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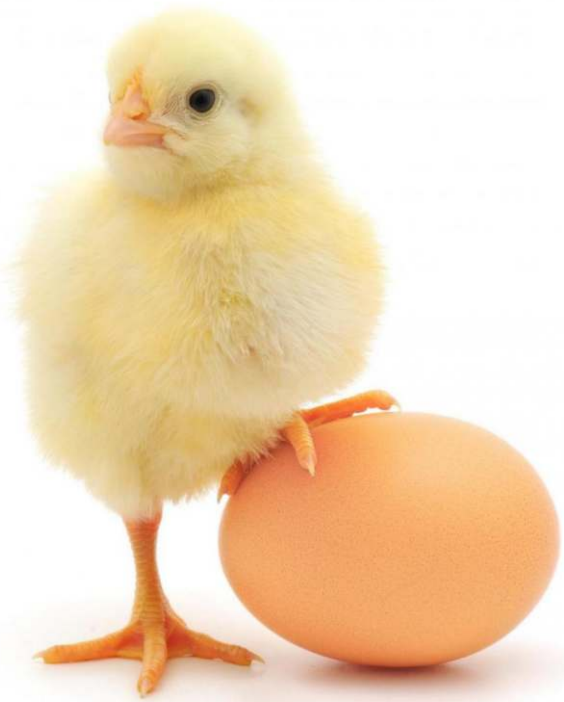

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The Effect of Glycine Supplementation on Performance of Broilers Fed Sub-marginal Protein with Adequate Synthetic Methionine and Lysine

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Abstract: A study was conducted to determine if synthetic glycine could replace dietary protein and improve performance of commercial broilers. Nine diets were formulated per feed regimen (starter, finisher, and withdrawal). A commercial diet was used as control (Diet A). Amino acids were reduced by 15% from Diet A to obtain Diet B. Synthetic methionine and lysine were added to Diet B to bring their level equal to Diet A, and create Diet C. Three levels of synthetic glycine (0, 0.05 and 0.1%) were added to Diets A, B, and C to obtain the nine dietary treatments. Male chicks (n = 3,150) originating from Ross male x Hubbard female breeder flocks were randomly placed in 63 floor pens in an open-sided house with thermostatically controlled curtains. Floor pens were divided into 7 blocks, each block containing 9 pens. The nine dietary treatments in each feed regimen were randomly assigned to pens in each of the seven blocks on d 1 (starter), 22 (finisher), and 43 (withdrawal) of age. Mortality, feed consumption (FC), body weight (BW) and feed to gain ratio (FG) were determined. Supplementing glycine, or methionine and lysine had no effect on FC. Glycine had no influence on the BW of chicks. The BW decreased with the reduction in dietary amino acids, and increased with an increase in dietary methionine and lysine fed the amino acid deficient diet. Glycine had no beneficial effect on FG, and 0.05% glycine increased ($P < 0.05$) FG up to 3 weeks. Addition of synthetic glycine (0.05 to 0.1%) to the 15% amino acid deficient diet could not make up for the deficiency of dietary amino acids in broiler diets.

Key words: Broilers, glycine, lysine, methionine, performance

Introduction

A major concern of nutritionists, environmentalists and poultry producers is to reduce nitrogen excretion, and to meet governmental regulations on environmental protection. Low protein diets are favored because they reduce the polluting effect on soil and water by reducing the nitrogen content of the droppings (Holsheimer and Jensen, 1992). It has been shown that broilers fed diets supplemented with amino acids had higher protein utilization and lower nitrogen excretion (DeSchepper and DeGroote, 1995). In 1992, Han *et al.* (1992) indicated that amino nitrogen (needed for dispensable amino acid synthesis) was a limiting factor in low protein diets. Previous research also indicated that addition of non-essential amino acids to low protein diets improved broiler performance (Parr and Summers, 1991; DeSchepper and DeGroote, 1995). Glutamic acid, a non-essential amino acid was reported to reduce carcass back bruising and drumstick deformities due to low dietary protein (Moran and Stilborn, 1996). Performance of chicks fed a low protein corn-soybean meal diet supplemented with essential amino acids, glycine and glutamic acid improved daily weight gain and feed conversion efficiency (Holsheimer *et al.*, 1994; Schutte *et al.*, 1997). Contrary to the beneficial response of glycine, Fontaine and Reytens (1969) reported a slight decline in growth by adding glycine to a diet containing 0.77% glycine. Nevertheless, adding 0.05% methionine improved weight gain by 23%, indicating utilization of glycine in presence of adequate methionine. Similarly, Baker and Sugahara (1970) observed no improvement in growth rate when glycine or choline was added to a diet deficient in glycine. Most previous studies were performed on chicks up to 3 wk of age, and used fewer chicks, which may have resulted in some discrepancies. Therefore, this study was conducted on a large number of chicks (n = 3,150) up to 7 wk of age to determine if glycine supplementation in amino acid deficient broiler diets would improve performance and profitability of broilers.

