Asian Journal of

Poultry Science

ISSN 1819-3609

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Poultry Science 1 (1): 16-21, 2007
ISSN 1819-3609

Effect of Energy Levels of Diets Formulated on Total or Digestible Amino Acid Basis on Broiler Performance and Carcass Trait

M. Ghaffari, M. Shivazad, M. Zaghari and R. Taherkhani
Department of Animal Science, Faculty of Agriculture, University of Tehran, Karaj, Iran

Abstract: An experiment was conducted to investigate effects of different level of ME in diets of as hatched broiler chicks with respect to method of formulation of Amino Acid (AA) requirement based on total and digestible AA requirements. The experiment was carried out using a complete block design with factorial arrangement. Main factors were included method of formulation of AA requirement (total and digestible) and different ME level (7 dietary ME from 3175 Kcal diluted to 2575 Kcal). Experimental period began at 10 days of age and lasted in 47 days of age. Weight gain and feed consumption were recorded for grower (10-28 days of age) and finisher (28-47 days of age) separately and then feed conversion ratios were computed. In grower period chicks received high ME diets had significantly lower feed intake, but they had higher weight gain and they also utilized their feed more efficiently compared to those received lower levels of ME. Method of formulation of AA requirement had no significant effect on none of the measured parameters during grower period. In finisher period, chicks fed diets formulated on digestible AA requirement had significantly lower feed intake and feed conversion ratio. Different levels of ME had no significant effect on feed intake and weight gain during finisher period. Results obtained in present study suggest that whereas method of formulation of AA requirement in grower period have no beneficial effect, formulation of diets based on digestible AA is advantageous in finisher period.

Key words: Total, digestible, amino acid, energy, broiler

INTRODUCTION

In the past, poultry diets were formulated to meet crude protein requirements. However, the growth of the synthetic amino acid industry permitted the reduction of crude protein levels in diets and nutritionists were then able to formulate diets considering the specific requirements of essential amino acids. Recent studies show the importance of formulation based on Digestible Amino Acids (DAA), as well as of amino acid balance, for optimal performance and reduction of environmental contamination due to better use of the protein of the diet and lower amount of nitrogen in the excreta (Baker and Han, 1994; Rostagno *et al*., 1995; Dari and Penz, 1996).

The wide variation in the composition and the amount of protein and/or amino acids present in animal byproducts is of great concern when using these raw materials. Protein quality and amino acid digestibility of these byproducts depend primarily on processing temperature, cooking time and drying process, which vary according to the processing system. The excess of energy intake is related to the calorie:protein (C:P) ratio in the diet and consequently, to carcass composition. In isocaloric diets, if crude protein level is decreased, there is an increase in C:P ratio, which results in fatter carcasses (Summers *et al*., 1965; Griffiths *et al*., 1977; Rosebrough and Steele, 1985).

This study was conducted to evaluate the live performance and carcass composition of broilers fed diets with seven different energy levels and two ways to express amino acid requirements, either as Total Amino Acid (TAA) or Digestible Amino Acid (DAA).

Corresponding Author: M. Ghaffari, Department of Animal Science, Faculty of Agriculture, University of Tehran, Karaj, Iran

MATERIALS AND METHODS

A total of 392 as hatched Ross 308 broiler chicks were used in this study. Chicks were reared on floor pens from day old to 10 days of age and received a standard starter diet (3200 kcal ME and 23% CP), Then after being subjected to an overnight period of feed withdrawal, chicks were weighted individually and transferred to battery cages (40×78×90 cm) and allocated to dietary treatments so that

Table 1: Composition and nutrient content of experimental diets in grower (10-28 days) period

