Influence of Temperature on the Arginine and Methionine Requirements of Young Broiler Chicks

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Primary Audience: Poultry Nutritionists, Researchers, Poultry Scientists

SUMMARY

Two experiments were conducted with Ross × Ross broiler chicks in battery brooders from 7 to 21 d of age to determine the Arg and Met requirements of young broiler chicks at control (25°C) and warm (35°C) temperatures. In both experiments, 1-d-old broiler chicks were fed a corn and soybean meal based starter diet for 7 d. Six replications (2 replicates in each of 3 rooms per temperature) with 8 chicks each were used for each treatment. In experiment 1, the basal diet was based on corn (34.52%), whey (26.96%), corn gluten meal (16.53%), soybean meal (11.74%), and poultry fat (23% of CP and 3.20 kcal/g of ME_n). Six levels of Arg (0, 0.1, 0.2, 0.3, 0.4, and 0.5%), supplementing the basal diet containing 0.95% Arg, were the dietary treatments. A broken-line linear model was used to estimate chick Arg requirements. Based on body gain and feed conversion ratio (FCR) data, respectively, the Arg requirements of young Ross × Ross broiler chicks raised at 35°C were 1.15 ± 0.03% and 1.13 ± 0.02%, whereas those of chicks at 25°C were 1.26 ± 0.03% and 1.27 ± 0.02%. In experiment 2, the influences of temperature and dietary Arg on the Met requirements of young broiler chicks were investigated. The basal diet was based on corn (53.45%), soybean meal (37.72%), and poultry fat (23% of CP and 3.20 kcal/g of ME). Experiment 2 had a 6 × 2 factorial arrangement, with the basal diet (0.35% Met and 1.52% Arg) supplemented with 6 levels of dietary Met (0, 0.05, 0.1, 0.15, 0.2, or 0.3%) and 2 levels of dietary Arg (0 and 1.0%). When chicks were fed a corn-soybean meal basal diet containing 1.52% Arg, the Met requirements of young Ross × Ross broiler chicks raised at 35°C were 0.43 ± 0.02% and 0.43 ± 0.03%, whereas those of chicks at 25°C was 0.43 ± 0.01% and 0.48 ± 0.03%, based on body gain and FCR data, respectively. When Arg levels were increased to 2.52%, the Met requirement of young Ross × Ross broiler chicks was greater at both temperatures ($P < 0.05$). The requirements of chicks raised at 35°C were 0.50 ± 0.02% and 0.49 ± 0.02% and at 25°C were 0.59 ± 0.03% and 0.57 ± 0.02%, based on body gain and FCR data, respectively. Temperature and amino acid balance may both affect the amino acid requirements of broilers.

Key words: arginine requirement, methionine requirement, temperature, broiler, arginine–methionine interaction

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DESCRIPTION OF PROBLEM

Keshavarz and Fuller [1, 2] and Chamruspollert et al. [3] demonstrated the relationship between dietary Arg and Met levels is through the creatine biosynthesis pathway at ambient temperatures. They found that Arg toxicity could be overcome with additional Met. Chamruspollert et al. [3] also found an interrelationship among Arg, Met, and Lys, and the interaction was likely related to creatine biosynthesis. Their data suggested that under appropriate circumstances, dietary concentrations of Met, Arg, and Lys might each influence the nutritional requirements of the others.

Amino acid interactions in chicks raised at high temperatures likely differ from those raised at ambient temperature. Balnave et al. [4] examined the response of 3- to 7-wk-old broilers at 32°C to DL-methionine (DLM) and 2-hydroxy-4-(methylthio) butanoic acid (Alimet or HMB) supplementation of diets varying in Arg:Lys ratio. They showed that at 32°C a favorable response to HMB is especially evident with Arg:Lys ratios of 1.20 and higher, although DLM tended to give better growth when the diets with an Arg:Lys ratio of 1.03 were fed. Their results suggested a relationship between Met source and Arg:Lys ratio at 32°C. However, in their studies they did not have a control group with chickens raised under normal ambient temperature conditions. Chamruspollert et al. [5] further demonstrated the interaction between Arg and Met at warm temperature (35°C) is through the creatine biosynthesis pathway. They found that Arg metabolized through arginase or creatine synthesis was slower when chicks were reared at 35°C.

In vivo studies by Balnave and Oliva [6] showed that the digestibility of Arg in diets could be significantly decreased at high temperature (30°C). Brake et al. [7, 8] suggested that dietary Arg is important during hot weather because its availability from dietary sources is decreased, or its metabolic requirement is increased. Besides a reduction of Arg availability, total epithelial uptake of ^{14}C-DL-Met (diffusion plus energy-dependent and independent uptake) is reduced by 34% in the intestines of heat-stressed birds [9]. Mitchell and Carlisle [10] provided data supporting the idea of changes in amino acid absorption in the gut when chicks were kept in hot environments. They observed that size of the absorptive compartment was reduced by heat stress as reflected by decreased villus heights (19%) and wet (26%) and dry (31%) weight per unit length of jejunum. Therefore, the Arg requirement of birds under warm temperatures might have been altered due to changes in gut morphology, amino acid absorption, or amino acid metabolism.

