Different Levels of Digestible Methionine on Performance of Broiler Starter

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Abstract. Dietary protein and amino acid supply is the most expensive component of poultry diets. Therefore several efforts made by the industry to minimize the cost of the protein portion of the diet. Accordingly, there has been a recent move to use digestible amino acid values in the formulation of poultry diets. The efficiency of protein utilization depends to a large extent on the amino acid composition of the diet. The study was conducted to determine the digestible methionine requirement of broilers during the starter periods. One hundred and seventy five (175) chicks were allocated to 5 treatments with five replicates of seven chicks per replicate in a completely randomized design. Chicks were fed experimental diets from one day old to 21 days of age. Dietary treatments included 5 titrated levels each of digestible methionine (3.0, 4.5, 6.0, 7.5, and 9.0 g/kg diet) added to a basal diet. The allowance of digestible methionine, rather than digestible sulphur amino acids was used in formulating the diets. Supplemental synthetic DL-Methionine which were considered to be 100% digestible were added to diets to obtain the concentration of the digestible amino acid. Each week until the conclusion of the trial, birds were individually weighed, feed intake per pen was measured, and feed conversion ratio (FCR) was computed. This study suggested that the digestible methionine requirement for broiler starter is 4.7 g/kg for optimal body weight gain and 4.6 g/kg for optimal feed conversion ratio.

Key Words: amino acid, broiler, digestible, methionine, starter

Introduction

The dietary requirement for protein is actually a requirement for the amino acids contained in the dietary protein (Coon et al., 2002). Dietary protein and amino acid supply is the most expensive component of poultry diets and it is for this reason that every effort is made by the industry to minimize the cost of the protein portion of the diet. Accordingly, there has been a recent move to use digestible amino acid values in the formulation of poultry diets. The concept of digestible amino acids is based on the realization that amino acids in most ingredients are not completely digested (Parsons, 2002). Formulation with digestible amino acids potentially provides diets which more closely meet the birds actual amino acid requirements and also it allows for the inclusion of low quality protein sources in the diet (Bryden and Ravindran, 2000). Several studies (Bryden et al., 2000; Bryden and Li 2004; Mulyantini et al., 2004) obtained that dietary formulation based on a digestibility amino acid basis significantly improved weight gains and feed efficiency of broilers. In contrast, diets based on total amino acid concentrations may not provide an appropriate balance of amino acids to meet the birds' requirements. However, many feed companies still use total amino acids to specify poultry diets and there is a need for a better-feed formulation system than one based on total amino acids.

There is now sufficient data available to allow the nutritionist to use digestible values with a degree of confidence although more research is required to adequately describe the factors that contribute to the variation that has been noted in digestible amino acids values. However, there has been less research conducted on the digestible amino acid requirements of poultry to optimize dietary protein utilization. It is necessary to be able to match digestible amino acid supply from the diet with the digestible amino acid requirements of the bird. Methionine, is considered to be the first most limiting amino acids in broilers diets (Kalinowski et al., 2003). It is important to have accurate information on requirement of this amino acid on a digestible basis in formulating diets to optimize growth and production. Extensive work has been done

to estimate amino acids requirement of poultry (Kadim et al., 2002; Oviedo and Waldroup, 2002). However, all of the studies were based on total amino acid values. The requirements vary greatly depending on the response criteria and the mathematical model applied for estimation. Therefore, accurate estimates of ileal digestible amino acid requirements need to be obtained for optimum growth performance of broiler chickens. Since the main sites of absorption of amino acids are the jejunum and ileum, Lemme et al. (2004) suggested that the analysis of ileal contents rather than excreta might be a reliable method for assessing protein and amino acid digestibility. No studies have been conducted on ileal digestible methionine requirement for optimum growth of broiler starter. This experiment was conducted to investigate broiler chicken growth during the starter phase to graded levels of digestible methionine.

Materials and Methods

This experiment used 175 mixed sex broiler chickens from 1 to 21 days of age. Chicks were obtained from a local hatchery, wing tagged and weighed individually. Birds were allocated so that the average initial body weights for each floor pen were similar (45 ± 2.9) Chicks were fed experimental diets from one day old to 21 days of age. Analysis of the diets is shown in Table 1. Dietary treatments included 5 titrated levels each of digestible methionine added to a basal diet (Table 2). Dietary treatments included the following levels of digestible methionine: 3.0, 4.5, 6.0, 7.5, and 9.0 g/kg diet. The allowance of digestible methionine, rather than digestible sulphur amino acids was used in formulating the diets. The levels of other amino acids were similar among treatments and set as recommended by the University of Illinois for digestible amino acid requirements of male broilers (Baker and Han, 1994). Supplemental synthetic DL-Methionine which were considered to be 100% digestible were added to diets to obtain the concentration of the digestible amino acid. Each week until the conclusion of the trial, birds were individually weighed, feed intake per pen was measured, and feed conversion ratio (FCR) was computed.

