Journal of Animal and Veterinary Advances 10 (18): 2394-2397, 2011
ISSN: 1680-5593

The Efficiency of Energy and Protein of Broiler Chickens Fed on Diets with Different Lysine Concentrations

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Abstract: An experiment was conducted to evaluate the performance and carcass yield of broilers fed diets (starter and grower) with different levels of lysine requirements, very high lysine (120% NRC), high lysine (110% NRC), standard (100% NRC) and low lysine (90% NRC) in a completely randomized experimental design. All diets were isocaloric and isonitrogenous. In broilers receiving very high lysine (120% NRC), body weight in 42 days significantly increased by 248 g compared with standard lysine diet. Feeding broilers with very high lysine diets (120% NRC) significantly increased protein and energy intake (starter, grower and 0- 42 days of age) compared with others treatments ($p<0.05$). Lysine efficiency was significantly difference in all of periods of trail ($p<0.05$) and very high lysine levels was significantly greater than standard treatment. Protein Efficiency Ratio (PER) and Energy Efficiency Ratio (EER) were unaffected by dietary treatments. Lysine levels had significantly effect on Production Efficiency Factor (PEF). This study showed that increasing lysine level (120% NRC) in diet significantly increased carcass percentage and abdominal fat pad, gizzard and heart weight compared with standard group ($p<0.05$). The results of this study suggest that additional lysine at the level of 120% of NRC in starter (1.32%) and grower (1.22%) diets significantly improved body weight and PEF.

Key words: Lysine, requirements, energy, protein efficiency, treatments, Iran

INTRODUCTION

Amino Acids (AA) requirements of broilers have been extensively studied as well as related factors of influence such as sex, age, genetic strain, heat stress, energy concentration and interactions with crude protein level (Acar *et al*., 1991; Garcia *et al*., 2006; Sterling *et al*., 2002). The wide variation in the composition and digestibility of AA present in feedstuffs is of great concern when using these raw materials. The importance of utilizing the correct amount of balanced dietary protein and AA for poultry is a high priority issue for two reasons. First, the costs of protein and AA are some of the most expensive nutrients in feeds/per unit weight. Second, the environmental concerns about nitrogen losses in poultry waste.

The concentration of protein and AA in broiler diets will have a large impact on breast meat yield, feed/gain ratio and number of days required to produce the appropriate body weight for each type of market. Depending upon genetic strain and the market objectives for each broiler complex, a broiler integrator will probably utilize several different protein and AA dietary programs (Acar *et al*., 1991). Lysine, one the key AA for protein synthesis and muscle deposition has also been demonstrated to be involved in the synthesis of cytokines, proliferation of lymphocytes and thus in the optimum functioning of immune system in response to infection. An inadequate supply of Lys. would reduce antibody response and cell-mediated immunity in chickens (Geraert and Adisseo, 2010). Lysine needed for optimizing breast meat yield may be higher than the amount needed for optimal body weight gain and feed efficiency (Acar *et al*., 1991). The objective of the nutritionists has long been to optimize growth and tissue accretion by increasing nutrient density such as AA. The question remains about the potential benefits of AA beyond the protein synthesis for muscle developments. The overall efficiency that absorbed lysine is used for protein accretion in young growing chicks and pigs is between 70 and 80% (Mohn *et al*., 2000). Essential amino acid recommendations for broilers by the NRC (1994) are largely based on experimentation conducted several decades ago.

Therefore, the objective of this study was to evaluate the four different lysine requirement levels, very high lysine (+20% NRC), high lysine (+10% NRC), standard (NRC) and low lysine (−10% NRC) with same protein and

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energy requirements recommended by NRC (1994) effects on the protein and energy efficiency of Arian broiler.

MATERIALS AND METHODS

An experiment with Arian male broilers was conducted from 1-6 weeks of age. At day 1, 200 male chicks four treatments with five replicates were placed in 20 floor pens (10 chicks per pen and 0.1 m^2 floor space/chick). Water and feed were also supplied *ad libitum*. The lighting regimen was continuous with 24 h of light daily throughout the experimental periods.

The basic chemical composition of the feed materials was determined according to AOAC (1990). Before formulation of the experimental diets, samples of the protein contributing ingredients (corn, soybean meal) were analyzed for total amino acid concentration. The total amino acid values of the ingredients were assayed by high pressure liquid chromatography analysis. The following treatments were applied; 1-Diet with Very High Lysine (VH Lys.) requirement level (120% NRC), 2-Diet with High Lysine (H Lys.) requirement level (110% NRC), 3-Diet with Standard Lysine (S Lys.) requirement level (100% NRC) and 4-Diet with Low Lysine (L Lys.) requirement level (90% NRC). Feeds provided were in mash form and were milled with a 3 mm screen to obtain a similar particle size in all diets. Broiler starter diet formulated according to NRC (1994) recommendations to contain 22% CP and 3,040 kcal of ME/kg in starter diets and 19% CP and 3,100 kcal ME kg^{-1} in grower diets. Diets were formulated isoenergetic and isonitrogenic (Table 1). Body weights and feed consumption were obtained at 21 and 42 days of age. These parameters were calculated to end of experiment:

