Research Note

Dietary Glycine Needs of Broiler Chicks

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ABSTRACT Dietary Gly might become a limiting factor in all-vegetable diets fed to broiler chicks when low CP is formulated in combination with marginal levels of dietary Thr and Ser. A study was conducted to evaluate dietary Gly needs of broiler chicks. Day-old Ross 508 male chicks were placed in 32 floor pens (15 chicks/pen). Chicks were fed a common prestarter diet from 0 to 7 d of age and then fed a diet that contained progressive amounts of dietary Gly ranging from 0.62 to 1.22% from 7 to 20 d of age. Treatment effects were observed for weight gain and feed conversion. Chicks responded in a quadratic manner to supplementation with dietary Gly. The dietary Gly level necessary to support maximum growth and feed conversion for the chick from 7 to 20 d of age was estimated to be at 0.98 (1.76% Gly + Ser) and 1.02% (1.80% Gly + Ser), respectively. Plasma Thr and Ser were unaffected by Gly supplementation, but plasma free Gly increased linearly. Dietary Gly may need to be considered as a limiting nutrient in early nutrition, especially if CP is low, and only vegetable ingredients are being used.

(*Key words*: chick, glycine, plasma amino acid)

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INTRODUCTION

Metabolic pathways involving Gly are diverse and include the synthesis of proteins, purines, porphyrin moiety of heme groups (Shemin and Rittenberg, 1945), glutathione, creatine (Bloch and Schoenheimer, 1941), uric acid (Christman and Mosier, 1929), glycocholic acid, and hippuric acid (Rittenberg and Schoenheimer, 1939) among others. Although Gly has been categorized as a nonessential amino acid in poultry, there might be circumstances when it becomes limiting for maximum growth of chicks (Almquist and Grau, 1944; Wixom et al., 1955; Greene et al., 1960; D'Mello, 1973). The NRC (1994) recommends 1.25% dietary Gly and Ser for broiler chicks; although individual requirements have ranged from 0.42 to 2.00% in different reports (Greene et al., 1960; Klain et al., 1960; Dean and Scott, 1965; Coon et al., 1974; Heger and Pack, 1996, Schutte et al., 1997).

Given that there are excesses of nitrogen-related compounds in a diet, there appears to be general agreement that Gly is necessary to synthesize uric acid molecules to excrete excess nitrogen. However, low CP diets may become marginally deficient in Gly and Ser. This scenario could be encountered when formulating all-vegetable diets with supplemental Met, Lys, and Thr. Consequently, a study was conducted to evaluate the Gly needs of broiler chicks from 7 to 20 d of age in a diet with marginally reduced CP content.

MATERIALS AND METHODS

Day-old Ross × Ross 508 male broilers were obtained from a commercial hatchery after being vaccinated against Marek's disease (d 18 via in ovo administration) and Newcastle disease and infectious bronchitis (via coarse spray at hatch). Chicks were randomly distributed across 32 pens (15 chicks/pen). Each concrete pad floor pen measured 0.9 × 1.2 m with the walls of the experimental house being curtain sided. Each pen contained 1 tube feeder, 3 nipples from a nipple drinker line, and used litter. Supplemental pan feeders were used in each pen from d 1 to 7 to ensure good feed consumption at placement. Feed and water were provided ad libitum. The facility was heated with gas brooders located at the center aisle that were programmed to provide thermoneutral conditions throughout the study. Ventilation was accomplished with negative pressure. The lighting program was 23L:1D.

All birds received a common prestarter diet up to 7 d of age. From placement until d 7 chicks became acclimated to the facility. The titration study measured Gly responses in broiler chicks from 7 to 20 d of age. Dietary levels ranged from 0.62% Gly (1.40% Gly + Ser) with equal increments of 0.12% Gly accomplished by the addition of crystalline Gly at the expense of a inert filler up to 1.22% (2.00% Gly + Ser; Table 1). Representative samples from the experimental diets were analyzed for Gly and Ser content (Llames and Fontaine, 1994). The basal diet was analyzed for total amino acids, including Gly and Ser, and the remaining diets were

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TABLE 1. Composition of prestarter and titration diet (%)