Table 1. Determined nutrient composition of starter basal diets (1-21 days of age)

Analysis (g/kg)	Methionine basal diet
Protein	218.00
Fat	32.11
Calcium	10.22
Phosphorus	4.51
AME (MJ/kg)	12.47
Lysine	13.27
Methionine	3.43
Methionine + cystine	7.65
Threonine	10.18
Tryptophan	2.25
Arginine	14.33
Valine	11.68
Leucine	20.50
Isoleucine	9.70
Choline (ppm)	15.23
Digestible lysine	11.76
Digestible methionine	3.00
Digestible threonine	7.88
Digestible tryptophan	1.90
Digestible arginine	12.39
Digestible isoleucine	7.89
Digestible leucine	16.52
Digestible valine	8.99
Digestible histidine	4.10
Digestible phenylalanine	8.56

The trial followed a completely randomized design on the basis of initial weight and pen location. One hundred and seventy five (175) chicks were allocated to 5 treatments with five replicates of seven chicks per replicate. Data for weight gain, feed intake and FCR were subjected to Anova procedures appropriate (Steel and Torie, 1980) by using the General Linear Model (GLM) procedure of SAS software. From 1 to 21 days of age, the digestible levels of each amino acids for optimum weight gain and FCR were tested by polynomial quadratic models. Digestible amino acids requirements were estimated by fitting the data of the experiment to a quadratic response curve. Then, determining the dietary amino acids levels (X) required for maximal weight gain and minimum feed conversion ratio (Y). A value of 95% of the X value required for maximal 100 Y was selected as the requirement estimate. A quadratic equation was $Y = a + bX - cX_2$. The X value required to achieve maximal Y was obtained by dividing the derivative of Y by the derivative of X.

Results and Discussion

Body weight gain, feed intake and FCR of birds fed diets containing graded levels of methionine are presented in Table 3. Overall, increasing digestible methionine levels significantly improved (P<0.05) weight gain, feed intake and feed conversion ratio.Broiles fed diets containing 3.0 g/kg digestible methionine had significantly (P<0.05) lower body weight compared with other levels. There were no significant differences in body weight of birds fed diets containing digestible methionine from 4.5 g/kg to 9.0 g/kg. Feed intake of birds increased when dietary digestible methionine level increased from 3.0 to 6.0 g/kg. Feed conversion ratio was significantly (P<0.05) improved when dietary digestible methionine content increased from 3.0 to 4.5 g/kg. The level of digestible methionine that maximized weight gain was calculated to be 4.7 g/kg and for lowest FCR was 4.6 g/kg at 95% of maximum response (Figure 1 and 2).

This value is similar to the total methionine value of 5.0 g/kg (about 4.4 g/kg digestible methionine) recommended by Kalinowski et al. (2003) and NRC (1994), and higher than 4.05 g/kg recommended by Baker and Han (1994). The difference findings reported might be due the variation of genotype and to the much faster growth rate of the modern broiler chicken. Food intake was depressed and feather synthesis enhanced in lean relative to fat chickens. The low weight gain and feed intake of birds fed 3.0 g/kg digestible methionine was probably due to the higher requirement of methionine during early phase of growth, and a higher sensitivity of broiler starter to digestible methionine deficiencies. Increased growth rates observed for chickens fed diets containing 4.5, 6.0 and 7.5g digestible methionine/kg than chickens fed diets containing 3.0g digestible methionine/kg indicated that an adequate amino acid intake is essential to reach the optimum growth. The improved growth reflected an increase in feed and amino acid intake. D'Mello (2003b) obtained that at marginal deficiencies of methionine birds ate more food in attempt to meet their requiremet. Unlike this study, there was not trend indicating that birds ate more at marginal deficiency of methionine.

This study shown that feed intake increased with increasing concentration of digestible methionine. Number of studies had investigated the effects of total methionine on broiler growth, but published data on the effects of digestible methionine are limited. The previous studies with total methionine demonstrated that weight gain increased and FCR decreased with increasing methionine levels, which are in agreement with the results of the current study. Weight gain and feed intake seemed to decrease at the highest level of digestible methionine (9.0 g/kg) even though statistically was not different with the level of 4.5 to 7.5 g/kg. The level of 9.0 g/kg can still be tolerated by birds in starter period. Black (2000) found that the negative effects of excess intake of methionine cause the greatest growth depressions.

Table 2. Digestible amino acid levels and crude protein levels (g/kg) of experimental broiler starter diets

Amino acid	Methionine test diets				
	1	2	3	4	5
Lysine	11.2	11.2	11.2	11.2	11.2
Methionine	3.0	4.5	6.0	7.5	9.0
Threonine	7.9	7.9	7.9	7.9	7.9
Tryptophan	1.9	1.9	1.9	1.9	1.9
Valine	9.0	9.0	9.0	9.0	9.0
Arginine	12.4	12.4	12.4	12.4	12.4
Isoleucine	7.9	7.9	7.9	7.9	7.9
Leucin	16.5	16.5	16.5	16.5	16.5
Histidine	4.1	4.1	4.1	4.1	4.1
Phenylalanine	8.6	8.6	8.6	8.6	8.6
Crude protein	218	218	218	218	218

