

# CHOICE FEEDING AND AMINO ACID REQUIREMENTS FOR BROILERS

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## ABSTRAK

Penelitian ini dilakukan menggunakan faktorial untuk mengetahui respon ayam pedaging komersial terhadap pemberian pakan bebas memilih and asam amino esensial terbatas terhadap pertumbuhan dan komposisi karkas. Sebanyak 432 ekor anak ayam umur satu hari ditimbang dan dibagi secara acak pada 48 kandang indukan dari kawat dengan ukuran 1 m<sup>2</sup>. Penelitian menggunakan 2 strain broiler betina dan jantan dan 4 perlakuan pakan dengan 6 ulangan terdiri dari 9 ekor setiap ulangan. Ayam diberi ransum yang merupakan campuran *summit* dan *dilution* dengan estimasi kandungan protein 240 g/kg pada umur satu hari kemudian ayam memperoleh pakan dengan protein 120, 150 atau 180 g/kg pada umur 42 hari untuk betina, sedangkan yang jantan memperoleh pakan dengan protein 130, 160, atau 190 g/kg atau ayam diberi kesempatan memilih *summit* dan *dilution*. Pada umur 42 hari ayam dipotong untuk diukur komposisi karkasnya. Hasil penelitian menunjukkan bahwa kebutuhan asam amino untuk meningkatkan bobot badan lebih tinggi dari yang direkomendasikan oleh NRC. Pemberian pakan bebas memilih menunjukkan pertumbuhan maupun komposisi karkas yang lebih baik dibanding dengan pemberian ransum protein rendah.

*Kata kunci: bebas memilih , summit and dilution, pertumbuhan, ayam pedaging*

## ABSTRACT

The study was conducted as a completely randomized design, with a factorial arrangement to determine the response of commercial broilers to choice feeding and limiting amino acids on growth and carcass performance. A total of 432 male birds were weighed at one-d-old and randomly distributed to 48 wire-floored brooder cage each 1.0 m<sup>2</sup>. There were 2 sexes and 4 dietary treatments with 6 replicates each of 9 birds. Birds were given one of three dietary regimens with dietary change every 7 days. All groups were fed free choice of *summit* and *dilution* diets. The estimated dietary level of crude protein at day-old was 240 g/kg and the level at 42 d was either 120, 150 or 180 g/kg for females or 130, 160 and 190 g/kg for males. At 43 d of age, all birds from each dietary treatment were slaughtered for measurement of body composition. Results reveal that lysine requirement for maximum gain in this study was higher than NRC recommendation. The free choice-fed bird was significantly higher, in terms of growth and body composition than that obtained on the low dietary protein regimen.

*Keywords: free choice feeding, summit and dilution, growth, broilers*

## INTRODUCTION

The effects of limiting amino acids on performance of broiler chickens have been studied extensively (Hickling *et al.*, 1990; Kidd *et al.*,

1996; Kidd *et al.*, 2000; Carew *et al.*, 1997; Corzo *et al.*, 2006; Mehri *et al.*, 2010). Growth responses and carcass composition of broilers to amino acids can be improved by appropriate levels (Kerr *et al.*, 1999; Kamran *et al.*, 2004;

Corzo *et al.* 2006; Tavernari *et al.*, 2009; Mehri *et al.*, 2010). On the other hand, depressed growth rate and increase abdominal fat were associated with failure in amino acid supplementation in conventional feeding system due to deficiency in amino acid intake (Saxena *et al.*, 1962; Kidd *et al.*, 1996).