Balnave and Oliva [11] reported that the requirement of broilers for Met was less at high temperatures than at neutral temperatures, with variations between constant and cycling high temperatures. Brake et al. [7, 8] and Mendes et al. [12] reported that increasing the Arg:Lys ratio in broiler diets reduced mortality and improved feed efficiency in birds reared at high temperatures.

The objective of the first experiment described here was to determine the influence of control versus warm temperatures (25 vs. 35°C) on the Arg requirement of broiler chicks. The objective of the second experiment was to further study the effect of Arg levels on the Met requirement of broiler chicks kept at the same 2 temperatures.

MATERIALS AND METHODS

Experiment 1

Seven hundred 1-d-old Ross × Ross 208 [13] broiler chicks were obtained from a commercial hatchery [14]. For the first 7 d, all chicks were fed a standard corn and soybean meal basal starter diet (g/kg: corn, 547.2; soybean meal, 336.8; poultry fat, 55.9; poultry by-product meal, 30; defluorinated phosphorus, 14.6; limestone, 6.3; salt, 4; vitamin premix, 2.5; mineral premix, 0.8; DL-methionine, 1.9) and were reared at 37°C. On d 7, 8 chicks were wing-banded, weighed, and randomly assigned to individual pens in raised-wire floored batteries [15] in 25 or 35°C rooms. Temperature and humidity in each room were recorded twice daily (at 0700 and 1500 h). Six levels of supplemental L-Arg (0, 0.1, 0.2, 0.3, 0.4, or 0.5%) were the dietary treatments. The basal diet provided 0.95% Arg. Each treatment was repeated 6 times with 2 replicates in each of 3 controlled temperature rooms. To produce an Arg deficiency, a diet was formu-

TABLE 1. Composition and nutrient content of the basal diets.

		Composition		
Ingredient		Experiment 1		Experiment 2
Corn		34.52		53.45
Whey (dehydrated)		26.96		—
Gluten meal		16.53		—
Soybean meal		11.74		37.72
Poultry fat		7.15		5.96
Defluorinated phosphate		1.64		1.70
Limestone		0.20		0.64
Common salt		0.09		0.40
Mineral premix[A]		0.08		0.08
Vitamin premix[B]		0.05		0.05
L-Lys		0.50		—
L-Trp		0.41		—
L-Thr		0.33		—
	Calculated[C]	Analyzed[D]	Calculated	Analyzed
Composition				
ME_n[C] (kcal/kg)	3,200	3,340	3,200	3,280
Calcium (%)	0.90		0.90	
Available phosphorus	0.45	0.45		
Crude protein	23.00	23.06	23.00	22.81
Choline (mg/g)	0.96		1.29	
Vitamin B_{12} (ug/kg)	1.32		1.32	
Folic acid (mg/kg)	1.52		1.68	
Amino acid profile				
Arg	0.95	0.90	1.52	1.59
Met	0.45	0.53	0.35	0.38
Cys	0.42	0.46	0.37	0.45
Lys	1.20	1.11	1.25	1.32
Gly + Ser	1.75	1.85	2.46	2.15

[A]Trace mineral premix provided the following in milligrams per kilogram of diet: Mn, 60; Zn, 50; Fe, 30; Cu, 5; I, 1.5.
[B]Vitamin premix provided the following per kilogram of diet: vitamin A, 6,614 IU from *trans*-retinyl acetate; cholecalciferol, 705 IU; vitamin E, 13 IU from all-*rac*-tocopherol acetate; riboflavin, 6.6 mg; Ca pantothenate, 12 mg; nicotinic acid, 39 mg; vitamin B_{12}, 0.011 mg; vitamin B_6, 1.9 mg; menadione, 1.3 mg (as menadione sodium bisulfate complex); folic acid, 0.72 mg; D-biotin, 0.055 mg; thiamine, 1.1 mg (as thiamine mononitrate); ethoxyquin, 125 mg.
[C]Based on NRC [16] ingredient composition tables.
[D]Degussa Corporation, Allendale, NJ.

lated with whey, gluten meal, corn, soybean meal, and poultry grease (Table 1). The diet was formulated to meet requirements [16] for all nutrients, except for Arg. Body weight gain, feed consumption, and feed conversion ratio (FCR) were measured from 7 to 21 d of age.

Experiment 2

Thirteen hundred 1-d-old Ross × Ross 208 broiler chicks obtained from a commercial hatchery were fed the starter diet described in experiment 1 for 7 d. Experiment 2 had a split-plot design, with whole plots completely randomized by 2 temperatures at 25 or 35°C, and the split plots had a 6 × 2 factorial arrangement.

The basal diet (0.35% Met and 1.52% Arg) was supplemented with 6 levels of supplemental DL-Met (0, 0.05, 0.1, 0.15, 0.2, or 0.3%) and 2 levels of supplemental L-Arg (0 or 1%). Each treatment was replicated 6 times with 2 replicates in each of 3 controlled temperature rooms. On d 21, two chicks from each pen were individually weighed and killed by CO_2 asphyxiation. The abdominal fat pad was removed and weighed. Body weight gain, feed consumption, and FCR were measured from 7 to 21 d of age.

