ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 6 (4): 276-279, 2007
ISSN 1682-8356

Effects of Different Levels of Metabolizable Energy and Formulation of Diet Based on Digestible and Total Amino Acid Requirements on Performance of Male Broiler

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

Abstract: In order to evaluate the effects of different levels of energy and method of formulation of Amino Acid (AA) requirements of diets, this experiment was conducted using 294 male broiler chicks. 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). Method of formulation of AA requirement had no significant effect on cumulative feed consumption. Formulation of diet based on total or digestible AA had no significant effect on weight gain whereas high ME diets resulted in higher weight gain. Diets formulated based on total or digestible AA had feed conversion ratios that were not significantly different. Abdominal fat pad were significantly lower in chicks fed diets formulated on digestible AA basis. Energy content of diets affected fat pad significantly. Abdominal fat pad increased significantly as ME content of diets increased. Results obtained in our study suggest that even whit corn soybean meal based diets, formulation of diets AA requirement may be a beneficial tool for optimization of performance.

Key words: Amino acid requirement, metabolizable energy, diet, male broiler

Introduction

There are very few comprehensive studies testing the use of Digestible Amino Acids (DAA) under practical conditions. However, some work demonstrates better broiler performance when DAA levels are taken into consideration in feed formulation. The interest in DAA formulation arises from advantages of feeding chickens less dietary protein to support the desired performance. Some of these advantages are maximization of the use of these amino acids for protein synthesis and not as energy source, decreased environmental pollution, reduced feed cost and decreased requirements for the limiting amino acid (Smith, 1968; Elwell and Soares, 1975; Fernandez *et al*., 1995; Rostagno *et al*., 1995).

The objective of this study was to evaluate appropriateness of formulation of corn soybean meal based diet on the basis of total and digestible AA requirement when diets had varying levels of ME.

Materials and Methods

A total of 294 feather sexed male 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 pens had equal initial weight and weight distribution. Three replicate groups of 7 chicks were fed each of dietary treatments. Experimental period began at 10 d of age and lasted in 49 d 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 d of age and a finisher diet from 28-49 d 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 procedures. Diets used in this study are presented in Table 1.

Body weight and feed consumption were measured at 28 and 49 d of age and then weight gain and feed efficiency 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 (2001), 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 (2001). Statistical significance was considered $p<0.05$.

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

Energy	3175		3075		2975		2875	
	T	D	T	D	T	D	T	D
Corn	46.44	45.78	51.34	50.61	56.23	55.46	61.12	60.39
Soybean meal 44	37.39	36.30	35.25	34.24	33.12	32.18	30.99	30.13
Wheat bran	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Canola	4.10	5.68	3.69	5.28	3.29	4.85	2.89	4.34
Fat acid	8.06	8.29	5.84	6.09	3.62	3.87	1.4	1.64
Oyster shell	1.52	1.51	1.47	1.45	1.41	1.4	1.36	1.35
DCP	1.41	1.40	1.33	0.13	1.25	1.24	1.17	1.16
Salt	0.34	0.34	0.33	0.33	0.31	0.31	0.3	0.3
Mineral mix	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
DL-Methionine	0.18	0.21	0.17	0.19	0.16	0.18	0.15	0.17
L-Lysine	0.06	-	0.08	-	0.10	-	0.12	0.03
Calculated nutrient								