Free choice feeding as one of alternative feeding systems have been studied to develop the ability of the birds to regulate their protein intake to support the maximum growth (Leeson and Caston, 1993; Yo *et al.*, 1997). Even, choice feeding has been suggested as a means of estimating nutrient needs of broilers (Cerrate *et al.*, 2007a; Cerrate *et al.*, 2007b). Leeson and Caston (1993) found that free choice cereal feeding resulted in reduced carcass yield, increased abdominal fatness and reduced breast meat yield. Yao *et al.* (2006) also showed that broilers on a choice feeding of corn and protein concentrate increased abdominal fat. However, it was reported by Ramlah and Halim (1994) that birds given a choice between a complete feed and corn had better feed efficiency which was reflected by the lower total feed intake. Similarly, Hruby *et al.* (1995) revealed that broilers under high temperature chose a diet lower in total protein and had no effect on breast meat weight. Thus, it seems that the successful free choice feeding is dependent on the method of offering the diet from which the birds would select the appropriate a mixture to fulfill their nutrient requirements. Therefore this study was conducted to examine free choice feeding with summit and dilution diets and formulated diets of mixture between these two diets to the notional 42-d crude protein (CP) levels.

## MATERIALS AND METHODS

### Birds and Management Procedure

One-day-old male broiler chicks of commercial strain were obtained from a local hatchery and randomly allocated to wire-floored brooder cages in a controlled room with the ambient temperature reduced from 31 to 25°C at d 12 and maintained to this level till day 21. Birds have continual access to water in a nipple drinking tube. They were then transferred to single cages in a fan-ventilated, temperature-controlled room. 24 hours of light was provided throughout the experimental period. Vaccination procedures against diseases were carried out at the

supplying hatcheries.

### Dietary Treatments and Experimental Design

A technique of blending the summit and dilution was intended to examine the growth and body composition responses to variety of dietary amino acid concentration. The summit diet was formulated to contain a large excess of assume requirement of all indispensable amino acids except the one under the test, which was set up around 145% of the assume requirement (Gous and Morris, 1985). The summit and dilution diets were blended in appropriate proportions to provide the required concentration of amino acids in the respective diets. The mixtures of the two diets contained the same amino acid balance of amino acids. The advantages of the dilution diet with balanced amino acids were avoiding intake amount of feed of deficiencies in amino acids intakes (Emmans, 1987).

Four hundred and thirty of male broiler chicks of strain Cobb were reared in 48 cages in a brooder room until 6 d of age. They were then wing-banded and randomly allocated to 48 groups of 9 birds per cage and the experimental diets were introduced.

The experimental design was factorial arrangement with 4 feeding regimens and two sexes with six replications. In the case of males the notional 42-d crude protein (CP) levels were 130, 160 and 190 g/kg and for females, 120, 150 and 180 g/kg. Diets were changed every 7 days and nutrient allowances were achieved again by blending appropriate amounts of summit and dilution diets together. The ingredient and nutrient composition of the summit and dilution diets is shown in Table 1. The calculated range in dietary lysine and methionine levels in the blended diets given to the males and females is presented in Table 2. Additional to the blended dietary regimens, one group of birds for free choice regimen was provided with access to both the summit and dilution diets in a split trough. At 21 days, 30 birds nearest the mean weight of each sex x dietary regimen group were transferred to 240 individual bird cages and maintained on the relevant nutritional regimens. Birds and feed were weighed every 7 days at change of diet throughout the experiment.

### Measurements

Birds were individually weighed from day 1 to 42 d and feed consumption was determined. Mortality was also recorded and weights of dead

Table 1. Ingredient (g/kg) and Determined Nutrient Composition of the Summit and Dilution Diets

Ingredients	Summit	Dilution
Maize 8.5%	-	825.10
Sorghum	470.80	22.00
Wheat	150.00	51.70
Sunflower	20.35	-
Limestone	1.90	5.99
Salt	-	2.78
Soybean meal 49%	225.40	9.30
Fishmeal Peruvian 66%	75.00	-
Meat meal 50%	50.10	69.30
Rice hulls	-	11.50
DL-Methionine	1.60	0.13
Lysine Mono-HCL	4.19	2.14
Vitamins and minerals	6.68	6.68
Nutrients		
ME (Kcal/kg)*	3,100	3,100
Crude Protein	250	120
Lysine (total)	16.8	5.30
Methionine	5.61	2.10
Methionine plus cystine	9.00	4.18
Isoleucine	9.99	3.70
Leucine	21.49	12.21
Threonine	9.04	4.10
Tryptophan	2.56	1.03
Calcium	10.00	10.00
Phosphorus (available)	6.00	4.50
Calculated value		

birds were used to adjust feed conversion ratio (FCR) particularly at 1 to 21 d. At the end of the trial (43 days of age), all the birds were killed by neck dislocation after a 12-h fast to determine dressing percentage, breast meat and abdominal fat.