Statistical Analysis

The data were analyzed with the GLM for regression analysis and nonlinear models

TABLE 2. Feed intake (g), body weight gain (g), and feed conversion ratio (g/g) of chicks fed diets containing graded levels of Arg at control (25°C) and warm (35°C) temperatures, from 7 to 21 d of age (experiment 1)[A]

Temperature	Arg (% in diet)	n	Feed intake (g)	Body weight gain (g)	FCR (g/g)
25°C	0.95	6	747 ± 14[b]	479 ± 10[c]	1.56 ± 0.02[a]
	1.05	6	742 ± 11[b]	488 ± 10[c]	1.52 ± 0.01[a]
	1.15	6	758 ± 12[b]	509 ± 9[b]	1.49 ± 0.01[ab]
	1.25	6	783 ± 16[a]	540 ± 10[a]	1.45 ± 0.02[bc]
	1.35	6	765 ± 14[ab]	535 ± 11[a]	1.43 ± 0.02[c]
	1.45	6	784 ± 14[a]	537 ± 8[a]	1.46 ± 0.01[b]
35°C	0.95	6	598 ± 12[a]	379 ± 10[b]	1.58 ± 0.02[a]
	1.05	6	590 ± 18[a]	388 ± 14[b]	1.52 ± 0.02[ab]
	.15	6	609 ± 19[a]	409 ± 12[a]	1.49 ± 0.01[ab]
	1.25	6	607 ± 16[a]	410 ± 14[a]	1.48 ± 0.02[b]
	1.35	6	618 ± 20[a]	415 ± 12[a]	1.49 ± 0.02[ab]
	1.45	6	615 ± 19[a]	410 ± 13[a]	1.50 ± 0.02[ab]
Main effect means					
25°C		36	763 ± 13[a]	515 ± 9[a]	1.49 ± 0.02
35°C		36	606 ± 11[b]	401 ± 11[b]	1.51 ± 0.01
ANOVA	df		Probability		
Temperature	1		0.0338	0.0105	0.4825
Room (Temp)	4		0.7323	0.3838	0.6555
Arg	1		0.0190	0.0030	0.0440
Arg × Arg	1		0.0241	0.0311	0.0189
Arg × Temp	1		0.0518	0.0627	0.0523
Arg × Arg × Temp	1		0.1238	0.2121	0.0989
Error	62				

[a–c]Values without a common superscript differ significantly ($P < 0.05$) when tested with Duncan's new multiple range test following analysis of variance.
[A]Values as means ± standard errors of n replicate pens of 8 birds each.

(NLIN) procedures of SAS software [17]. Means were separated using Duncan's new multiple range test [18]. The broken-line linear model was used to estimate chick Arg and Met requirements: response = max + rc × (req − x) × I, where max = plateau, rc = rate constant, req = requirement, x = level, and I = 1 when x < req, otherwise I = 0.

RESULTS AND DISCUSSION

In both experiments, temperatures in each room fluctuated; they ranged between 32 and 37°C for the warm room (average = 34.5°C) and between 21 and 27°C for control temperature rooms (average = 24.0°C). Humidity among rooms was similar, between 55 and 70%. In experiment 1, as expected, chicks reared at 35°C consumed less feed and gained less weight, compared with those at 25°C ($P < 0.05$; Table 2). Temperature had no effect on FCR ($P = 0.4825$). Curvilinear (quadratic) responses to dietary Arg level were found for body weight gain, feed intake, and FCR ($P < 0.05$). The interaction of Arg × Arg × temperature was not significant ($P > 0.05$), suggesting that the quadratic responses of Arg (Arg × Arg) were the same at 25 and 35°C.

The Arg requirement of young chicks at 25°C in this study (Table 3) was similar to the requirement suggested by NRC [16] (1.27 vs. 1.25%). A similar requirement was estimated by Labadan et al. [19] who reported that, using breast meat yield data, the Arg requirement is 1.27% for 1-to-14-d-old chicks.

The Arg requirement of young broilers chicks reared at 35°C was lower than that of chicks at 25°C (1.27 vs. 1.14%) (Table 3 and Figures 1 and 2). A change in the amino acid requirement of chicks at the warm temperature was expected due to changes in amino acid absorption and metabolism [5, 6, 9, 10, 20]. Chamruspollert et al. [5] observed that chicks raised at 35°C had lower arginase activity and had less creatine and creatinine in their excreta compared

TABLE 3. The Arg (experiment 1) and Met (experiment 2) requirements of young broiler chicks raised at 25°C and 35°C, using body gain and feed conversion ratio (FCR) as parameters as calculated using broken-line analysis[A]

Experiment	Parameter	Temperature 25°C	35°C
Arginine requirement			
Experiment 1	Body gain	1.26 ± 0.03	1.15 ± 0.03*
	FCR	1.27 ± 0.02	1.13 ± 0.02*
	Average	1.27	1.14
Methionine requirement			
Experiment 2			
1.52% Arg	Body gain	0.43 ± 0.01	0.43 ± 0.02
	FCR	0.48 ± 0.03	0.43 ± 0.03
	Average	0.46	0.43
2.52% Arg	Body gain	0.59 ± 0.03†	0.50 ± 0.02*†
	FCR	0.57 ± 0.02†	0.49 ± 0.02*
	Average	0.58	0.50

[A]Average ± SEM of 6 replications with 8 chicks per replication per treatment.
*Significant difference from chicks raised at 25°C.
†Significant difference from chicks fed 1.52% Arg within temperature.

with those raised at 25°C. Warm temperatures seemed to slow the Arg metabolism of chicks through arginase and the creatine synthesis pathway. Therefore, chicks raised under warm temperatures (35°C) required less Arg compared with those kept at lower (25°C) temperatures.

