J. Agric. Sci. Technol. (2002) Vol. 4: 111-117

Digestible Lysine Requirement of Arian Male and Female Broiler Chicks During Six to Twenty-one Days of Age

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ABSTRACT

An experiment was conducted to determine the dietary digestible lysine requirement of male and female broiler chickens (Arian) during the period from 6 to 21 days post-hatching. An amino acid-fortified basal diet containing corn and soybean meal as intact protein sources provided 20 % CP, and 3200 kcal AME_n / kg. In this experiment 150 male and 150 female chicks were allocated on the basis of BW to 12 treatments in a factorial arrangement (two sexes at six digestible lysine levels) with five replications of five chicks each in a completely randomized design (CRD). The digestible lysine levels fed were 0.85, 0.95, 1.05, 1.15, 1.25 and 1.35%. The growth rate and feed efficiency of birds fed the basal diet fortified with a surfeit level of l-Lysine-HCl were equal to those of birds fed a corn-soybean meal positive control diet. Average body-weight gain (ABWG) and gain: feed (GF) responded quadratically ($P<0.05$) to incremental dietary lysine addition. Subjecting the growth data to broken-line analysis indicated that the digestible lysine requirement for maximum body weight gain was 1.075% for males and 1.049% for females. The lysine requirement for maximum feed efficiency was 1.179% for males and 1.149% for females. Male chicks required a higher level of dietary lysine than females for both maximal ABWG and GF. Regardless of sex, 8.8% more digestible lysine (percentage of diet) was required for maximal GF than that needed for maximal ABWG.

Keywords: Broiler chickens, Digestible amino acid, Lysine requirement.

INTRODUCTION

Diet formulation on a digestible amino acid basis should more consistently meet the animals' amino acid requirements than those based on total amino acid concentration. The principle, attributable to the fact that nutrients in feedstuffs are recognized to be incompletely digested and metabolized by animals, has been applied widely in the field of energy metabolism. Indeed formulation of diets based on total amino acid concentrations is analogous to formulating poultry diets based on gross energy rather than metabolizable energy.

The benefits of formulating diets based on amino acid digestibility or availability have been documentated in research studies with various poultry (Fernandez *et al*., 1995; Michele and Parsons, 1999; Kamyab and Firman, 2000). The performance of chicks was depressed when soybean meal or feather meal were substituted for crystalline amino acids in diets containing equal levels of total amino acids (Smith, 1968). Similar results were observed when sunflower, rapeseed or cottonseed meal were substituted for soybean meal in practical diets (Green, 1986; Parsons, 1992). Formulation of diets containing these ingredients on an equal digestible amino acid basis resulted in much improved performance that was often similar to the performance obtained from the control of reference diets.

Determination of digestible amino acids composition of feedstuffs and accurate requirement estimates for digestible amino acids are critical in attempts to apply the concept of amino acid availability in formulating a broiler diet. Lysine is often one of

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the limiting amino acids in broiler diets (Han and Baker, 1994). As such, it is used as the reference amino acid to which all other indispensable amino acids are ratioed in the ideal amino acid pattern (Baker and Han, 1994). However good information on digestible or bioavailable lysine requirements of broilers is still very limited. The objective of the present investigation was to determine requirements of digestible lysine for male and female broilers from one to three weeks of age.

MATERIALS AND METHODS

General

In this experiment, chicks were fed a standard corn-soybean meal starter diet (containing 1.1 % Lys, 3200 kcal AME_n /kg) and kept in a temperature-controlled building on floor from day 0 to 5 days posthatch. On the day sixth posthatch, chicks were held four hours without feed then individually weighed, wing banded, and assigned to diets

Table1. Composition of basal diets [1, 2]

Percentage	Ingredient
Corn	56.70
Soybean meal (CP 46.3 %)	26.41
Monocalcium phosphate	1.59
Oyster shells	1.60
Vitamin premix[a]	0.25
Mineral premix[b]	0.25
DL-Methionine	0.49
L-Threonine	0.35
L-Tryptophan	0.04
L-Isoleucine	0.26
L-Leucine	0.05
L-Arginine	0.34
L-Valine	0.34
L-Histidine	0.04
Experimental supplements[c]	11.29
Calculated Analysis	
AME_n , kcal/kg	3200
Nitrogen	3.2
Lysine	0.85
Methionine+Cystine	0.97
Threonine	0.90
Tryptophan	0.22
Isoleucine	0.90
Leucine	1.47
Arginine	1.47
Histidine	0.47
Valine	1.04
Phenylalanine+Tyrosine	1.42
Calcium	1.00
Available phosphorus	0.45

