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Effect of Energy Levels of Diets Formulated on Total and Digestible Amino Acid Basis on Performance of Female Broiler

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Abstract: In order to evaluate the effects of different levels of energy and method for formulation of Amino Acid (AA) requirements of diets, this experiment was conducted using 294 female broiler chicks. The experiment was carried out using a complete block design with a 7×2 factorial arrangement. Factors were included different levels of energy (7 energy levels) and formulation methods of diets AA requirements (total and digestible). Results showed that feed consumption decreased by increasing level of energy. Body weight and feed conversion ratio were promoted by increasing level of energy. Formulation methods of AA requirement had significant effect on cumulative feed consumption, weight gain (in grower period) and feed conversion ratio ($p<0.05$). Interaction effects of independent factors affected on cumulative feed consumption, body weight and feed conversion ratio ($p<0.05$). 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 showed that formulation of diet on digestible AA contained the low energy resulted in promotion of performance.

Key words: Amino acid requirement, metabolizable energy, diet, female 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 result in fatter carcasses (Summers *et al*., 1965; Griffiths *et al*., 1977; Rosebrough and Steele, 1985).

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 female 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 day of age and lasted in 49 day of age. The experiment was carried out using a complete block design with a 7×2 factorial arrangement. Factors were included different levels of energy (7 energy levels) and

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methods of formulation of diets AA requirements (total and digestible). Chicks received a grower diet from 10-28 day of age and a finisher diet from 28-49 day 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 methods 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 (1995). Diets used in this study are shown in Table 1.

Body weight and feed consumption were measured at 28 and 49 day 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 (SAS, 1990), 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 (SAS, 1990). Means were compared using Duncan's multiple-range test and significance was determined at $p \leq 0.05$.

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

	Calculated nutrient													
	3175		3075		2975		2875		2775		2675		2575	
Energy	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 44	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	12.97
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
DCP	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
Sand														2.72
Metabolizable energy														
Cost	262.21	257.93	250.35	247.16	238.49	236.39	226.14	225.63	218.04	216.40	210.51	211.01	203.42	206.63
Weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Protein	21.33	21.03	20.85	20.44	20.37	19.85	19.92	19.26	19.23	19.23	18.54	18.54	17.84	17.84
D-Protein	17.11	16.84	16.76	16.41	16.42	15.97	16.11	15.53	15.54	15.49	14.98	14.93	14.40	14.37
Calcium	0.90	0.90	0.87	0.87	0.84	0.84	0.82	0.82	0.79	0.79	0.76	0.76	0.73	0.73
Avail. Phos	0.45	0.45	0.44	0.44	0.42	0.42	0.41	0.41	0.39	0.39	0.38	0.38	0.37	0.37
Chlorine	0.26	0.24	0.25	0.24	0.25	0.23	0.24	0.23	0.24	0.23	0.24	0.22	0.24	0.22
Potassium	0.86	0.86	0.84	0.83	0.82	0.80	0.79	0.77	0.79	0.81	0.80	0.81	0.82	0.79
Sodium	0.16	0.16	0.16	0.16	0.15	0.15	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13
Cf	1.55	1.46	1.58	1.41	1.60	1.37	1.65	1.33	1.87	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	1.06	0.99	1.02	0.95	0.98	0.92	0.94	0.89	0.90	0.85
Methionine	0.53	0.56	0.51	0.54	0.48	0.52	0.45	0.50	0.44	0.47	0.42	0.45	0.40	0.43
D-Met	0.50	0.53	0.48	0.51	0.45	0.49	0.43	0.47	0.41	0.44	0.40	0.42	0.38	0.41
Met+Cys	0.88	0.91	0.85	0.88	0.83	0.85	0.80	0.82	0.77	0.80	0.74	0.77	0.72	0.74
D-Met+Cys	0.75	0.78	0.73	0.76	0.70	0.73	0.68	0.71	0.67	0.68	0.68	0.66	0.69	0.63
Threonine	0.79	0.79	0.77	0.77	0.74	0.74	0.72	0.72	0.70	0.70	0.67	0.68	0.64	0.65
D-Thr	0.69	0.69	0.67	0.67	0.65	0.65	0.62	0.63	0.61	0.60	0.59	0.58	0.58	0.56
Isoleucine	1.03	1.02	0.99	0.98	0.96	0.94	0.93	0.91	0.89	0.90	0.85	0.86	0.81	0.82
D-Ile	0.95	0.94	0.91	0.90	0.88	0.87	0.85	0.83	0.82	0.83	0.77	0.78	0.73	0.75
Arginine	1.41	1.39	1.37	1.34	1.32	1.29	1.28	1.24	1.23	1.22	1.19	1.20	1.14	1.16
D-Arg	1.29	1.28	1.25	1.23	1.21	1.18	1.17	1.13	1.12	1.11	1.07	1.08	1.02	1.04
Tryptophan	0.27	0.25	0.27	0.24	0.27	0.23	0.27	0.22	0.25	0.23	0.24	0.23	0.23	0.22
D-Trp	0.24	0.23	0.24	0.22	0.24	0.21	0.24	0.21	0.22	0.21	0.22	0.21	0.22	0.21

T: Diets formulated on total amino acid; D: Diets formulated on digestible amino acid; D-(AA): Digestible (AA)

RESULTS AND DISCUSSION

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

Method of formulation of AA requirement had significant effect on cumulative feed consumption ($p<0.05$). Diet formulation based on digestible AA resulted on decreasing feed consumption in grower and finisher periods.