There are several reports on changing Arg:Lys ratios under warm temperature conditions. Increasing the Arg:Lys ratio (adding Arg) in broiler diets reduced mortality and improved the growth performance of birds reared at warm temperatures [7, 8, 12, 21]. However, direct

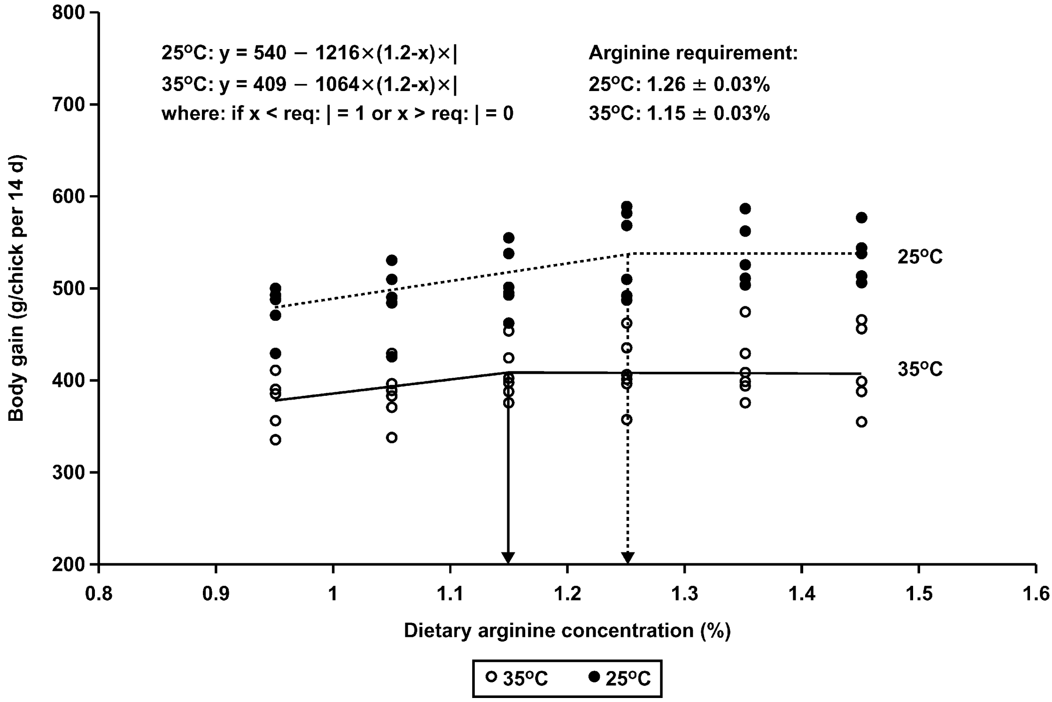

FIGURE 1. Estimated arginine requirements of chicks raised at 25 and 35°C, using body weight gain data (7 to 21 d of age) fitted by the broken-line linear model (experiment 1).