	Energy (kcal)													
	3175		3075		2975		2875		2775		2675		2575	
Ingredients	T	D	T	D	T	D	T	D	T	D	T	D	T	D
Corn	52.95	54.84	56.71	58.85	60.47	62.89	64.18	66.92	64.08	50.04	59.76	57.18	53.57	57.53
Soybean meal	35.10	34.99	32.96	33.00	30.81	31.00	28.63	29.01	26.84	27.82	23.95	24.98	21.60	23.53
Wheat bran	-	-	-	-	-	-	-	-	4.15	0.17	10.95	10.49	17.56	15.69
Barley	-	-	-	-	-	-	-	-	-	18.36	0.79	3.97	3.68	-
Canola	0.81	-	1.37	-	1.93	-	2.26	-	1.41	-	1.16	-	0.11	-
Fat acid	6.94	6.02	4.96	4.15	2.29	2.27	0.90	0.40	-	-	-	-	-	-
Oyster shell	1.54	1.54	1.48	1.48	1.41	1.43	1.35	1.37	1.35	1.40	1.38	1.40	1.41	1.36
Dicalcium Phosphate	1.47	1.47	1.37	1.38	1.28	1.30	1.19	1.22	1.08	1.18	0.94	0.96	0.81	0.87
Salt	0.34	0.34	0.32	0.32	0.31	0.31	0.30	0.30	0.28	0.29	0.26	0.26	0.25	0.25
Mineral mix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin mix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.21	0.25	0.19	0.23	0.16	0.21	0.14	0.20	0.14	0.17	0.13	0.17	0.13	0.16
L-Lysine	0.14	0.05	0.15	0.07	0.15	0.08	0.15	0.09	0.16	0.06	0.18	0.09	0.20	0.10

	Energy (kcal kg^{-1})													
	3175		3075		2975		2875		2775		2675		2575	
Calculated analysis (%)	T	D	T	D	T	D	T	D	T	D	T	D	T	D
Protein	21.32	21.03	20.84	20.44	20.36	19.85	19.92	19.26	19.23	19.23	18.53	18.54	17.84	17.84
D-Protein	17.10	16.84	16.76	16.41	16.41	15.97	16.10	15.53	15.53	15.49	14.97	14.93	14.40	14.37
Calcium	0.90	0.90	0.87	0.87	0.84	0.84	0.81	0.82	0.78	0.79	0.75	0.76	0.73	0.73
Available Phosphorus	0.45	0.45	0.43	0.44	0.42	0.42	0.40	0.41	0.39	0.39	0.37	0.38	0.37	0.37
Chlorine	0.25	0.24	0.25	0.24	0.24	0.23	0.24	0.23	0.23	0.23	0.23	0.22	0.24	0.22
Potassium	0.86	0.86	0.83	0.83	0.81	0.80	0.79	0.77	0.79	0.81	0.80	0.81	0.82	0.79
Sodium	0.16	0.16	0.15	0.16	0.14	0.15	0.14	0.14	0.13	0.14	0.13	0.13	0.13	0.13
Cf	1.55	1.46	1.57	1.41	1.60	1.37	1.64	1.33	1.86	1.21	2.47	2.25	3.06	2.47
Lysine	1.25	1.17	1.21	1.13	1.17	1.09	1.13	1.06	1.09	1.03	1.05	1.00	1.01	0.96
D-Lys	1.13	1.05	1.09	1.02	1.05	0.99	1.01	0.95	0.98	0.92	0.94	0.89	0.90	0.85
Methionine	0.53	0.56	0.50	0.54	0.48	0.52	0.45	0.50	0.43	0.47	0.41	0.45	0.40	0.43
D-Met	0.50	0.53	0.47	0.51	0.45	0.49	0.42	0.47	0.41	0.44	0.39	0.42	0.38	0.41
Met+Cys	0.88	0.91	0.85	0.88	0.82	0.85	0.79	0.82	0.77	0.80	0.74	0.77	0.72	0.74
D-Met+Cys	0.75	0.78	0.72	0.76	0.70	0.73	0.67	0.71	0.67	0.68	0.68	0.66	0.69	0.63
Threonine	0.79	0.79	0.76	0.77	0.74	0.74	0.71	0.72	0.69	0.70	0.66	0.68	0.64	0.65
D-Thr	0.69	0.69	0.66	0.67	0.64	0.65	0.62	0.63	0.61	0.60	0.59	0.58	0.58	0.56
Isoleucine	1.02	1.02	0.99	0.98	0.96	0.94	0.92	0.91	0.89	0.90	0.84	0.86	0.81	0.82
D-Ile	0.94	0.94	0.91	0.90	0.88	0.87	0.85	0.83	0.81	0.83	0.77	0.78	0.73	0.75
Arginine	1.41	1.39	1.36	1.34	1.32	1.29	1.28	1.24	1.23	1.22	1.18	1.20	1.14	1.16
D-Arg	1.29	1.28	1.24	1.23	1.20	1.18	1.16	1.13	1.11	1.11	1.06	1.08	1.02	1.04
Tryptophan	0.26	0.25	0.26	0.24	0.26	0.23	0.26	0.22	0.24	0.23	0.24	0.23	0.23	0.22
D-Trp	0.24	0.23	0.24	0.22	0.23	0.21	0.23	0.21	0.22	0.21	0.22	0.21	0.22	0.21