Materials and Methods

Diets used by a large broiler company for each growth phase were used as the positive controls (Diets A; Table 1). To create an amino acid deficiency, amino acids (crude protein) from Diet A were reduced by 15% to obtain the negative control or Diet B. To Diet B, synthetic methionine and synthetic lysine were added to bring the methionine and lysine levels equal to Diet A, and create Diet C. A total of nine diets were formulated for each feed regimen (starter: 1 to 21 d of age; finisher: 22 to 42 d of age, and withdrawal: 43 to 49 d of age) based on the digestible amino acids for better economic performance and correct assessment of amino acid availability (Rostagno *et al.*, 1995). Three levels of synthetic glycine[1] (0, 0.05 and 0.1%) were added to Diets A, B, and C to get

[1]Hampshire Chemical Corporation, Deerpark, TX 77536

Table 1: Composition of basal diets formulated based on digestible amino acids

Ingredients	Broiler Starter			Broiler Finisher			Broiler Withdrawal		
	A	B	C	A	B	C	A	B	C
	%								
Corn (8.6%)[1]	57.97	65.78	65.41	63.80	70.58	70.30	68.52	74.51	74.10
Soybean meal (48%)[1]	34.92	28.48	28.46	29.33	23.75	23.70	24.93	19.99	20.09
Poultry Oil	3.34	1.95	2.02	3.33	2.13	2.19	3.45	2.39	2.47
Dicalcium phosphate	1.67	1.73	1.71	1.62	1.67	1.67	1.34	1.38	1.38
Calcium	0.88	0.88	0.88	0.73	0.73	0.73	0.71	0.71	0.71
Salt (NaCl)	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral premix[3]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine[4]	0.15	0.09	0.21	0.12	0.05	0.15	0.05	0.05	0.09
L-lysine[5]	...	...	0.20	...	...	0.18	...	...	0.15
Coban[6]	0.08	0.08	0.08	0.08	0.08	0.08	...	...	...
Calculated analysis									
Protein, %	20.84	18.34	18.50	18.60	16.43	16.56	16.85	14.93	15.09
ME, kcal/kg	3080	3080	3080	3146	3146	3146	3212	3214	3212
Calcium, %	0.88	0.88	0.88	0.80	0.80	0.80	0.72	0.72	0.72
Nonphytate P, %	0.44	0.44	0.44	0.42	0.42	0.42	0.36	0.36	0.36
Sodium, %	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Met + cystine, %	0.84	0.72	0.84	0.73	0.63	0.73	0.64	0.54	0.64
Lysine, %	1.19	1.01	1.19	1.03	0.88	1.03	0.91	0.78	0.91
Tryptophan, %	0.25	0.22	0.22	0.22	0.19	0.19	0.20	0.17	0.17
Glycine, %	0.89	0.78	0.78	0.79	0.70	0.70	0.72	0.63	0.63
Histidine, %	0.57	0.51	0.50	0.51	0.46	0.45	0.47	0.42	0.42
Threonine, %	0.80	0.70	0.70	0.71	0.63	0.62	0.64	0.57	0.57

[1]Amino acid analysis of corn and soybean meal was determined by chemical analysis. [2]Provided per kg of diet: retinyl acetate, 8000 IU; cholecalciferol, 2,200 ICU; dl-alpha tocopheryl acetate, 8 IU; vitamin B_{12}, 0.02 mg; riboflavin, 5.5 mg; D-calcium pantothenic acid, 13 mg; niacin, 36 mg; choline, 500 mg; folic acid, 0.5 mg; thiamin, 1 mg; pyridoxine hydrochloride, 2.2 mg; biotin, 0.05 mg; menadione sodium bisulfite complex, 2 mg. [3]Provided per kg of diet: manganese, 65 mg; iodine, 1 mg; iron, 55 mg; copper, 6 mg; zinc, 55 mg; selenium, 0.3 mg. [4]Degussa Corp., Ridgefield Park NJ 07660. [5]Biokyowa Inc., Cape Girardeau, MO 63701.[6]Coban contains monensin sodium 132g/kg. A coccidiostat from Elanco Animal Health, Eli Lilly and Co. Indianapolis, IN 46285. *Glycine was obtained from Hampshire Chemical Corporation, Deerpark, TX 77536.