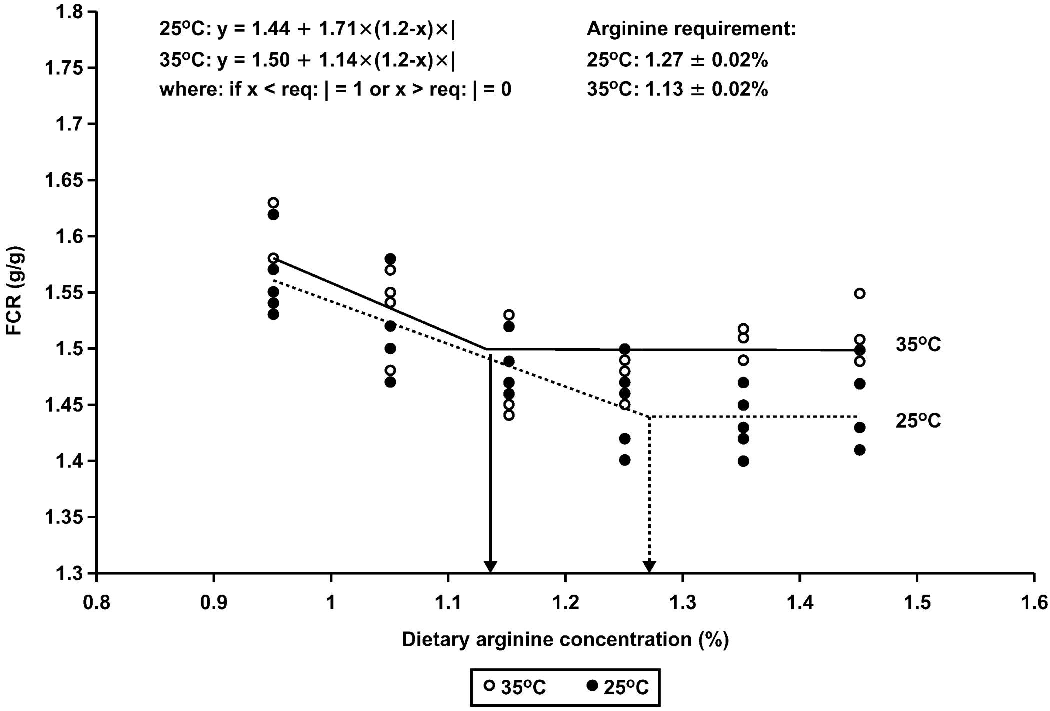

FIGURE 2. Estimated Arg requirements of chicks raised at 25 and 35°C, using feed conversion ratio (FCR) data (7 to 21 d of age) fitted by the broken-line linear model (experiment 1).

comparison of these experiments is complicated because the exact Arg and Lys levels were not reported; only how they were related to each other in the ratio was reported. For example, the ratio of one may be achieved by many levels of Arg and Lys in the diet. The varied levels of Arg and Lys with the same ratio might correspond differently to chick performance. Therefore, we are not able to directly compare our results to their studies.

In experiment 2, chicks reared at 35°C consumed less feed (P = 0.0009) and gained less weight (P = 0.0022) than those reared at 25°C (Table 4). The percentage of fat pad of chicks raised at 35°C was higher (P = 0.0325) than those of chicks at 25°C. Supplementation of Met to diets of chicks reared at both temperatures improved the chick growth performance (significant linear and quadratic effects; $P < 0.05$). The growth of chicks fed Arg supplements were particularly depressed at low Met levels and reached a plateau at higher levels, explaining the significant Met × Met × Arg interaction and increased the Met requirement when Arg was fed (Tables 3 and 4). Met supplementation had no effect on percentage of fat pad ($P > 0.05$).

The Met requirements estimated from body gain and FCR data were similar (Table 3 and Figures 3 to 6), although other studies found requirements for FCR usually greater than for gain [22, 23, 24]. The Met requirement of broilers is quite variable ranging from 0.18% [25] to 0.57% [24]. Several factors, including amino acid interactions and temperature, may cause the wide range in the requirements among the experiments. In earlier studies, adding 1% L-Arg to the diets increased the Met requirement at both temperatures. Due to their relationship through creatine biosynthesis, an increase in dietary Arg may increase the Met required for the pathway [1, 2, 3]. When chicks were fed diets containing higher Arg levels, chicks excrete more creatine and creatinine [5], which implies an increase in creatine biosynthesis from Arg. Differences in Met requirements may be related to the Arg levels of the basal diets used, as well as choline [26, 27, 28], betaine [29], vitamin B_{12} [30, 31], and folic acid [31] levels.

TABLE 4. Feed intake (g), body weight gain (g), feed conversion ratio (g/g), and percentage of fat pad of chicks fed diets containing graded levels of Met and two levels of Arg at control (25°C) and warm (35°C) temperatures, from 7 to 21 d of age (experiment 2)[A]