D: Digestible, T: Total

pens had equal initial weight and weight distribution. Four replicate groups of 7 chicks were fed each of dietary treatments. Experimental period began at 10 days of age and lasted in 47 days of age. The experiment was carried out using a complete block design with a 7×2 factorial arrangement. Factors were included different level of energy (7 energy levels) and method of formulation of diets AA requirements (total and digestible). Chicks received a grower diet from 10-28 days of age and a finisher diet from 28-49 days of age. Seven levels of ME used for formulation of diets in grower period were 3175, 3075, 2975, 2875, 2675 and 2575 kcal ME per kg of diet. Energy level in finisher period began with 2625 and increased by 100 kcal to achieve 3225 kcal. As diets were diluted, the ratio between ME and other nutrients were kept fix. For each ME level, two method of formulation of AA requirements of diets (total and digestible AA requirement) were employed. All the diets met or exceeded nutrients recommended by Ross management manual. Before formulation of diets, feed ingredients were analyzed for CP, total P, Ca and ether extract according to the AOAC (1995) procedures. Diets used in this study in grower period are presented in Table 1. The same ingredients were used for formulation of diets in finisher period.

Body weight and feed consumption were measured at 28 and 47 days of age and then weight gain and feed conversion ratios were calculated. At the termination of experiment, 2 birds from each replicate were selected randomly and were slaughtered and their empty carcass weight, gastrointestinal tract weight, abdominal fat, liver weight and heart weight were measured.

Data were statistically evaluated by the analysis of variance procedure of SAS software (1996), involving a factorial arrangement of main factor (energy level and method of formulation of AA requirements) in a complete block design. Significant differences between means were separated by the GLM procedure of SAS software (1996). Statistical significance was considered $p<0.05$.

RESULTS AND DISCUSSION

Weight gain, feed consumption and feed conversion ratio of chicks fed diets with different levels of ME which was formulated either on the basis of total or digestible AA in grower period (10-28 days of age) are presented in Table 2. Different levels of ME significantly affected weight gain ($p<0.001$), feed consumption ($p<0.001$) and feed conversion ratio ($p<0.001$). Chicks received high ME

Table 2: Performance of male broiler fed diets formulated based on total and digestible AA with different levels of ME in grower period (10-28 days age)

	Method of expressing AA requirements					
	Feed intake (g)		Body weight gain (g)		Feed conversion (g g^{-1})	
Traits	T	D	T	D	T	D
ME level						
3175	1484.82^{a}	1497.70^{a}	1092.14^{a}	1038.00^{a}	1.36^{b}	1.44^{c}
3075	1471.71^{a}	1452.70^{a}	1046.07^{a}	905.36^{ab}	1.41^{b}	1.60^{b}
2975	1389.98^{b}	1366.77^{b}	916.07^{ab}	856.07^{b}	1.52^{b}	1.60^{b}
2875	1403.66^{ab}	1424.91^{ab}	737.50^{b}	849.29^{b}	1.90^{a}	1.68^{ab}
2775	1344.68^{bc}	1320.96^{c}	748.57^{b}	762.14^{bc}	1.80^{a}	1.73^{ab}
2675	1347.29^{bc}	1398.79^{b}	699.65^{c}	659.07^{c}	1.93^{a}	1.97^{a}
2575	1315.62^{c}	1342.20^{c}	677.14^{c}	680.36^{c}	1.94^{a}	1.97^{a}
AA						
Total	1.393		845.310		1.690	
Digestible	1.386		821.470		1.710	
Probability						
AA	0.780		0.190		0.360	
E	0.001		0.001		0.001	
AA×E	0.990		0.210		0.100	