Metab. Energy	3175		3075		2975		2875	
	T	D	T	D	T	D	T	D
Cost	267.27	266.56	255.19	254.25	243.11	241.99	231.03	229.95
Weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Protein	23.01	23.01	22.28	22.28	21.56	21.56	20.83	20.83
D-Protein	18.45	18.48	17.90	17.92	17.35	17.37	16.81	16.82
Calcium	0.90	0.90	0.87	0.87	0.84	0.84	0.82	0.82
Avail. Phos	0.45	0.45	0.44	0.44	0.42	0.42	0.41	0.41
Chlorine	0.24	0.23	0.24	0.22	0.24	0.22	0.23	0.22
Potassium	0.93	0.93	0.90	0.90	0.87	0.87	0.83	0.83
Sodium	0.16	0.16	0.16	0.16	0.15	0.15	0.14	0.14
Cf	2.02	2.19	1.93	2.09	1.83	2.00	1.74	1.90
Lysine	1.30	1.26	1.26	1.20	1.22	1.15	1.18	1.11
D-Lys	1.17	1.12	1.13	1.07	1.09	1.02	1.06	0.99
Methionine	0.53	0.56	0.51	0.54	0.49	0.52	0.48	0.50
D-Met	0.50	0.53	0.48	0.51	0.47	0.49	0.45	0.47
Met + Cys	0.92	0.96	0.89	0.93	0.86	0.89	0.83	0.86
D-Met+Cys	0.78	0.81	0.75	0.78	0.73	0.76	0.71	0.73
Threonine	0.83	0.82	0.80	0.79	0.78	0.77	0.75	0.74
D-Thr	0.72	0.71	0.70	0.69	0.68	0.67	0.65	0.64
Isoleucine	1.11	1.11	1.07	1.07	1.03	1.02	0.98	0.98
D-Ile	1.02	1.02	0.98	0.98	0.94	0.94	0.90	0.90
Arginine	1.54	1.54	1.48	1.48	1.42	1.42	1.35	1.36
D-Arg	1.41	1.41	1.35	1.35	1.30	1.30	1.24	1.24
Tryptophan	0.33	0.35	0.32	0.34	0.30	0.32	0.28	0.30
D-Trp	0.30	0.32	0.28	0.30	0.27	0.29	0.25	0.27

Energy	2775		2675		2575	
	T	D	T	D	T	D
Corn	54.51	55.27	48.91	42.90	48.79	50.58
Soybean meal 44	29.13	28.62	26.68	27.14	23.95	24.22
Wheat bran	0.42	-	7.17	5.31	15.40	15.82
Barley	10.89	10.06	13.3	21.18	8.55	6.15
Canola	1.48	2.58	0.46	-	-	-
Fat acid	-	-	-	-	-	-
Oyster shell	1.37	1.35	1.4	1.42	1.42	1.42
DCP	1.13	1.12	1	1.04	0.83	0.82
Salt	0.29	0.29	0.27	0.27	0.25	0.25
Mineral mix	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
DL-Methionine	0.15	0.17	0.15	0.17	0.14	0.17
L-Lysine	0.14	0.04	0.15	0.06	0.18	0.10

Calculated nutrient						
Metab. Energy	2775		2675		2575	
	T	D	T	D	T	D
Cost	220.01	218.83	212.83	211.84	206.18	206.42
Weight	1.00	1.00	1.00	1.00	1.00	1.00
Protein	20.11	20.11	19.38	19.38	18.66	18.66
D-Protein	16.22	16.23	15.62	15.59	15.02	15.01
Calcium	0.79	0.79	0.76	0.76	0.73	0.73
Avail. Phos	0.39	0.39	0.38	0.38	0.37	0.37
Chlorine	0.24	0.22	0.24	0.23	0.24	0.22
Potassium	0.83	0.82	0.84	0.85	0.85	0.86
Sodium	0.14	0.14	0.13	0.13	0.13	0.13
Cf	1.50	2.09	1.97	2.75	2.69	3.06
Lysine	1.14	1.07	1.10	1.03	1.06	1.00
D-Lys	1.02	0.95	0.98	0.92	0.94	0.88
Methionine	0.46	0.48	0.44	0.47	0.42	0.45
D-Met	0.43	0.45	0.41	0.44	0.40	0.42
Met + Cys	0.80	0.83	0.78	0.80	0.75	0.77
D-Met+Cys	0.68	0.71	0.66	0.68	0.63	0.66
Threonine	0.73	0.72	0.70	0.70	0.67	0.68
D-Thr	0.63	0.62	0.60	0.60	0.57	0.58
Isoleucine	0.94	0.94	0.90	0.91	0.86	0.86
D-Ile	0.86	0.86	0.82	0.83	0.77	0.78
Arginine	1.28	1.29	1.24	1.24	1.20	1.21
D-Arg	1.17	1.18	1.12	1.12	1.08	1.08
Tryptophan	0.26	0.27	0.25	0.25	0.24	0.24
D-Trp	0.24	0.25	0.23	0.23	0.22	0.22

Table 2: Performance of male broiler fed diets formulated based on total and digestible AA with different levels of ME

Composition	F.I. (g)	B.W.G (g)	F.C (g/g)
ME level		Main effects	
3175	4.904	2.656^{a}	1.79^{f}
3075	4.950	2.549^{ab}	1.92^{e}
2975	4.779	2.431^{bc}	1.96^{de}
2875	4.833	2.405^{bc}	2.01^{cd}
2775	4.772	2.25 6^{d}	2.07^{c}
2675	4.858	2.140^{de}	2.23^{b}
2575	4.829	1.946^{e}	2.43^{a}
Amino acid		Main effects	
Total	4.860	2.339	2.05
Digestible	4.833	2.341	2.07
		Probability	
AA	0.63	0.94	0.44
E	0.57	0.001	0.001
AA*E	0.42	0.99	0.03

F.I.= Feed Intake. B.W.G. = Body weight gain.
F.C. = Feed converions

Results and Discussion

Feed intake, Weight gain and feed conversion ratio of broiler chicks received dietary treatment are presented in Table 2.