#### Data Analysis

Growth and carcass data were analysed by ANOVA according to the General Linear Model of SAS version 7.0 (SAS, 1996). The major independent variables were sex and diet. Least significant difference multiple range tests

(probability  $P < 0.05$ ) were used to identify all results showing a significant difference, unless otherwise stated (Kaps and Lamberson, 2004)

## RESULTS AND DISCUSSION

### Growth Performance

There was a decrease ( $P < 0.05$ ) in daily food intake with increasing dietary protein levels in both sexes and a marked increase in both consumption and FCR in the free choice fed birds from d 0-21 of age (Table 3). Males grew faster ( $P < 0.05$ ) than females and were more efficient

( $P < 0.05$ ) converting feed consumed into live body weight throughout the study. Growth rate in the females increased with dietary protein level but in the males, the growth rate was maximum on MP-160 dietary regimen (68 g/d) from 21 to 42 d of age. However, it was interesting that the free choice-fed birds grew as rapidly as the best of the composite diet groups in both sexes. Food intake

in the males given composite diets was greatest on the intermediate MP-160 dietary regimen (134 g/d) and in the females was greatest in the birds given the high protein HP-180 dietary regimen (128 g/d). When the linear regression equation used to predict lysine requirement was applied and calculated for males (Table 4), the average total lysine levels were 13.87; 15.45 and 17.03

Table 2. The Calculated Range in Lysine and Methionine (g/kg) in Each Dietary Regimen from Day Old to 42 Days of Age for Females and Males

Sex	Dietary Protein	Lysine	Methionine
Female	LP-120	19.1 - 7.5	9.3-2.8
	MP-150	19.4 -10.4	9.5-4.5
	HP-180	19.6 -13.5	9.6-6.2
	Free choice *		
Male	LP-130	19.1- 8.5	9.3-3.4
	MP-160	19.4-11.5	9.5-5.1
	HP-190	19.7-14.4	9.6-6.7
	Free choice *		

\* Free choice was not calculated due to dependent on selection by the birds

Table 3. Gain (G, g/d), Feed Intake (FI, g/d) and FCR of Broilers Receiving Different Crude Protein Level and Free Choice Feeding from 0-21 and from 21-42 Days of Age

Sex		0-21 d			21-42 d		
		Gain	FI	FCR	Gain	FI	FCR
Female	LP-120	35	45.7 <sup>ab</sup>	1.433 <sup>b</sup>	52 <sup>c</sup>	120	2.316
	MP-150	35	43.4 <sup>bc</sup>	1.369 <sup>b</sup>	55 <sup>b</sup>	118	2.162
	HP-180	33	42.2 <sup>c</sup>	1.412 <sup>b</sup>	59 <sup>a</sup>	128	2.196
	Free Choice	34	40.4 <sup>a</sup>	1.565 <sup>a</sup>	58 <sup>a</sup>	118	2.018
	LSD	2.28	3.3	0.086	1.6	7.2	0.381
Males	LP-130	35	45.2 <sup>b</sup>	1.437 <sup>b</sup>	60 <sup>b</sup>	129 <sup>ab</sup>	2.166 <sup>a</sup>
	MP-160	35	43.4 <sup>b</sup>	1.363 <sup>bc</sup>	68 <sup>a</sup>	134 <sup>a</sup>	1.976 <sup>b</sup>
	HP-190	35	43.6 <sup>b</sup>	1.324 <sup>c</sup>	64 <sup>ab</sup>	118 <sup>c</sup>	1.864 <sup>c</sup>
	Free Choice	35	50.0 <sup>a</sup>	1.564 <sup>a</sup>	67 <sup>a</sup>	123 <sup>bc</sup>	1.824 <sup>c</sup>
	LSD	2.14	2.6	0.079	3.8	7.5	83