Temperature	Arg	Met	n	Intake (g)	Body weight gain (g)	FCR (g/g)	Fat pad (%)
	– (% in diet) –						
25°C	1.52	0.35	6	915 ± 21[a]	548 ± 21[b]	1.67 ± 0.02[a]	1.49 ± 0.09
	1.52	0.40	6	926 ± 25[a]	576 ± 19[b]	1.61 ± 0.03[ab]	1.53 ± 0.14
	1.52	0.45	6	943 ± 19[a]	602 ± 24[ab]	1.57 ± 0.02[b]	1.39 ± 0.11
	1.52	0.50	6	930 ± 21[a]	600 ± 16[ab]	1.55 ± 0.03[b]	1.42 ± 0.12
	1.52	0.55	6	937 ± 24[a]	604 ± 21[ab]	1.55 ± 0.04[b]	1.36 ± 0.14
	1.52	0.65	6	934 ± 25[a]	606 ± 20[ab]	1.54 ± 0.03[b]	1.38 ± 0.08
	2.52	0.35	6	789 ± 20[b]	474 ± 18[c]	1.66 ± 0.02[a]	1.41 ± 0.09
	2.52	0.40	6	925 ± 27[a]	582 ± 16[b]	1.59 ± 0.03[b]	1.46 ± 0.11
	2.52	0.45	6	916 ± 18[a]	598 ± 29[ab]	1.53 ± 0.02[bc]	1.40 ± 0.14
	2.52	0.50	6	927 ± 22[a]	611 ± 24[ab]	1.52 ± 0.01[c]	1.23 ± 0.08
	2.52	0.55	6	931 ± 19[a]	632 ± 19[a]	1.47 ± 0.02[d]	1.45 ± 0.13
	2.52	0.65	6	933 ± 23[a]	629 ± 21[a]	1.48 ± 0.03[d]	1.42 ± 0.12
35°C	1.52	0.35	6	710 ± 25[ab]	434 ± 22[b]	1.64 ± 0.02[a]	1.82 ± 0.07[a]
	1.52	0.40	6	719 ± 15[a]	470 ± 25[ab]	1.53 ± 0.04[b]	1.54 ± 0.13[ab]
	1.52	0.45	6	714 ± 13[ab]	484 ± 19[a]	1.48 ± 0.02[bc]	1.64 ± 0.11[ab]
	1.52	0.50	6	703 ± 19[a]	477 ± 13[a]	1.47 ± 0.03[bc]	1.54 ± 0.09[ab]
	1.52	0.55	6	727 ± 26[a]	485 ± 18[a]	1.50 ± 0.03[bc]	1.64 ± 0.07[ab]
	1.52	0.65	6	706 ± 22[ab]	480 ± 21[a]	1.47 ± 0.04[bc]	1.64 ± 0.08[ab]
	2.52	0.35	6	645 ± 23[b]	398 ± 19[c]	1.62 ± 0.03[a]	1.44 ± 0.06[b]
	2.52	0.40	6	701 ± 20[ab]	457 ± 19[ab]	1.53 ± 0.02[b]	1.69 ± 0.08[ab]
	2.52	0.45	6	720 ± 19[a]	488 ± 21[a]	1.48 ± 0.01[bc]	1.65 ± 0.07[ab]
	2.52	0.50	6	718 ± 26[a]	498 ± 15[a]	1.44 ± 0.04[c]	1.60 ± 0.12[ab]
	2.52	0.55	6	717 ± 23[a]	489 ± 18[a]	1.47 ± 0.03[bc]	1.66 ± 0.11[ab]
	2.52	0.65	6	721 ± 25[a]	495 ± 17[a]	1.46 ± 0.02[bc]	1.50 ± 0.08[b]
Main effect means							
25°C			72	917 ± 30[a]	589 ± 29[a]	1.56 ± 0.06	1.41 ± 0.08[b]
35°C			72	708 ± 26[b]	471 ± 22[b]	1.51 ± 0.04	1.61 ± 0.09[a]
25°C	1.52		36	931 ± 24	589 ± 26	1.58 ± 0.03[b]	1.40 ± 0.11
	2.52		36	904 ± 21	587 ± 22	1.54 ± 0.02[a]	1.43 ± 0.09
35°C	1.52		36	713 ± 21	472 ± 21	1.51 ± 0.06	1.59 ± 0.11
	2.52		36	704 ± 18	470 ± 20	1.50 ± 0.04	1.64 ± 0.09
25°C		0.35	12	852 ± 19[b]	511 ± 25[c]	1.67 ± 0.03[a]	1.45 ± 0.05
		0.40	12	926 ± 21[a]	579 ± 19[b]	1.60 ± 0.05[a]	1.50 ± 0.12
		0.45	12	930 ± 22[a]	600 ± 22[ab]	1.55 ± 0.04[b]	1.40 ± 0.13
		0.50	12	929 ± 25[a]	606 ± 21[a]	1.53 ± 0.06[b]	1.33 ± 0.06
		0.55	12	934 ± 21[a]	618 ± 20[a]	1.51 ± 0.04[b]	1.41 ± 0.05
		0.65	12	934 ± 18[a]	618 ± 18[a]	1.51 ± 0.06[b]	1.40 ± 0.12
35°C		0.35	12	678 ± 19[b]	416 ± 17[b]	1.63 ± 0.03[a]	1.63 ± 0.08
		0.40	12	710 ± 23[ab]	464 ± 19[a]	1.53 ± 0.07[ab]	1.62 ± 0.13
		0.45	12	717 ± 22[ab]	486 ± 23[a]	1.48 ± 0.03[b]	1.65 ± 0.08
		0.50	12	711 ± 20[ab]	488 ± 21[a]	1.46 ± 0.02[b]	1.57 ± 0.09
		0.55	12	722 ± 19[a]	487 ± 20[a]	1.48 ± 0.04[b]	1.65 ± 0.11
		0.65	12	714 ± 22[ab]	488 ± 21[a]	1.46 ± 0.05[b]	1.57 ± 0.13

[a–d]Values with no common superscript differ significantly ($P < 0.05$) when tested with Duncan's new multiple range test following analysis of variance.
[A]Values as means ± standard errors of n replicate pens of 8 birds each.