D: Digestible, T: Total, AA: Method of expressing, AA requirement, E: Metabolizable energy values with different superscripts are significantly different

Table 3: Performance of male broiler fed diets formulated based on total and digestible AA with different levels of ME in finisher period (28-47 days of age)

	Method of expressing AA requirements					
	Feed intake (g)		Weight gain (g)		Feed conversion ratio	
Traits	T	D	T	D	T	D
ME level						
3225	3160.72	3052.83	1493.39	1529.14	2.12	2.00
3125	3183.46	2986.41	1439.29	1458.57	2.21	2.05
3025	3321.45	3069.25	1468.40	1441.43	2.26	2.13
2925	3391.08	2999.02	1490.72	1500.89	2.27	2.00
2825	3230.33	3024.76	1460.18	1441.43	2.21	2.10
2725	3413.78	2974.79	1409.47	1435.04	2.42	2.07
2625	3618.31	2719.24	1258.75	1241.25	2.87	2.19
AA						
Total	3331[a]		1435		2.32[a]	
Digestible	2975[b]		1431		2.07[b]	
Probability						
AA	0.0001		0.94		0.03	
E	0.9800		0.19		0.17	
AA×E	0.2300		0.90		0.77	

D: Digestible, T: Total, AA: Method of expressing AA requirement, E: Metabolizable energy

diets had significantly lower feed consumption and feed conversion ratio, whereas they gained more in comparison to those fed low ME diets. These results agree with those published by Sizemore and Siegel (1993) and Leeson *et al*. (1996) and Miranda *et al*. (2000). It seems that capacity of digestive tract and higher content of crude fiber in diluted diets are the limiting factors resulted in lower feed consumption and consequently poor performance in chicks received low energy diets. Araujo *et al*. (2005) also reported higher feed intake in chicks fed higher levels of ME in grower period. However, ME level had no significant effect on feed intake, weight gain and feed efficiency (Table 3). A possible reason for lack of effect of ME level in finisher period may be related to increased capacity of gastrointestinal tract as bird ages.

Feed intake was not significantly influenced by the way amino acid requirements were expressed in grower period (Table 2), which is consistent with previously published results from experiments comparing diets based on alternative ingredients with low amino acid digestibility to diets based on ingredients with high amino acid digestibility (corn and soybean meal) and to diets with low digestibility ingredients supplemented with synthetic amino acids (Rostagno *et al*., 1995; Dari and Penz, 1996). However, in finisher period diet formulation based on DAA resulted in lower feed intake and better feed conversion (Table 3), which agrees with the results published by Fernandez *et al*. (1985), Rostagno *et al*. (1995) and Dari and Penz (1996).

Method of formulation of AA requirements had no significant effect on any of measured parameters (Table 4). However, ME content of diets significantly affected carcass yield ($p<0.002$), abdominal fat ($p<0.001$) and liver weight ($p<0.002$). Neither ME content of diets, nor method of expressing AA requirement had no significant effect on gastrointestinal tract weight. As ME content of diets decreased, carcass yield significantly decreased. Chicks received diets with higher ME content had significantly abdominal fat percentage. These results are in good agreement with those reported by Maiorka *et al*. (2004). Relative liver weight increased significantly as energy levels of diets increased, this may be a consequence of an increased metabolic rate due to increased ME intake. Results obtained in present study suggest that whereas method of formulation of AA requirement in grower period have no beneficial effect, formulation of diets based on digestible AA is advantageous in finisher period.