L, M and H indicates Low, Medium and High dietary amino acid concentration, respectively  
Means within columns with no common superscript differ significantly ( $P < 0.05$ )

Table 4. Estimate of the Coefficients of Regression for the Gain of Male Commercial Broilers Fed on Increasing Protein Concentration

Source of Variation	Protein Level	Estimate	Standard Error
Intercept	130	607.833	81.899
	160	590.962	102.065
	190	471.041	110.200
Common Slope		2.016	0.246

Significant at the 0.001 level;  $R^2 = 0.52851$

g/kg in the 130; 160 and 190 g/kg CP dietary regimens. Assuming that the digestible lysine is 0.81% (Han and Baker, 1994), then the average digestible lysine levels provided were 11.23; 12.51 and 13.79 g/kg diet for the LP-130, MP-160 and HP-190 regimens respectively. This suggests that lysine requirements for maximum gain for males in this study was 12.51 g/kg diet and males were more responsive for lysine than females. Total protein intake of males in MP-160 during the grower phase was 312.2±29.2 (Table 5). This means that males were not better responsive in high dietary protein or lysine. These results did not differ to report by Corzo *et al.* (2006) who observed that males response to lysine more accurately than females and male broilers required a minimum of 0.88% total Lysine (0.80% digestible).

In regard to FCR, there was a linear decrease in FCR with increase in dietary protein ( $P < 0.05$ ), although these differences were not significant in the females. FCR in the free choice-fed birds was the lowest compared to the high protein dietary regimen group in both sexes (Table 3).

The lowest feed conversion found in the free choice group compared to the single diet in the present study are in agreement with previous observation (Cerrate *et al.*, 2007a; Cerrate *et al.*, 2007b; Cerrate *et al.*, 2008). In the single complete diet, improving feed conversion was in line with increasing the dietary protein with a balance amino acids (Hussein *et al.*, 2001). When birds given a choice, they had the ability to choose the diet of the appropriate content of CP and energy to meet their requirements for protein and energy independently (Forbes and Shariatmadari, 1994; Hruby *et al.*, 1995; Yo *et al.*, 1997).

### Body Composition

Breast meat and abdominal fat of 42-day-old

Table 5. Calculated Protein Intake (g) of Female and Male Broilers on Four Different Feeding Regimens during the Growing Phase (21-42 d)

Sex	Dietary Protein	Protein intake
Female	LP-120	283.9±21.7
	MP-150	283.1±30.1
	HP-180	276.1±24.9
	Free Choice	283.8±28.5
Male	LP-130	297.6±36.6
	MP-160	312.2±29.2
	HP-190	283.0±25.6
	Free Choice	288.9±39.1

broilers as affected by total dietary lysine and methionine are presented in Table 6. Breast meat yield was significantly improved ( $P < 0.05$ ) as limiting amino acids increased with a significant reduction in abdominal fat ( $P < 0.01$ ) in the males. However, in the females, no effect of dietary amino acids on breast meat was observed ( $P > 0.05$ ) with significantly lower abdominal fat ( $P < 0.01$ ). These results are in agreement with most reported studies, regardless of sex, who found increasing level of Lysine (Leclercq, 1998; Kerr *et al.*, 1999; Corzo *et al.*, 2006) and methionine (Garcia Neto *et al.*, 2000) resulted in increased breast muscle protein and reduced abdominal fat. The decreased fat deposition with increased dietary protein is also in agreement with the well accepted negative relationship between dietary protein and carcass fat (Gous *et al.*, 1990; Leclercq, 1995; Garcia Neto *et al.*, 2000). The effect of an increase in breast meat and a decrease in fat deposition has been achieved by a reduction

Table 6. The Effects of Three Dietary Protein and Free Choice Regimens on the Breast Meat Proportion (BM, g/kg) and Abdominal Fat (AF, g/kg) from Hatch to 43 d of Age