Ingredient	Prestarter (0–7 d)	Titration (7–20 d)[1]
Corn	54.67	72.08
Soybean meal	36.73	17.63
Corn gluten meal	—	2.78
Poultry fat	4.37	1.28
Dicalcium phosphorus	1.75	1.86
Limestone	1.24	1.28
Filler[2]	—	0.62
Salt	0.44	0.29
DL-Met	0.28	0.33
Vitamin-mineral premix[3]	0.25	0.25
L-Lys HCl	0.19	0.45
Monensin Na[4]	0.08	0.08
Choline Cl	0.001	0.02
L-Arg	—	0.33
$NaHCO_2$	—	0.23
L-Ile	—	0.17
L-Val	—	0.16
L-Thr	—	0.13
L-Trp	—	0.03
Calculated composition		
CP (%)	23.1	18.0
ME (kcal/kg)	3,100	3,125
Ca (%)	0.90	0.90
Available P (%)	0.45	0.45
Lys (%)	1.32	1.05
Met + Cys (%)	0.98	0.90
Thr (%)	0.84	0.73
Ile (%)	0.91	0.80
Arg (%)	1.46	1.25
Val (%)	1.03	0.90
Gly (%)	0.90	0.62
Gly + Ser (%)	1.98	1.40

[1]Calculated and analyzed (in parenthesis) Gly values (%) are as follows: 0.62 (0.66), 0.74 (0.76), 0.86 (0.81), 0.98 (0.93), 1.10 (0.98), 1.22 (1.10).

[2]Filler represented inert space (sand) in the diet to which crystalline-Gly was added at the expense of it.

[3]The vitamin and mineral premix contained per kilogram of diet: retinyl acetate, 2,654 μg; cholecalciferol, 110 μg; DL-α-tocopherol acetate, 9.9 mg; menadione, 0.9 mg; B_{12}, 0.01 mg; folic acid, 0.6 μg; choline, 379 mg; D-pantothenic acid, 8.8 mg; riboflavin, 5.0 mg; niacin, 33 mg; thiamin, 1.0 mg; D-biotin, 0.1 mg; pyridoxine, 0.9 mg; ethoxiquin, 28 mg; manganese, 55 mg; zinc, 50 mg; iron, 28 mg; copper, 4 mg; iodine, 0.5 mg; selenium, 0.1 mg.

[4]Coban 60 provided 90 g of monensin sodium per 907.2 kg of feed.

analyzed for supplemented Gly. Current digestible Gly values are scarce and questionable because uric acid in poultry excreta breaks down to Gly during amino acid hydrolysis for analysis, thus only total Gly values were used. At 17 d of age one bird per pen was bled via intracardial puncture. Blood samples were collected into a heparinized container and centrifuged at 4,000 rpm for 10 min. Plasma was removed and frozen at –70°C. The frozen plasma samples were thawed at 4°C and deproteinized using 30 mg of sulfosalicylic acid per milliliter of plasma. The Gly, Ser, and Thr concentrations of the deproteinized plasma were determined by precolumn derivatization with o-pthalaldehyde followed by separation on an adsorbosphere o-pthalaldehyde HR 5 μm column[2] (150 × 4.6 mm) using an automated HPLC system[3] with a fluorescence detector. At 20 d of age, BW, feed consumption, and conversion were determined. Dead chicks were weighed and recorded daily to adjust feed consumption data.

Pen means were used as the experimental unit for all analyses. The study followed a completely randomized design. All data were analyzed using the GLM procedure of SAS software (SAS Institute, 1996). Differences among means were separated with repeated *t*-test using the least squares means procedure of SAS software (SAS Institute, 1996). When quadratic responses ($P < 0.05$) were detected, dietary Gly needed for optimization was calculated by taking 95% of the maximum response (minimum for feed conversion).

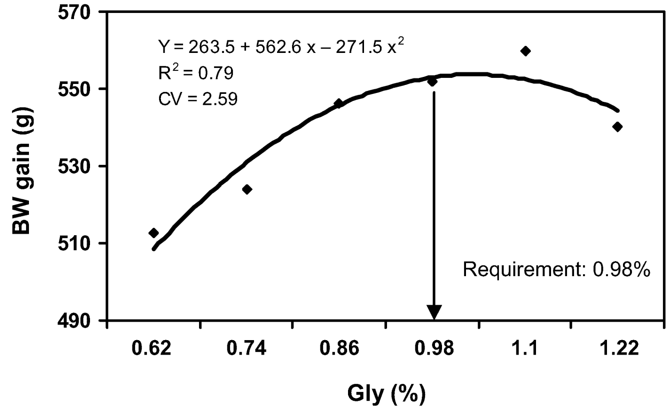

FIGURE 1. Dietary Gly need for maximization of BW gain (95% of maximum response) of broiler male chicks from 7 to 20 d of age (Gly + Ser = 1.76%).