Table 4: Carcass dissections of broiler fed diets formulated based on total and digestible AA with different levels of ME

Trait ME level Grower	 Finisher	Carcass yield (g)	Gastrointestinal tract weight[1] (%)	Abdominal fat[1] (%)	Liver[1] (%)
3175	3225	2025^{a}	0.143	0.031^{a}	0.0300^{a}
3075	3125	2018^{a}	0.138	0.029^{ab}	0.0290^{ab}
2975	3025	1908^{ab}	0.145	0.031^{ab}	0.0290^{abc}
2875	2925	1889^{b}	0.143	0.027^{cb}	0.0290^{abc}
2775	2825	1885^{b}	0.142	0.023^{cd}	0.0270^{bc}
2675	2725	1860^{b}	0.142	0.022^{cd}	0.0265^{c}
2575	2625	1780^{c}	0.146	0.021^{d}	0.0260^{c}
AA					
Total		2285	0.121	0.023	55.02
Digestible		2230	0.120	0.022	54.89
Probability					
AA		0.851	0.208	0.120	0.947
E		0.002	0.490	0.001	0.041
AA×E		0.929	0.860	0.220	0.260

1: Gastrointestinal, liver and abdominal fat weight are expressed as percentage of eviscerated carcass, D: Digestible, T: Total, AA: Method of expressing AA requirement, E: Metabolizable energy values with different superscripts are significantly different

REFERENCES

AOAC, 1995. Official Methods of Analysis. 6th Edn., Assoc. Off. Anal. Chem., Washington, DC.

Araujo, L.F., O.M. Junqueira, C.S.S. Araujo, L.C.G.S. Barbosa and J. Stringhini, 2005. Energy and lysine for broilers from 44-55 days of age. Bras. Cienc. Avic., 7: 237-241.

Baker, D.H. and Y. Han, 1994. Ideal amino acid profile for chicks during the first three weeks of posthatching. Poult. Sci., 73: 1441-1447.

Dari, R.L. and A.M. Jr. Penz, 1996. The use of digestible amino acid and ideal protein concept in diet formulation for broilers. Poult. Sci., 75 (Suppl): 67.

Fernandez, R.S., Y. Zhang and C.M. Parsons, 1985. Dietary formulation with cottonseed meal on a total amino acid versus a digestible amino acid basis. Poult. Sci., 74: 1168-1179

Griffiths, L., S. Lesson and J.D. Summers, 1977. Fat deposition in broilers: Effect of dietary energy to protein balance and early life caloric restriction on productive performance and abdominal fat pad size. Poult. Sci., 56: 638-646.

Lesson, S., L. Caston and J.D. Summers, 1996. Broiler response to diet energy. Poult. Sci., 75: 529-535.

Maiorka, A., F. Dahlke, E. Santin, A.M. Kessler and J.R.A.M. Penz, 2004. Effect of energy levels of diets formulated on total or digestible amino acid basis on broiler performance. Braz. J. Poult. Sci., 6: 87-91.

Miranda de Oliveira, R.F., J.T. Zanusso, J.L. Donzele, R.A. Ferreira, L.F.T. Albino, S.R. Valerio, A. Rodrigues de Oliveira Neto and H. Maximiano do Carmo, 2000. Metabolizable energy levels for broiler chickens from 1-21 days of age under high environmental temperature. Bras. Zootec., 29: 810-816.

Rosebrough, R.W. and N.C. Steele, 1985. Energy and protein relationships in the broiler 1. Effect of protein levels and feeding regimens on growth, body composition and *in vitro* lipogenesis of broiler chicks. Poult. Sci., 64: 119-126.

Rostagno, H.S., J.M.R. Pupa and M. Pack, 1995. Diet formulation for broilers based on total versus digestible amino acids. J. Applied Poult. Res., 4: 1-7.

SAS Institute, 1990. SAS/STAT User's Guide: Statistics. Release 6.04 Edn., SAS Institute Inc. Cary, NC.

Sizemore, F.G. and H.S. Sigel, 1993. Growth, feed conversion and carcass composition in females of four broiler crosses fed starter diets with different energy levels and energy to protein ratios. Poult. Sci., 72: 2216-2228.

Summers, J.D., S.J. Slinger and G.C. Ashton, 1965. The effect of dietary energy and protein on carcass composition with a note on a method for estimating carcass composition. Poult. Sci., 44: 501-509.