Table 3. Growth performance of broiler (1-21 days) fed graded levels of digestible methionine

Parameter	Digestible methionine levels (g/kg diet)					Pooled	P-value
	3.0	4.5	6.0	7.5	9.0	SEM	
Initital weight (g)							
1 days	42.1	42.3	42.7	42.2	42.8	0.55	0.860
Body weight (g)							
7 days	131.3[b]	143.9[a]	143.6[a]	144.3[a]	144.5[a]	3.15	0.012
15 days	376.8[b]	440.9[a]	427.5[a]	440.8[a]	440.8[a]	10.80	<0.001
21 days	677.4[b]	806.8[a]	785.3[a]	804.3[a]	804.3[a]	19.03	<0.001
Weight gain (g/b/d)							
1-7 days	12.7[b]	14.5[a]	14.4[a]	14.6[a]	14.5[a]	0.47	0.021
7-15 days	30.7[b]	36.2[a]	35.5[a]	37.2[a]	37.0[a]	1.17	0.008
15-21 days	50.1[b]	61.0[a]	59.6[a]	62.2[a]	60.6[a]	1.82	0.000
1-21 days	30.0[b]	35.7[a]	35.4[a]	36.8[a]	35.4[a]	0.94	<0.001
Feed intake (g/b/d)							
1-7 days	15.3[b]	16.8[a]	16.8[a]	17.0[a]	16.7[ab]	0.50	0.21
7-15 days	45.9[b]	49.7	48.7	51.7	51.1	2.08	0.31
15-21 days	85.2	90.8	91.5	91.1	89.2	2.29	0.29
1-21 days	46.3[b]	50.1[ab]	50.3[a]	51.4[a]	50.2[ab]	1.22	0.19
FCR (g/g))							
1-7 days	1.21	1.16	1.18	1.17	1.15	0.04	0.81
7-15 days	1.49[a]	1.36[b]	1.37[b]	1.39	1.39[b]	0.03	0.80
15-21 days	1.72[a]	1.49[b]	1.54[b]	1.47[ab]	1.47[b]	0.05	0.08
1-21 days	1.55[a]	1.40[b]	1.42[b]	1.40[ab]	1.40[b]	0.02	<0.001

Values of weight gain are means from individual birds
Values of feed intake are means from five replicate pens
Values in the same row with different superscripts are significantly difference (P<0.05)

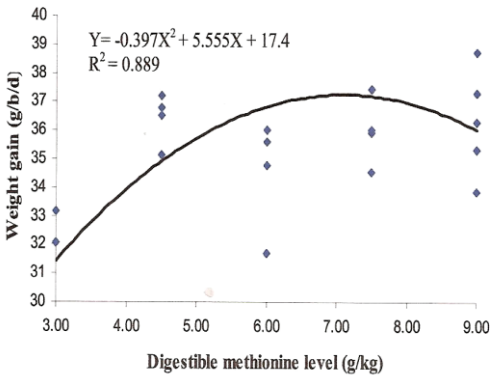

Figure 1. Quadratic responses of weight gain (Y) of broiler starter to dietary digestible methionine levels (X)

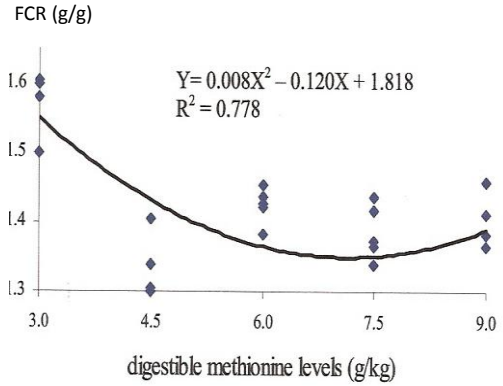

Figure 1. Quadratic responses of FCR (Y) of broiler starter to dietary digestible methionine levels (X)

When methionine is provided at levels exceeding use for protein synthesis, the additional methyl groups may decrease the dietary choline requirement (Han and Lee, 2000). Based on ideal protein consideration, Baker et al. (1996) found that the digestible methionine requirement in birds 1 to 21 days of age was 72% of digestible lysine requirement. In this experiment, male chicks were observed to require 12.0g/kg digestible lysine for maximal feed efficiency, and 72% of this is 0.806%, which is close to the NRC (1994) estimate of 0.90% for chicks during the first 3 week posthatching. Some of the additional results suggest requirement higher than those of the NRC and some suggest lower requirements. Experimental diets based on cereal grain normally contain plenty of cystine (Black et al., 2005). However, as methionine can be converted to cystine, a diet low in the latter amino acid will increase methionine requirements. Diets can be relatively high in

total sulfur amino acids but low in methionine. Kalinowski et al. (2003) maintained that up to 50% of the digestible sulfur amino acids of chicks less than 3 weeks of age can be supplied by cystine

Conclusions

This study suggested that the digestible methionine requirement for broiler starter is 4.7 g/kg for optimal body weight gain and 4.6 g/kg for optimal feed conversion ratio. Further studies are required to define the digestible methionine requirement for growth for finisher broilers.

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