Digestible methionine requirement for performance and carcass yield of broiler finisher

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ABSTRACT: The objectives of the studies were to establish accurate estimates of digestible methionine requirements for broiler chickens given sorghum based diets during the 3-6 week finisher phase. This experiment used 175 male broiler chickens which were fed experimental diets from 3 to 6 weeks of age. Each diet was fed in mash form to 5 pens of broilers (7 birds/pen). Dietary treatments included the following levels of digestible methionine: 2.0 3.5, 5.0, 6.5 and 8.0 g/kg. In conclusion, digestible methionine level of 5.80-5.92 g/kg diet appeared to be adequate to support good growth in broilers from 21 to 42 days of age. The dietary level of methionine needed to optimize breast meat yield appears to be higher than that needed for optimal live performance traits.

Key words: amino acids, broiler, carcass, digestible, methionine.

INTRODUCTION

Protein is one of the most costly components of a poultry diet. The dietary requirement for protein is actually a requirement for the amino acids contained in the dietary protein. However, amino acids in most ingredients are not completely digested and diets based on total amino acid concentrations may not provide an appropriate balance of amino acids to meet the birds' requirements. The use of *digestible* rather than *total* dietary amino acids provides a further refinement with likely positive benefits.

Methionine is considered to be the first most limiting amino acids in broilers diets. It is important to have accurate information on requirements of this amino acid on a digestible basis in formulating diets to optimize growth and production. Determination of dietary methionine for maximum feed efficiency and breast muscle and minimal abdominal fat are crucial. Several studies (Bryden and Li, 2002 ;Hickling *et al.*, 1990 ;Moran and Bilgili, 1994) show that increasing dietary methionine increased broiler growth performance and breast meat yield and reduced abdominal fat. However, a great deal of controversy still exists over the level of dietary limiting amino acids required to maximise broiler performance and breast meat yield. Also, all the previous studies were based on total amino acid values where graded levels of synthetic amino acids were added. To date no studies have been conducted on ileal digestible methionine requirement for optimum growth and carcass yield of broiler finisher given sorghum based diet. The objectives of the studies reported herein were to establish accurate estimates of digestible methionine requirements for broiler chickens given sorghum based diets during the 3-6 week grower/finisher phase.

MATERIALS AND METHODS

This experiment used 175 male broiler chickens which were fed experimental diets from three weeks to six weeks of age. Five sorghum-based experimental finisher diets were formulated. Each assay diet was fed in mash form to 5 pens of broilers (7 birds/pen). An intact protein basal diet (19%) was formulated to meet or exceed the requirement recommended by the National Research Council (1994) for all nutrients. Dietary treatments included the following levels of digestible methionine: 2.0 3.5, 5.0, 6.5 and 8.0 g/kg. All essential amino acids were held at a constant ratio to lysine to obtain the same ratio for all treatments. Digestible amino acid requirements were estimated for the following: maximal weight gain, feed intake, breast muscle yields, as well as for minimal FCR and abdominal fat.

On day 42, two birds with mean weights close to the pen mean were euthanased by an intracardial injection of sodium pentobarbitone solution and individually weighed. The breast meat (*Pectoralis* *major and Pectoratis minor*) was removed by cutting laterally at the wing joint and dissecting the muscles from the carcass. The abdominal fat, which included the fat surrounding the gizzard extending within the ischium and surrounding the bursa of fabricius, cloaca, and adjacent abdominal muscles, was removed and weighed. The yield of breast meat and abdominal fat were expressed as proportions of live weight.

$$\text{Breast meat (\%)} = \frac{\text{Breast meat weight (g)}}{\text{Body weight (g)}} \times 100$$

$$\text{Abdominal fat} = \frac{\text{Abdominal fat weight (g)}}{\text{Body weight (g)}} \times 100$$

Measurement

Each week until the conclusion of the trial, birds were individually weighed, feed intake per pen was measured, and feed conversion ratio (FCR) was calculated, and carcass yield was obtained.

Statistical Analysis

One hundreds and seventy five (175) chicks were allocated to 5 treatments with five replicates of seven chicks per replicate in a completely randomized design. Data for weight gain, feed intake, FCR and body component yields were subjected to ANOVA procedures (Steel and Torrie, 1980) using the General Linear Model (GLM) procedure of SAS software Digestible amino acid requirements for weight gain, feed intake, feed conversion ratio and carcass yields were estimated by fitting the data to linear and quadratic response curves.