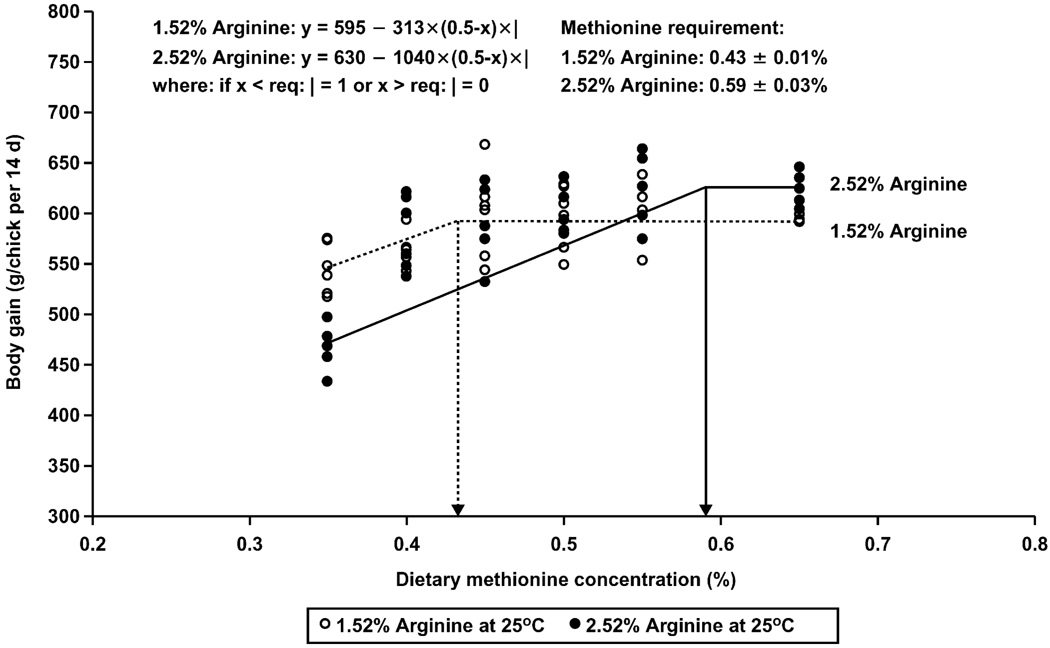

FIGURE 3. Estimated Met requirements of chicks fed diets containing 1.52 and 2.52% Arg at 25°C, using body gain data (7 to 21 d of age) fitted by the broken-line linear model (experiment 2).

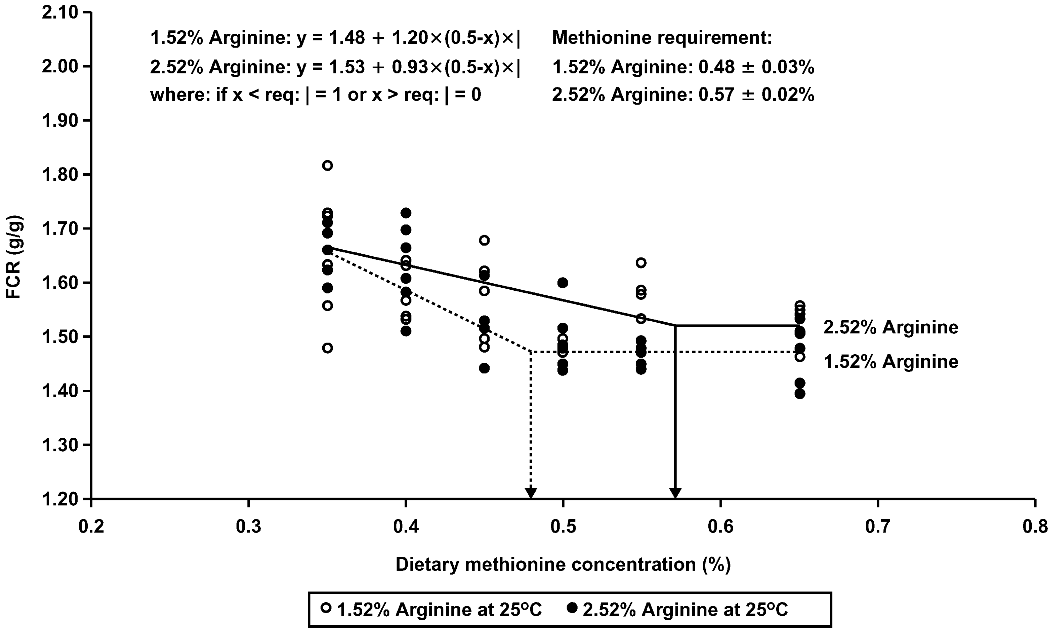

FIGURE 4. Estimated Met requirements of chicks fed diets containing 1.52 and 2.52% Arg at 25°C, using feed conversion ratio (FCR) data (7 to 21 d of age) fitted by the broken-line linear model (experiment 2).