Sex	Dietary Protein	Breast Meat	Abdominal fat
Female	LP-120	183.7	19.7 <sup>a</sup>
	MP-150	187.2	16.2 <sup>b</sup>
	HP-180	192.0	14.1 <sup>b</sup>
	Free Choice	191.9	16.7 <sup>b</sup>
	LSD	NS	2.4
Male	LP-130	190.3 <sup>b</sup>	14.4 <sup>a</sup>
	MP-160	193.8 <sup>ab</sup>	11.6 <sup>b</sup>
	HP-190	199.9 <sup>a</sup>	7.1 <sup>c</sup>
	Free Choice	193.9 <sup>ab</sup>	10.8 <sup>b</sup>
	LSD	6.6	2.3
Diet	Female	NS	**
	Male	*	**

\*(P<0.05); \*\* (P<0. 01); NS- Not Significant (P>0.05)

L, M and H indicates Low, Medium and High dietary amino acid concentration respectively  
Means within columns with no common superscript differ significantly (P<0.05)

in the dietary concentration of an appropriately balanced diet in terms of amino acid concentration. Supplementation with synthetic amino acids has been shown to give variable results, depending on dietary amino acid balance (Fancher and Jensen, 1989; Moran and Bilgili, 1990; Garcia Neto *et al.*, 2000).

Looking at protein intake (g/d) in the two sexes and four dietary regimen groups during the starter and grower phases (Figure 1), it showed that males given the high protein regimen consumed more protein than the other groups from the onset, whereas protein consumption in the females did not diverge until the grower phase. However, the choice fed birds consumed as much protein over the latter two weeks as those given the high protein regimen in both sexes. In both sexes, protein consumption was least on the low protein regimen.

Previous research has shown that protein retention was very closely related to lysine concentration (Kerr *et al.*, 1999; Kidd *et al.*, 2000; Corzo *et al.*, 2006). Gains and breast meat yield were improved to be due to an adequate supply of lysine (Bartov and Plavnik, 1998; Garcia Neto *et*

*al.*, 2000). As shown in Table 1, the level of lysine in the starter diet in each dietary regimen was considerably higher than 1.10% as suggested by NRC (1994) so that any response to dietary lysine or other amino acid levels was related more to the levels in the finisher rather than the starter phase. Sibbald and Wolynetz (1986) suggested that the total lysine requirements were about 9.6 g/kg during the starter period. Subsequent studies found 13.9 or 14.4 g lysine/kg diet given to chicks from d 0 to 21 reduced food consumption by 3.5% and reduced gain by 5.3% compared with feeding 13.4 g lysine/kg diet (Latshaw, 1993). In the present study, the 13.79 g lysine /kg diet gave maximum breast meat and lowest abdominal fat. The present study also provides evidence that lysine for maximum gain differed from that for maximum breast meat production (Table 3 and Table 6). These results are similar to those obtained by Abdel-Maksoud *et al.* (2010) who reported the optimum dietary requirements for body weight, FCR and feed efficiency in broilers up to 18 days are in the range of 1.2-1.35%.

In the present study, the maize used in the dilution diet was roller- rather than hammer-