RESULTS AND DISCUSSION

The results of this study are shown in Table 1. There was a dramatic improvement in growth rate over the 21 d test period by increasing the digestible methionine level from 2.0 to 3.5 g/kg; there was essentially no improvement in growth rate with increase in methionine above 3.5 g/kg. FCR decreased to a minimum at 5.0 g/kg methionine, but there was no significant difference in FCR between birds receiving diets containing 3.5, 5.0, 6.5 and 7.0 g/kg digestible methionine. Given that the diets were iso-energetic, the substantially greater food intake on the 3.5 than the 2.0 g/kg diets, suggests that amino-static regulation of food intake, in relation to methionine at least, is not a particularly powerful mechanism. Similar effects were observed by Schutte and Pack (1995).

The previous studies with total methionine demonstrated that weight gain increased and FCR decreased with increasing methionine levels (Schutte and Pack, 1995), which are in agreement with the results of the current study. The results of these experiments suggest that digestible methionine requirement for minimum FCR is higher than for maximum weight gain. This finding is supported by others (Schutte and Pack, 1995 ;Van Weerden *et al.*, 1976). This suggests that the somewhat higher level of methionine stimulates not only food intake but also a greater efficiency of food utilization. Chee and Polin (1978) had previously postulated a role for methionine in feed intake regulation or chickens. This current study together with earlier studies (Hickling *et al.*, 1990 ;Leo *et al.*, 1989 ;Schutte and Pack, 1995) suggest that the NRC (1994) recommendation of .38% *total* methionine for the age period of 3 to 6 weeks may be too low. Possible explanations for the discrepancy are: change in genotype and growth performance over the 12 to 30 years; the degree of methionine digestibility in the original studies; as well as differences in dietary cystine levels.

Although the quadratic fits for both growth rate and food intake shown in Figures 1 and 2, were significant, in both cases the fit tended to overestimate requirements. Using a "bent-stick" fit, the estimated requirement was considerably lower, and in both cases approached 3.5 g/kg. During 21-42 days, the response in weight gain, feed intake and FCR to graded levels of methionine were linear ($P<0.05$) and quadratic ($P<0.05$). Using the quadratic fit, $Y = -8.33 + 29.44X - 2.54X2$. weight gain was maximized at a dietary level of 5.80 g/kg digestible methionine Digestible methionine level to maximize feed intake and minimized FCR was 5.92 g/kg diet. The prediction equations for FCR are given in Figure 3.

Table1. Growth performance and carcass yield of broilers from 21-42 days of age given graded levels of digestible methionine in the diet

	Digestible methionine levels, g/kg diet					Pooled	P-value
Parameter	2,0	3,5	5,0	6,5	8,0	SEM	
Initital weight, g							
21 days	785,5	783,2	784,3	784,0	782,1	16,07	0,999
Body weight, g							
28d	1014[b]	1179[a]	1189[a]	1180[a]	1156[a]	24,95	<0,001
35d	1314[c]	1708[ab]	1741[ab]	1776[a]	1661[b]	38,88	<0,001
42d	1570[b]	2265[a]	2315[a]	2317[a]	2183[a]	49,38	<0,001
Weight gain, g/b/d							
21-28 days	32,8[b]	56,5[a]	57,7[a]	55,6[a]	53,5[a]	2,22	<0.0001
28-35days	42,7[c]	75,7[ab]	78,6[ab]	84,7[a]	72,1[b]	3,34	<0,0001
35-42days	36,6[b]	79,5[a]	82,1[a]	76,9[a]	74,5[a]	3,40	<0,0001
21-42days	37,4[b]	70,6[a]	72,6[a]	72,4[a]	66,7[a]	2,35	<0,0001
Feed intake, g/b/d							
21-28 days	86,2[b]	107,3[a]	106,1[a]	103,9[a]	101,7[a]	2,80	<0.0001
28-35days	119,7[b]	172,7[a]	163,1[a]	170,3[a]	168,0[a]	4,85	<0,0001
35-42days	130,8[b]	204,0[a]	197,0[a]	197,8[a]	196,5[a]	8,41	<0,0001
21-42days	112,3[b]	161,3[a]	155,3[a]	157,4[a]	155,4[a]	3,95	<0,0001
FCR, g/g							
21-28 days	2,64[b]	1,90[a]	1,87[a]	1,87[a]	1,91[a]	0,21	0,05
28-35days	2,81[b]	2,30[a]	2,08[a]	2,01[a]	2,34[a]	0,17	0,01
35-42days	3,59[b]	2,57[a]	2,41[a]	2,58[a]	2,65[a]	0,01	0,01
21-42days	3,01[b]	2,29[a]	2,14[a]	2,17[a]	2,34[a]	0,19	0,01
Carcass:							
Breast muscle, %	12.9[b]	14,7[a]	13,3[a]	14,9[a]	14,4[a]	1,40	0,000
Abdominal fat, %	1,90	2,31	1,79	2,19	1,90	0,68	0,067