1. As-fed basis.
2. Calculated amino acid composition is reported on a digestible amino acid basis.
[a] Vitamin premix provided the following per kilogram of diet: Vitamin A, 9000IU; Cholecalciferol, 2000IU; Vitamin E ,18IU; Vitamin k3, 4mg; Vitamin B12, 0.015mg; Biotin, 0.15mg; Folacin , 1mg; Niacin, 30mg; Pantothenic acid, 25mg; Pyridoxine, 2.9mg; Riboflavine, 6.6mg; Thiamine 1.8mg.
[b] Mineral premix provided the following per kilogram of diet: Copper (as cupric sulfate 5H20), 10mg; Iodin (as calciumiodate), 0.99mg; Iron (as ferrous sulfate 7H20), 50mg; Manganese (as manganese oxide), 99mg; Selenium (as sodium selenite), 0.2m ; Zinc (as zinc oxid), 84mg.
[c] See Table 2.

Table 2. Composition of experimental supplements[1, 2].

	Digestible lysine level (%)					
Ingredient	0.85	0.95	1.05	1.15	1.25	1.35
	----------%----------					
L-Lysin-HCl	0.09	0.22	0.34	0.47	0.60	0.72
L-Glutamic acid	2.13	1.92	1.72	1.52	1.31	1.12
Corn oil	4.98	4.96	4.93	4.90	4.88	4.85
Sucrose	3.58	3.66	3.75	3.83	3.91	3.99
sodium bicarbonate	0.15	0.21	0.27	0.33	0.39	0.45
Salt	0.36	0.32	0.28	0.24	0.20	0.16
Total	11.29	11.29	11.29	11.29	11.29	11.29

1. All diets were identical to the basal diet except for L-Lysine-HCl , L-Glutamic acid , corn oil ,sucrose, sodium bicarbonate and salt levels.
2. As-fed basis.

and battery pens such that each would have very nearly the same average initial body weight and weight range. They were kept in thermostatically controlled batteries with raised wire floors from 6 to 21 days of age. Feed and water were supplied for *ad libitum* consumption and a 24 hour constant light schedule was maintained. Feed ingredients in the diet were analyzed for both crude protein and amino acids (except for tryptophan). The amino acid composition of the corn and soybean meal was determined after acid hydrolysis, whereas total sulfur amino acid content was determined after performic acid oxidation and acid hydrolysis (AOAC, 1990) followed by ion-exchange chromatography. Diets were formulated based on analyzed values. Digestible amino acids were calculated using digestibility coefficient of Rhone-Poulenc (1993) and by assuming 100% digestibility of crystalline amino acids (Chung and Baker, 1992). This diet was given from 6 to 21 days of age and, at the end of trial, all chicks were weighed individually and pen feed intake was measured. Growth performance was evaluated by average body weight gain (ABWG) and gain: feed (GF).

Experimental Design

An experiment was conducted to determine the lysine requirement of Arian male and female broiler chicks. In this experiment one hundred and fifty male and one hundred and fifty female chicks were allocated to 12 treatments (two sexes at six digestible lysine levels) with five replicates of five chicks per replicate in a completely randomized design (CRD) in a factorial arrangement. The initial body weight averaged 125g for both male and female chicks. Additionally a positive control corn-soybean meal (PC) diet (standard starter diet) was fed as a treatment, but data from the PC diet were not included in the statistical analysis. the dietary digestible lysine levels were 0.85 , 0.95 , 1.05 , 1.15 , 1.25 and 1.35% (Tables 1 and 2) .All diets contained the same amounts of corn and soybean meal, while various amounts of L-Lysine-HCl were substituted for isonitrogenous amounts of L-Glutamic acid. Changes in the dietary ingredients make sure that all diets were isoenergetic, isonitrogenous and equal in electrolyte balance (Na + K - Cl). All diets met an ideal amino acid ratio recommended by Illinois (Baker, 1997) for all other indispensable amino acids for chicks from 0 to 21 days old as determined for the level of 1.35% digestible lysine.

Statistical Analysis

Data from this experiment was subjected to ANOVA procedures appropriate for completely randomized designs by using the

Table 3. Growth performance of chicks fed six levels of lysine[1].