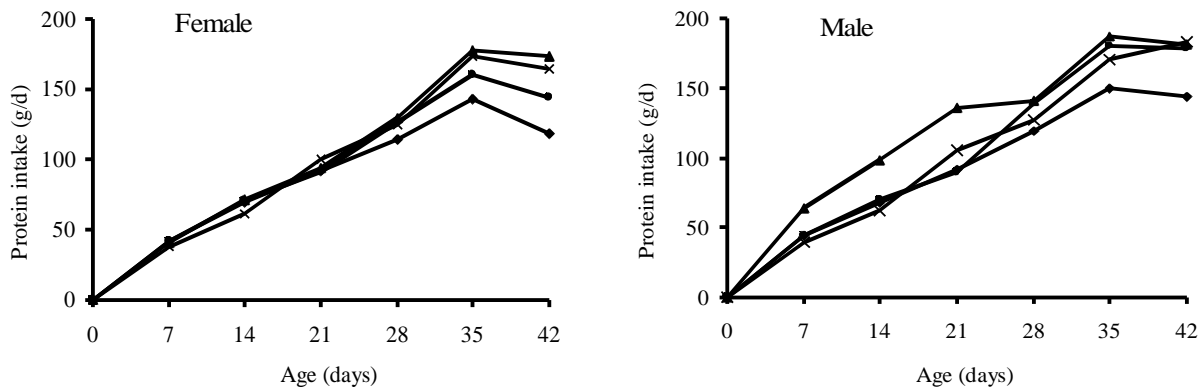


Figure 1. Protein Intake in the Males and Females given Four Dietary Regimens. Female:  $\blacklozenge$ —: L-120;  $\blacksquare$ —: M-150;  $\blacktriangle$ —: H-180;  $\times$ —: Choice; Male:  $\blacklozenge$ —: L-130;  $\bullet$ —: M-160;  $\blacktriangle$ —: H-190;  $\times$ —: Choice

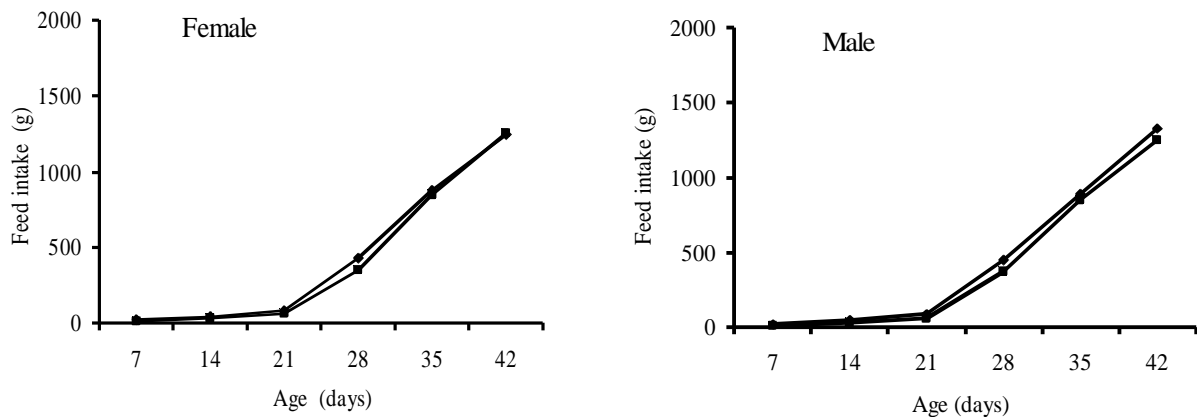


Figure 2. Cumulative Consumption of Summit ( $\blacklozenge$ —) and Dilution Diets ( $\blacksquare$ —) by Males and Females Allowed Free Choice of the Two Diets

milled and as a result the diets were of a much more similar physical appearance and consequently, the intake of summit and dilution diets was relatively similar (Figure 2). The choice made by the birds is not dictated necessarily by an innate drive to maximize growth and muscle deposition and minimize fat deposition. As a result, the choice birds had lower breast meat and higher abdominal fat. These results confirm of studies reported by Yo *et al.* (1997) that regulation to the intake of specific nutrient was influenced by preference for the sensory characteristics of the diet. Therefore, it is important to consider the physical presentation of the feed offered when feeding in a free choice system. The lower performance of the free choice fed birds in this study was supported by the study of Leclercq and

Guy (1991), Leclercq (1998) and Yao *et al.* (2006). Nevertheless, the performance of the choice-fed birds was significantly better, in terms of growth and body composition, than that obtained on the low dietary protein regimen.

## CONCLUSION

The results of the present study demonstrated the ability of birds to selectively consume diets to provide for their nutrient needs when offered choices in diet selection. The choice feeding method using diets of summit and dilution offer better result compared to the low dietary protein diet. Lysine requirement for gain differed from for breast meat deposition which was higher than

NRC recommended levels.

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