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)

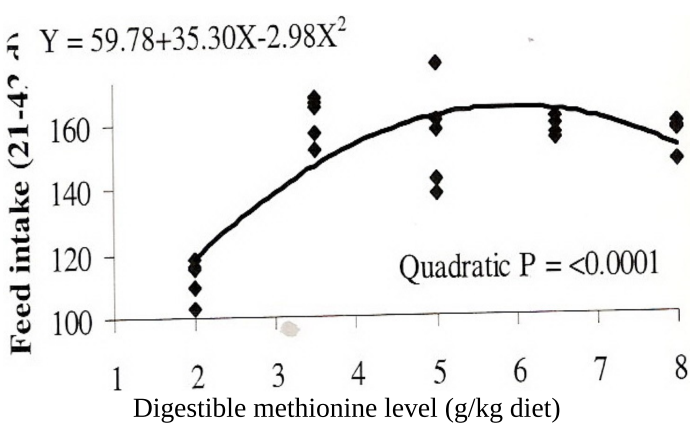

Figure 1. Curvilinear plot of feed intake as a function of dietary digestible methionine (points on the curve are observed mean values of five pens of seven birds)

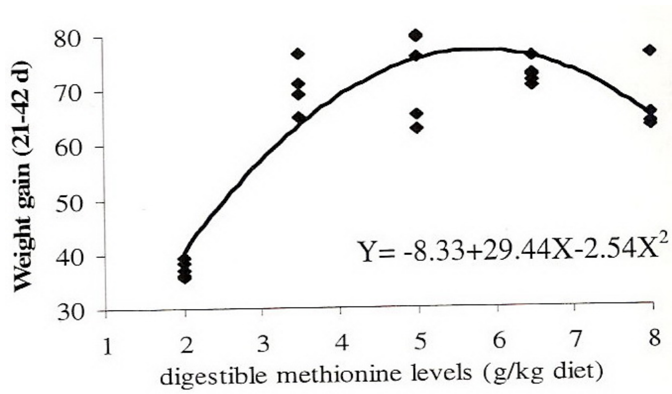

Figure 2. Curvilinear plot of weight gain as a function of dietary digestible methionine (points on the curve are observed mean values of five pens of seven birds)

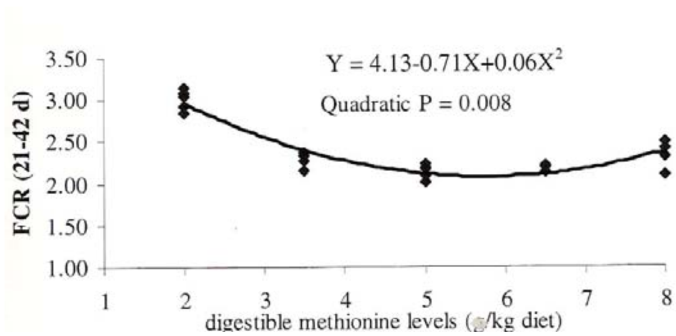

Figure 3. Curvilinear plot of feed conversion ratio as a function of dietary digestible methionine (points on the curve are observed mean values of five pens of seven birds)

Both absolute and proportional breast muscle yield essentially followed the same response pattern as growth rate with significant response at 3.5 g/kg methionine, with little response above this. There was, however, a reduced response in breast proportion at 5.0 g/kg, which is difficult to explain. The higher absolute amounts of abdominal fat in the higher methionine diets appears to be essentially a reflection of the higher body weights on these diets, as there were no significant differences in abdominal fat proportion between treatments. The latter finding is somewhat surprising since abdominal fat proportion might have been expected to decline with increase in dietary methionine (Hickling *et al.* 1990) up to at least the requirement for maximum growth rate. Several reports have demonstrated that the methionine requirement has been found to be higher for maximum breast meat yield than for maximum weight gain. Poor growth performance on the basal diet was probably responsible for the relatively low proportion of abdominal fat on this diet

The results experiment that examined the digestible amino acid requirements for methionine in grower periods demonstrate that amino acid requirements need to be evaluated on a timely basis so that diet formulations can meet the change in genetic capacity of birds for protein accretion and lean tissue deposition.

CONCLUSIONS

A digestible methionine level of 5.80-5.92 g/kg diet appeared to be adequate to support good growth in broilers from 21 to 42 days of age and is higher than the NRC (1994) recommendation and may reflect the faster growth rate of the current genotype. The dietary level of methionine needed in the grower-finisher period to optimize breast meat yield appears to be higher than that needed for optimal live performance traits.

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