Sex	Lysine level	ABWG[2]	GF[3]
	(%)	(g)	(g:g)
	0.85	449[b]	0.647[c]
	0.95	474[a]	0.655[bc]
	1.05	493[a]	0.699[ab]
Male	1.15	506[a]	0.712[a]
	1.25	494[a]	0.723[a]
	1.35	497[a]	0.719[a]
	SEM	6.1	0.008
	0.85	449[b]	0.655[b]
	0.95	455[a]	0.665[a]
	1.05	479[a]	0.661[a]
Female	1.15	471[a]	0.687[a]
	1.25	477[a]	0.694[a]
	1.35	466[a]	0.661[a]
	SEM	5.7	0.006

1 Means within a column with no common superscript differ significantly.
2 ABWG = average body weight gain.
3 GF = gain : feed.

General Linear Models (GLM) procedure of SAS software (SAS Institute, 1985). Digestible lysine requirements for body weight gain and feed efficiency were estimated by one-slope broken-line regression models (Robbins, 1986).

RESULTS

Weight gain and gain: feed ratio of male and female broilers responded quadratically ($P<0.05$) to incremental dietary lysine addition (Table 3). Male chick grew faster than female ($P<0.05$). Feed efficiency (Table 3) was higher for male birds than for female birds ($P<0.05$). No significant ($P>0.05$) interaction by sex of lysine level was observed for weight gain or feed efficiency. Fitted broken lines (Figure 1) indicated break points at 1.075% and 1.179 % digestible lysine for male weight gain and feed efficiency respectively, and at 1.049% and 1.149 % in female (Figure 2).

DISCUSSION

The translation of digestible lysine requirement of mixed-sex feeding, estimated according to data obtained from present research to total lysine, indicates that the total lysine requirement of broilers is about 1.18% and 1.29% for maximum gain and feed efficiency respectively. These findings indicated that the lysine requirement as estimated by NRC (1994) for 0 to 3-week old broilers which is equal to 1.1 % may be low. These results are in agreement with data reported by Han and Baker (1991, 1993), Baker and Han (1994) and Kidd *et al.* (1997).

Chicks fed diets containing 0.95 % di-

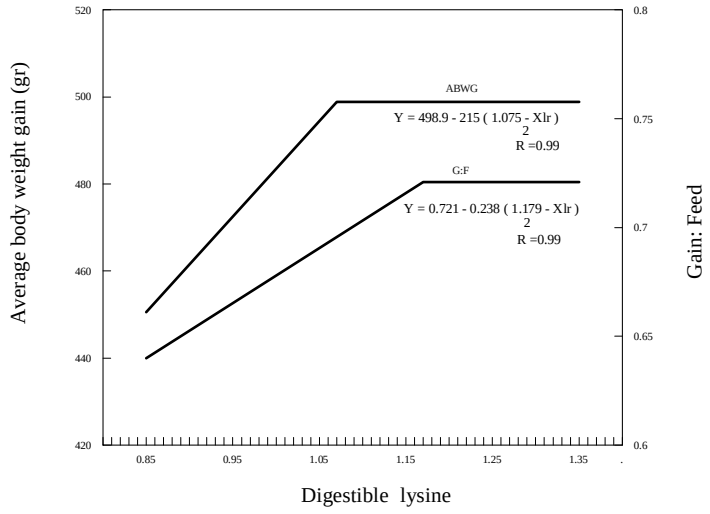

Figure 1. Broken-line plot of weight gain and feed efficiency for males.

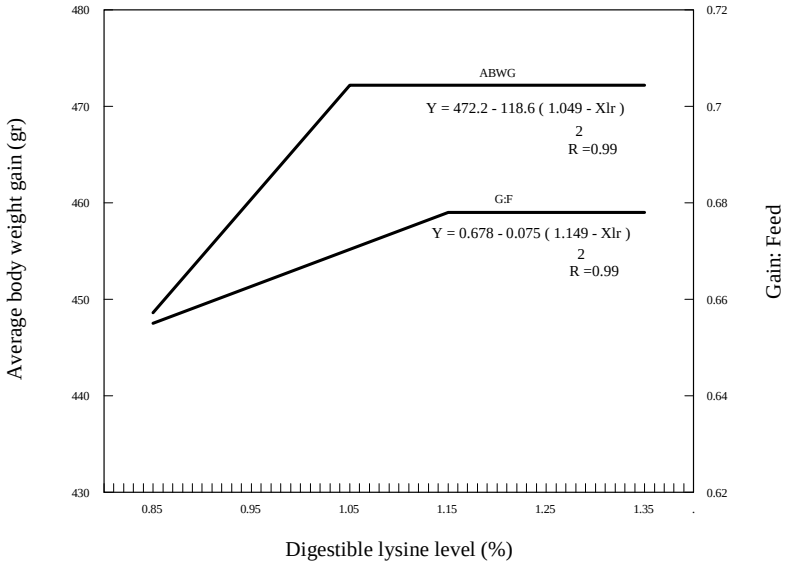

Figure 2. Broken-line plot of wight gain and feed efficiency for female.

gestible lysine had higher average body weight gain and gain: feed ratios than chicks fed a diet containing 0.85 % digestible lysine. Fortifying the basal diet with a surfeit level of lysine not only resulted in substantial improvement in body weight gain and feed efficiency but also yielded growth performance equal to those birds fed a positive control corn-soybean meal (CP) diet. This data indicates that the lysine content of the basal diet was low enough to generate useful lysine response curves (Table 1).