- Production Efficiency Factor (PEF) = (final bird weight, kg×livability %)/(age days×feed conversion ratio×100) (Lemme *et al*., 2006)
- Protein Efficiency Ratio (PER): Weight gain divided by protein intake (Kamran *et al*., 2008)
- Energy Efficiency Ratio (EER): Weight gain×100/total ME intake (Kamran *et al*., 2008)
- Lysine efficiency: Lysine intake (mg)/weight gain (g)

Parameters were tested for normal distributions before analyses. Data were analyzed by A completely randomized experimental design was used (GLM procedure, An ANOVA of SAS Institute) and where significance occurred, means were compared with the Duncan multiple range tests. Output data were expressed as means with SEM.

Table 1: Composition of experimental diets in starter (0-21 days) and grower (22-42 days) period

	Starter				Grower			
Lysine requirement levels	120%	110%	100%	90%	120%	110%	100%	90%
items/treatments	1	2	3	4	1	2	3	4
Corn, grain	54.01	55.01	55.39	57.32	64.99	65.87	67.06	66.79
Soybean meal (48%)	37.15	36.28	36.01	33.94	28.99	28.10	27.01	27.14
Soybean oil	2.80	2.80	2.80	3.00	3.27	3.40	3.00	3.22
Fish meal	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00
Oyster shells	1.88	1.88	1.88	1.88	1.50	1.50	1.40	1.80
Dical. phos.	1.00	1.00	1.00	1.00	0.23	0.23	0.23	0.20
Common salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Vitamin premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine	0.11	0.10	0.10	0.10	0.12	0.10	0.10	0.10
L-lysine HCl	0.35	0.23	0.12	0.06	0.20	0.10	0.50	0.05
Nutrients contents								
ME (Mcal Kg^{-1})	3.04	3.04	3.04	3.04	3.10	3.10	3.10	3.10
Protein (%)	22.00	22.00	22.00	22.00	19.00	19.00	19.00	19.00
Ether extract (%)	5.00	5.00	5.00	5.00	5.50	5.50	5.50	5.50
Linoleic acid (%)	2.50	2.50	2.50	2.50	2.50	3.00	2.50	2.50
Calcium (%)	1.00	1.00	1.00	1.00	0.90	0.90	0.90	0.90
Avail. phosphorus (%)	0.50	0.50	0.50	0.50	0.42	0.42	0.42	0.42
Sodium (%)	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12
Lys. (%)	1.32	1.22	1.10	1.03	1.22	1.10	1.00	0.91
Digestible Lys. (%)	1.22	1.11	1.01	0.92	1.09	0.98	0.89	0.82
MET (%)	0.51	0.51	0.51	0.51	0.42	0.42	0.42	0.42

Provides per kg of diet. vitamin A (7,000 IU), vitamin D_3 (1,400 IU), vitamin E (16.65 mg), vitamin K (1.5 mg), vitamin B_1 (0.6 mg), vitamin B_2 (2.36 mg), vitamin B_6 (0.6 mg), vitamin B_{12} (0.013 mg), biotin (0.15 mg), choline (1.54 g), pantothenic acid (9.32 mg), niacin (30.12 mg), folic acid (1.42 mg), selenium (0.65 mg), iodine (0.35 mg), iron (57.72 mg), copper (12.30 mg), zinc (141.48 mg) and manganese (173 mg)

RESULTS AND DICUSSION

The results of broiler performance in three periods of trail 0-21, 22-42 and 0-42 days of age are shown in Table 2 and 3. There was a significantly higher in body weight in broiler fed VH Lys. diet by 2227 g (p<0.05). The higher Lys. requirement reported by the current research and Corzo *et al.* (2004) probably relates to increased growth rate and feed intake. Maximum weight gain occurred at 120% dietary lysine from 0-42 days of age. These results indicated that the lysine requirement of Arian male broilers for maximum body weight gain was higher than those of values reported for other strains (Han and Baker, 1991). The results of previous experiments by Zaghari *et al.* (2007) indicated that the digestible lysine requirements of Arian male broilers to achieve maximum body weight gain in the starter period were 1.075% but in this study showed that the digestible lysine requirements of Arian male broilers to achieve maximum body weight gain in the starter period were 1.22%.

Protein and energy intake was significantly different in starter, grower and total period. Protein and energy intake was significantly highest in broiler fed VH Lys. diet in starter and total periods (p<0.05). BW in 42 days of age was significantly highest in birds that received VH Lys. starter and grower diets (p<0.05).

