not adjust their feed intake to changes in the dietary ME density. The differences in the effects of energy compound on broiler feed intake observed by others researcher may have been caused by differences the range of age of birds dietary trials, as well as by differences on formulation techniques in experiments.

It is concluded that, using the standard requirement of energy (EM 3200 kcal/kg) with adding 0.5g L-Leucine/kg diet in grower period could be a suitable for increasing weight gain and carcass weight for Cobb broiler chickens under the conditions of this study.

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