It seems that, reduced food intake observed in formulated rations based on digestible AA, is due to ability of this formulation method to balance rations close to chickens requirements. However formulation method based on digestible AA instead of total AA, provides chickens requirements and reduces food intake. As Rostagno *et al*. (1995) and Dari and Penz (1996) reported that lack of a significant effect of formulation of AA based on total or digestible requirement on cumulative feed consumption.

Results showed that by increasing level of energy feed intake were decreasing in grower and finisher periods ($p<0.05$). These results obtained in previous research (Leeson *et al*., 1996).

Formulation of grower diet based on digestible AA resulted in better weight gain, which agrees with results published by Fernandes *et al*. (1985), Rostagno *et al*. (1995) and Dari and Penz (1996).

Formulation of finisher diet based on total or digestible AA had no significant effect on weight gain. Same to results obtained in present 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 Leeson *et al*. (1996) and Sizemore and Siegel (1993). Because, food intake increase in the low level of energy, required food intake is restricted due to limited capacity of GI tract and physical satiety. Thus, reduced energy intake leads decreasing in weight gain.

Feed conversion ratio had better in diet formulation based on digestible AA in finisher diet, which agrees with results published by Rostagno *et al.* (1985), Dari and Penz (1996) and Maiorka *et al*. (2004).

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 Siegel, 1993; Leeson *et al*., 1996).

Interaction effect of independent factors affected on feed consumption, weight gain and feed conversion ratio in grower and finisher period ($p<0.05$). The evaluation of the contrasts showed that the formulation based digestible AA were best when diets contained the low energy level. For rations with low energy level, we usually use low digestible food stuff. So, formulation according to digestible AA is close to chickens requirements and chickens that feed with these rations (low energy levels), have suitable performance.

Carcass yield of female broiler received dietary treatment are shown in Table 3. Results show that 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 pad significantly.

Table 2: Performance of female broiler fed diets formulated based on total and digestible

	Main effects					
	Feed intake (g)		Body weight gain (g)		Feed conversion ($g\ g^{-1}$)	
Composition	Grower	Finisher	Grower	Finisher	Grower	Finisher
ME level						
3175	926^{c}	3.539^{ed}	629^{a}	1.722^{a}	1.47^{d}	2.06^{e}
3075	956^{bc}	3.49^{ed}	593^{b}	1.697^{a}	1.61^{d}	2.05^{e}
2975	986^{ab}	3.543^{ed}	562^{bc}	1.654^{a}	1.75^{d}	2.16^{d}
2875	987^{ab}	3.618^{cd}	557^{c}	1.574^{b}	1.77^{c}	2.25^{d}
2775	973^{ab}	3.669^{bc}	515^{d}	1.540^{bc}	1.87^{c}	2.35^{c}
2675	1.001^{a}	3.743^{ab}	497^{ed}	1.486^{c}	1.99^{b}	2.52^{b}
2575	1.011^{a}	3.822^{a}	480^{e}	1.393^{d}	2.10^{a}	2.73^{a}
Amino acid						
Total	996.32^{a}	3.671^{a}	563^{a}	1.579	1.79	2.33^{a}
Digestible	958.87^{b}	3.593^{b}	532^{b}	1.582	1.81	2.27^{b}

	Probability											
	F	p	F	p	F	p	F	p	F	p	F	p
AA	0.001	14.05	0.010	7.420	0.001	13.30	0.870	0.030	0.280	1.21	0.0090	7.7500
E	0.001	4.760	0.001	9.790	0.001	24.54	0.001	27.05	0.001	42.28	0.0001	118.29
AA×E	0.001	3.780	0.001	15.45	0.001	8.550	0.008	3.670	0.001	5.270	0.0001	6.9600

^{abc}: Means in the same column with a different superscript are significantly different ($p<0.05$)

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

	Main effects				
Diets	Carcass (g)	Digestion system (g)	Abdominal fat (g)	Liver (g)	Heart (g)
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}	42.20^{c}	56.17^{b}	12.85^{b}
2775	2325^{c}	264.40^{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					
Total	2482	13.32	57.65	301.31	49.61^{a}
Digestible	2486	13.29	57.70	301.25	42.19^{b}
Probability					
AA	0.210	0.170	0.690	0.450	0.003
E	0.001	0.001	0.001	0.002	0.001
AA×E	0.073	0.012	0.001	0.160	0.001

^{abc}: Means in the same column with a different superscript are significantly different ($p<0.05$)

Abdominal fat pad increased significantly as ME content of diets increased. These results observed in present 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 Leeson *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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