RESULTS AND DISCUSSION

Performance of chicks (Table 2) was satisfactory (NRC, 1994) in combination with a minimum incidence of mortality (1.25% cumulative). During the period between 7 and 20 d of age, dietary Gly supplementation resulted in a quadratic response for BW gain. Regression analysis

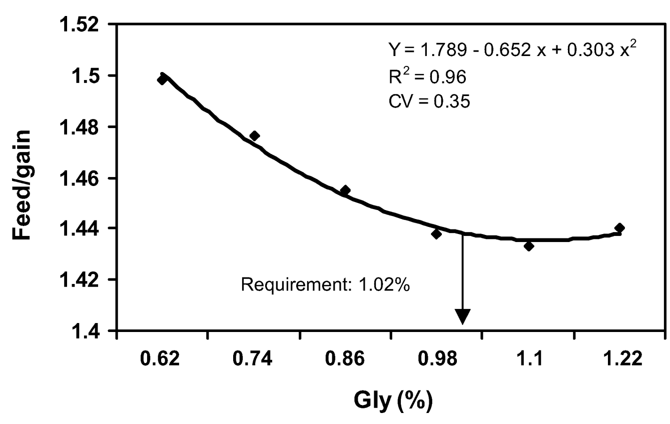

FIGURE 2. Dietary Gly need for maximization of feed per gain (95% of minimum response) of male broiler chicks from 7 to 20 d of age (Gly + Ser = 1.80%).

[2]Alltech, www.alltechweb.com.

[3]Beckman-Coulter System Gold, 32 Karat Software, Beckman-Coulter Instruments, Inc., Palo Alto, CA.

TABLE 2. Growth performance of male broiler chicks fed supplemented levels of Glyc from 7 to 20 d of age

Gly (%)	Gly + Ser (%)	BW gain (g)	Feed:gain (g:g)	Gly intake (g)
0.62	1.40	513[c]	1.50[a]	4.7[e]
0.74	1.52	524[bc]	1.48[ab]	5.7[d]
0.86	1.64	546[ab]	1.46[bc]	6.9[c]
0.98	1.76	552[ab]	1.44[bc]	7.8[b]
1.10	1.88	564[a]	1.43[c]	8.9[a]
1.22	2.00	540[abc]	1.44[bc]	9.5[a]
SEM		11.6	0.018	0.11
Analysis of variance				
Probability				
Gly		0.03	0.01	0.001
Gly linear		0.01	0.01	0.001
Gly quadratic		0.04	0.006	0.14
Gly cubic		0.26	0.62	0.40

[a–e]Means within a column not sharing a common superscript differ ($P \leq 0.05$).

showed that BW gain maximized at 0.98% dietary Gly (1.76% Gly+Ser) for BW gain (Figure 1). Feed conversion was also improved in a manner quadratic to increasing dietary levels of Gly. Feed conversion was optimized at 1.02% dietary Gly (1.80% Gly + Ser; Figure 2).

Low CP diets must be supplemented with essential amino acids to overcome any limitation. However, Jiang et al. (2001) demonstrated that Gly supplementation, but not Thr supplementation, to a low CP diet helped diminish growth depression. This result could be an indication in specificity of the need for dietary Gly, perhaps suggesting that transamination of amino acids such as Ser and Thr into Gly might not be metabolically efficacious to support Gly needs. These results are corroborated by Parr and Summers (1991) who suggested that Gly might become limiting when crude protein is reduced. Optimization results of dietary Gly in the present experimentation were in close agreement with those of Schutte et al. (1997) and Heger and Pack (1996). Furthermore, judging by the low CP content of the titration diet fed and considering that all essential amino acids were supplemented to adequate levels, the response exhibited in this study was likely a metabolic need for growth and not for maintenance-associated functions. There was an increase in blood plasma Gly concentration with dietary Gly supplementation (Table 3). However, plasma levels of Thr and Ser were unaffected by dietary Gly, an effect previously described by Baker et al. (1972).

TABLE 3. Blood plasma (nmol/mL) glycine, serine, and threonine of male broiler chicks at 17 d of age after being fed supplemented levels of Gly from 7 to 17 d of age

Gly (%)	Gly + Ser (%)	Gly	Ser	Thr
0.62	1.40	264[c]	322	490
0.74	1.52	258[c]	249	299
0.86	1.64	296[bc]	275	368
0.98	1.76	409[bc]	367	418
1.10	1.88	443[b]	324	330
1.22	2.00	622[a]	389	476
SEM		49.2	38.6	76.2
Analysis of variance				
Probability				
Gly		0.002	0.14	0.42
Gly linear		0.001	0.07	0.91
Gly quadratic		0.09	0.29	0.14
Gly cubic		0.95	0.30	0.62

[a–c]Means within a column not sharing a common superscript differ ($P \leq 0.05$).

Practical diets have values for total Gly + Ser content that oscillate between 0.85 and 2.05%. Based on results from this study, which used a low CP and used only vegetable ingredients, current recommendations of 1.25% for Gly + Ser by the NRC (1994) are too low, and high crude protein diets (23%) may potentially create a higher need for Gly + Ser as proposed by Heger and Pack (1996).

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