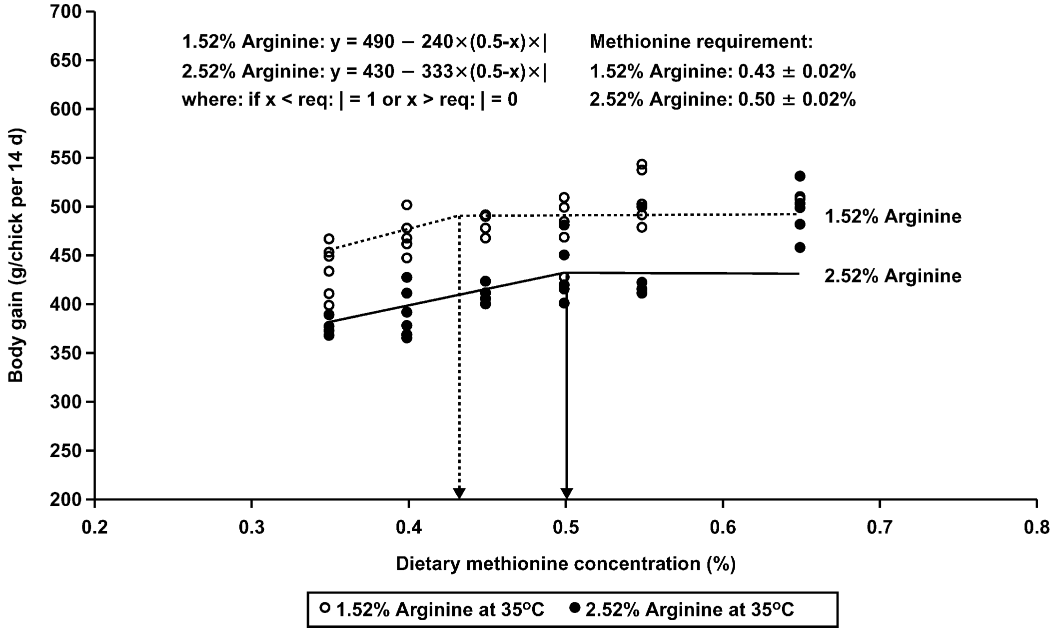

FIGURE 5. Estimated Met requirements of chicks fed diets containing 1.52 and 2.52% Arg at 35°C, using body gain data (7 to 21 d of age) fitted by the broken-line linear model (experiment 2).

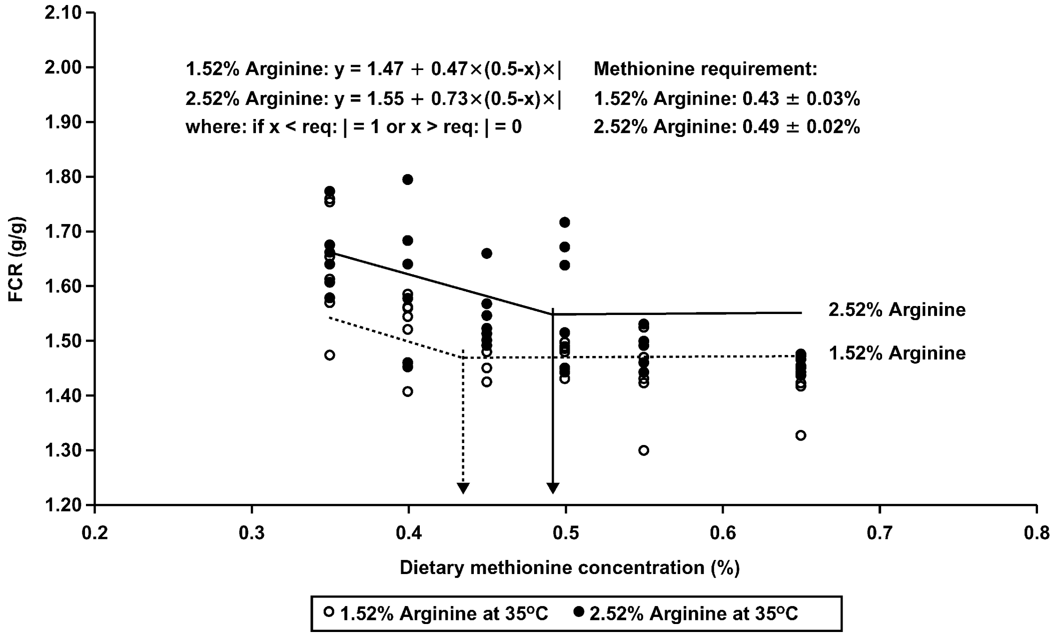

FIGURE 6. Estimated Met requirements of chicks fed diets containing 1.52 and 2.52% Arg at 35°C, using feed conversion ratio (FCR) data (7 to 21 d of age) fitted by the broken-line linear model.

Keeping chicks at warm temperatures influenced their Met requirements. Young Ross × Ross broiler chicks raised at 35°C required less Met, but this was true only when chicks were fed diets containing 2.52% Arg. Balnave and Oliva [6] reported that the requirement of broilers for Met was less at higher-than-neutral temperatures with variations between constant and cycling high temperatures. More studies are needed to quantify exactly how temperature alters Met requirements. Because of all the factors that influence the chicks' response to temperature (feather cover, activity, air movement, humidity), it is not clear whether either of the temperatures used in these experiments could be considered optimum; they were only used to demonstrate differences in response to amino acid supplementation at different temperatures.

CONCLUSIONS AND APPLICATIONS

1. The Arg requirement of starting broiler chicks is decreased as environmental temperature increases. Met requirements were also decreased with increasing temperature but only when excessive Arg was present.
2. The Arg:Met as well as Arg:Lys ratios may be important when formulating broiler feed.
3. The Met requirements may become very important when feedstuffs relatively high in Arg are substituted for corn and soybean meal in broiler diets. Ingredients with higher Arg:Met ratios than soybean meal (5.2:1) include gelatin (10.9:1); peanut meal (9.9:1); feather meal (9.8:1); cottonseed meal direct solvent extracted, 41% protein (9.1:1); and soybean protein concentrate, more than 70% protein (8.3:1), based on the NRC [16] ingredient composition table. Based on the results of experiment 2, diets high in Arg and based on these alternative ingredients likely changed the Met requirement and possibly changed the Lys requirement as well due to the interrelationship among Arg, Lys, and Met [3].

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