Body weight, protein and energy intake were highest for birds consuming the VH Lys. starter (1.32%) and grower (1.22%) diets (p<0.05) but protein Efficiency Ratio (EER) and Energy Efficiency Ratio (EER) were similar when compared to the other lysine levels diets in starter and grower periods (p>0.05). PER and EER were unaffected by dietary lysine levels.

This study diets formulated in the same amino acids (Isonitrogenic) and energy requirements (Isoenergetic) but were different in lysine requirement levels. Therefore, broiler fed VH Lys. intake more lysine than other treatments. Lysine efficiency (lysine intake (mg)/weight gain (g) was significantly increased in briolers fed VH Lys. diet in starter, grower and total periods.

Lysine Efficiency (Lys. E) was highest in VH Lys. treatmentt by 25.4 (mg g^{-1}) compared to S Lys. treatment by 20.8 (mg g^{-1}) from 0-42 days of age (p<0.05).

Treatment VH Lys. (120% NRC) protein and energy intake, Lys. E and Production Efficiency Factor (PEF) were significantly higher than others treatments (Table 2 and 3). This study showed the VH Lys. diets as they allow a better transformation of protein and energy intake into tissue synthesis and accretion. This is possibly related to a higher AA availability to synthesize muscle. Diets formulated with H Lys. level promoted a better conversion of AA into body weight gain. Differences in dietary AA density responses among published research (Corzo *et al*., 2004; Kidd *et al*., 2004) may be related to strain sources. The response to dietary AA/CP density (Smith *et al*., 1998; Sterling *et al*., 2006) and dietary Lys. (Bilgili *et al*., 1992; Acar *et al*., 1991; Han and Baker, 1991) differs among strain sources. A high-yielding strain was shown to contain more breast muscle total RNA and protein on a weight basis and total DNA content over a low-yielding strain (Acar *et al*., 1993). Muscle growth is largely related to the number of nuclei or total DNA (Kang *et al*., 1985). Hence, strains exhibiting rapid muscle growth should have balanced high dietary AA needs for muscle accretion. In some previous studies feeding low protein diets to broilers decreased growth performance (Ferguson *et al*., 1998).

Table 2: Effects of lysine levels on energy intake (g), Energy Efficiency Rate (PER) and Production Efficiency Factore (PEF)

Lysine levels	Body weight (g)	Energy intake (Mcal) 0-21 days	Energy intake (Mcal) 22-42 days	Energy intake (Mcal) 0-42 days	EER 0-21 days	EER 22-42 days	EER 0-42 days	PEF
120% NRC	2227.000[a]	3.546[a]	10.442[a]	13.988[a]	15.940	15.530	15.600	261.900[a]
110% NRC	2015.000[b]	3.144[b]	9.628[ab]	12.773[b]	17.570	14.760	15.430	234.600[ab]
NRC	1979.000[b]	3.055[b]	9.188[b]	12.243[b]	17.880	15.130	15.800	236.200[ab]
90% NRC	1925.000[b]	2.926[b]	9.609[ab]	12.535[b]	16.900	14.450	14.980	217.600[b]
p-value	0.042	0.033	0.036	0.022	0.279	0.275	0.327	0.021
SEM	53.570	106.630	253.480	308.780	0.594	0.297	0.255	3.144

Table 3: Effects of lysine levels on protein intake (g), Protein Efficiency Rate (PER) and lysine efficiency (mg lysine/g gain) and Production Efficiency Factor (PEF)

Lysine levels	Protein intake (g) 0-21 days	Protein intake (g) 22-42 days	Protein intake (g) 0-42 days	PER 0-21 days	PER 22-42 days	PER 0-42 days	Lys. E 0-21	Lys. E 22-42 --------days (mg g^{-1})--------	Lys. E 0-42
120% NRC	261.600[a]	603.700[a]	865.300[a]	2.160	2.690	2.520	29.100[a]	24.400[a]	25.400[a]
110% NRC	232.100[b]	556.600[ab]	788.700[b]	2.380	2.550	2.500	23.500[b]	23.600[a]	23.500[b]
NRC	225.400[b]	531.200[b]	756.600[b]	2.420	2.620	2.560	18.600[c]	20.700[b]	20.800[c]
90% NRC	215.900[b]	555.600[ab]	771.400[b]	2.290	2.500	2.440	20.200[c]	19.500[b]	19.600[c]
p-value	0.033	0.060	0.019	0.278	0.275	0.400	0.000	0.000	0.000
SEM	7.866	14.651	18.994	0.081	0.051	0.041	0.879	0.451	0.374

[a-c]Means followed by different superscript are significantly different (p<0.05)

CONCLUSION

Feeding broilers very high lysine density diets (120% NRC) increased protein and energy intake, lysine efficiency and production efficiency factor by 108.7 g, 1745 kcal, 4.6 and 25.7% more than broilers fed standard lysine density diets from 0-42 days of age, respectively. This study showed the VH Lys. diets as they allow a better transformation of protein and energy intake into tissue synthesis and accretion.

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