The lysine requirement estimates obtained from the broken-line regression models (Figures 1, 2) suggested a higher requirement for male than for females. Other studies (Huncher and Thomas, 1976; Kessler and Thomas, 1976) have suggested that arginine and tryptophan requirements for males are greater than those for females from 4 to 7 weeks posthatching. It seems logical that male broilers would require higher levels of amino acid than females, because male chicks contain more protein and less fat in their weight gain from both 0 to 3 weeks and 3 to 6 weeks posthatching (Kubena *et al.* 1974; Hurwitz *et al*., 1980; Han and Baker, 1991).

The fitted broken-lines (Figures 1and 2) suggested that body weight gain appeared to plateau at lysine levels considerably below those required for feed efficiency. In other words, 8.8% more digestible lysine (percentage of diet) was required for maximal feed efficiency than that needed for maximal weight gain. Maximal voluntary feed intake generally occurs at the dose allowing for maximal gain. As doses are increased beyond the levels needed for maximal gain, feed intake decreased while gain remained constant.

Most poultry nutritionists agree that a digestible lysine level near to 1.15% and 1.06 % of the diet maximized feed efficiency and weight gain respectively (Han and Baker, 1991, 1993; Knowles and Southern, 1998). Therefore an existing matrix of total amino acid requirements should be converted to digestible amino acid and use in practical feed formulation.

ACKNOWLEDGEMENT

The authors would like to thank Degussa for support of these studies.

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لیزین قابل هضم مورد نیاز جوجه های گوشتی نر و ماده آرین در مرحله ٦ تا ٢١ روزگی

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چکیده

آزمایشی در ارتباط با تعیین نیاز لیزین قابل هضم جوجه‌های گوشتی نر و ماده (آرین) در طی دوره ٦ تا ٢١ روزگی بعد از تفریخ انجام شد. جیره پایه شامل اسیدهای آمینه مصنوعی ذرت و کنجاله سویا بعنوان منبع طبیعی پروتئین و حاوی ٢٠ ٪ پروتئین خام و ٣٢٠٠ کیلو کالری انرژی قابل متابولیسم در هر کیلوگرم بود. در این آزمایش تعداد ١٥٠ قطعه جوجه نر و ١٥٠ قطعه جوجه ماده بر اساس وزن اولیه در قالب طرح کامل تصادفی بصورت فاکتوریل به ١٢ تیمار (٢ جنس × ٦ سطح لیزین قابل هضم) و ٥ تکرار که هر تکرار شامل ٥ جوجه بود اختصاص داده شدند. سطوح لیزین قابل هضم معادل ١/٣٥ ٪ ٢٥ /١ ١/١٥ ١/٠٥ ٠/٩٥ ٠/٨٥ بود. سرعت رشد وبازده غذایی جوجه هایی که جیره پایه بعلاوه اسیدهای آمینه را مصرف نموده بودند معادل گروه کنترل که جیره بر پایه ذرت ـ سویا مصرف نموده بودند بود. رابطه درجه دوم بین میانگین افزایش وزن بدن و بازده غذایی در مقابل افزایش سطح لیزین قابل هضم جیره مشاهده شد ($P < ٠/٠٥$). با استفاده از آنالیز تابعیت خط شکسته نیاز لیزین قابل هضم برای حداکثر افزایش وزن در جوجه های نر ١/٠٧٥ ودر جوجه‌های ماده ١/٠٤٩٪ تعیین گردید. میزان نیاز برای حداکثر بازده غذایی بترتیب در جوجه های نر وماده ١/١٧٩ و ١/١٤٩٪ بود. نیاز جوجه های نر برای حداکثر افزایش وزن وبازده غذایی بیشتر از ماده‌ها بود. صرف نظر از جنسیت میزان نیاز لیزین قابل هضم برای حداکثر بازده غذایی ٨/٨ ٪ بیشتر از این مقدار برای حداکثر افزایش وزن بود.