Method of formulation of AA requirement had no significant effect on cumulative feed consumption. Lack of a significant effect of formulation of AA based on total or digestible requirement reported by Rostagno *et al.*, 1995 and Dari and Penz, 1996. Although different levels of energy didn't affect cumulative feed intake, chicks received high energy diets in grower period had significantly ($p<0.05$) higher feed consumption, whereas in finisher period feed intake was higher ($p<0.05$) in low energy diets (only data for whole experimental period are presented). 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 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.

Formulation of diet based on total or digestible AA had no significant effect on weight gain. Same to results obtained in our study, Farell *et al.*, 1999 reported that chicks received diets formulated based on total and digestible AA had same weight gain. However levels of ME had significant effect on weight gain; Low ME diets resulted in significantly lower weight gain. These results are in agreement with those obtained by Lesson *et al.*, 1996 and Sizemore and Sigel, 1993.

As previously reported by Farrell *et al.*, 1999, diets formulated based on total or digestible AA had feed conversion ratios that were not significantly different. However, different levels of ME significantly affected feed conversion ratios. Dietary treatments with higher levels of ME resulted in more efficient use of feed compare to low ME diets. More efficient utilization of high ME compared to low ME diets has been previously reported (Sizemore and Sigel, 1993; Lesson *et al.*, 1996).

Carcass yield of male broiler received dietary treatment are presented in Table 3.Results show that

Table 3: Carcass yields of broiler fed diets formulated based on total and digestible AA with different levels of ME

	Carcass (g)	Digestion system (g)	Abdo-minal fat (g)	Liver (g)	Heart (g)
Diet	---------------------------- Main effects ----------------------------				
3175	2826^{a}	314.25^{a}	64.06^{a}	62.81^{a}	15.15^{a}
3075	2638^{b}	301.69^{ab}	55.45^{a}	63.79^{a}	14.91^{a}
2975	2539^{b}	293.08^{ab}	52.95^{b}	61.11^{a}	13.36^{b}
2875	2535^{b}	291.01^{b}	42.2^{c}	56.17^{b}	12.85^{b}
2775	2325^{c}	264.4^{b}	38.91^{c}	55.37^{bc}	13.00^{b}
2675	2336^{c}	296.83^{b}	37.03^{cd}	51.55^{c}	11.60^{c}
2575	2048^{d}	289.56^{c}	30.68^{d}	51.58^{c}	11.01^{c}
Amino acid	---------------------------- Main effects ----------------------------				
Total	2482	13.32	57.65	301.31	49.61^{a}
Digestible	2486	13.29	57.70	301.25	42.19^{b}
	---------------------------- Probability ----------------------------				
AA	0.21	0.17	0.69	0.45	0.003
E	0.001	0.001	0.001	0.002	0.001
AA*E	0.073	0.012	0001	0.16	0.001

abdominal fat pad were significantly ($p<0.05$) lower in chicks fed diets formulated on digestible AA basis. Energy content of diets also affected fat padsignificantly. Abdominal fat pad increased significantly as ME content of diets increased. These results observed in our study are in good agreement with those reported by Maiorka *et al*., 2004. Formulation of diets on the basis of digestible AA may help to more accurately supply the AA requirement in the surface of tissue and resulted in increased synthesis of protein tissue instead of fat tissue. Carcass weight, liver weight, heart weight and GIT weight were not affected by method of formulation of AA requirements of diets (Table 3). However ME levels significantly affect these parameters. Chicks received high ME diets, had significantly higher heart and liver weight. These results may be related to a higher metabolism in chicks fed high density diets. Carcass weight were also higher in chicks fed high ME diets. Higher carcass weight in chicks received higher ME previously reported Lesson *et al*., 1996. Results obtained in our study suggest that even whit corn soybean meal based diets, formulation of diets AA requirement may be a beneficial tool for optimization of performance.

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