experimental diets 1 to 9 for starter, finisher and withdrawal phase respectively. Male chicks originating from a Ross male x Hubbard female breeder flock were placed in floor pens (50 chicks/pen; 0.0822 m^2 per bird) in an open-sided house having thermostatically controlled curtains. Each pen was furnished with fresh bedding of pine shavings and equipped with a thermostatically controlled brooder, a chick feeder plate and a chick drinker at the time of placement. The trial was initiated during May and terminated in July. Standard husbandry practices were observed during the trial. All birds were vaccinated for Mareks disease, Newcastle disease and Infectious Bronchitis at the hatchery. Before placement, 50 chicks were weighed for each pen. Pens were randomly assigned to the dietary treatments in each of the seven blocks (consisting of nine pens per block) to minimize location effect. Chicks dying within 3 d of age were replaced with chicks of the same group kept under similar husbandry practices in an extra pen. On d 3 of the trial, chick feeder plates and drinkers in each pen were replaced by a starting tube feeder and a bell drinker. When starter diets were replaced with finisher diets at 3 wk of age, the starting tube feeders were replaced with the growing tube feeders. The finisher diets were replaced with withdrawal diets at 6 wk of age. Mortality was recorded daily, and dead birds per pen were weighed, and the weight was included in the weekly pen weight. Feed consumption (FC) of chicks/pen was determined weekly for 7 weeks. Body weights (BW) were measured (total weight/pen) at d 1 and at Wk 1, 2, 3, 6 and 7 to determine body weight gain and feed to gain ratio (FG). Corn and soybean meal were analyzed chemically for their amino acid composition.

The statistical model (Cochran and Cox, 1957) used for the analysis of dependent variables (FC, BW, FG, and mortality) was:

$$Y_{ijkl} = \mu_{ijkl} + T_i + B_j + R_{jk} + TB_{ij} + e_{ijkl}$$

Where, Y_{ijkl} is the individual observation, μ_{ijkl} is the experimental mean, T_i is the treatment effect, B_j is the block effect, R_{jk} is the replicate effect nested within each block, TB_{ij} is the interaction between treatment and block, and e_{ijkl} is the random error.

Data were subjected to analysis of variance (Steel and Torrie, 1980) as a randomized complete block design, using the General Linear Models procedure (SAS, 1989). Means were separated using Tukeys test (Steel and Torrie, 1980).

Table 2: Influence of glycine on cumulative feed consumption (FC) of broilers

Treatment	Cumulative weekly feed consumption (g/bird)					
	1	2	3	4	5	6
1 = Control	130^{abc}	464^{ab}	1025^{ab}	1882^{a}	2943^{a}	4111^{a}
2 = Control + 0.05% glycine	127^{abc}	465^{ab}	1025^{ab}	1884^{a}	2943^{a}	4047^{a}
3 = Control + 0.1% glycine	133^{ab}	469^{ab}	1026^{ab}	1874^{a}	2920^{ab}	4096^{a}
4 = Control - 15% amino acids	124^{bc}	458^{ab}	974.3^{b}	1786^{ab}	2823^{ab}	3912^{a}
5 = Diet 4 + 0.05% glycine	127^{abc}	481^{a}	1093^{a}	1877^{a}	2917^{ab}	4009^{a}
6 = Diet 4 + 0.1% glycine	127^{abc}	446^{ab}	986.5^{b}	1767^{b}	2786^{ab}	3905^{a}
7 = Diet 4 + methionine + lysine	136^{a}	465^{ab}	987.4^{b}	1824^{ab}	2899^{ab}	3984^{a}
8 = Diet 7 + 0.05% glycine	132^{abc}	461^{ab}	992.2^{b}	1816^{ab}	2889^{ab}	3959^{a}
9 = Diet 7 + 0.1% glycine	122^{c}	432^{b}	960.6^{b}	1744^{b}	2766^{b}	3917^{a}
SEM	2.1	8.5	17.0	22.5	35.3	53.8

^{abc}Values within the same column with different superscripts are significantly different at P < 0.05.

Table 3: Influence of glycine on body weight (BW) of broilers

Treatment	Weekly BW (g/bird)			
	1	2	3	6
1 = Control	116^{a}	354^{a}	689^{a}	2174^{a}
2 = Control + 0.05% glycine	112^{a}	352^{a}	687^{a}	2120^{ab}
3 = Control + 0.1% glycine	111^{a}	353^{a}	680^{a}	2184^{a}
4 = Control - 15% amino acids	100^{b}	311^{b}	612^{bc}	2017^{ab}
5 = Diet 4 + 0.05% glycine	100^{b}	311^{b}	598^{c}	1965^{b}
6 = Diet 4 + 0.1% glycine	100^{b}	310^{b}	610^{bc}	1965^{b}
7 = Diet 4 + methionine + lysine	113^{a}	343^{a}	639^{b}	2071^{ab}
8 = Diet 7 + 0.05% glycine	112^{a}	340^{a}	640^{b}	2067^{ab}
9 = Diet 7 + 0.1% glycine	98^{b}	300^{b}	595^{c}	2013^{ab}
SEM	2	4	8	38

^{abc} Values within the same column with different superscripts are significantly different at P < 0.05.

Results and Discussion

Although this study was conducted for seven weeks, a high mortality caused by heat stress occurred during Wk 7. Therefore, results are presented only for the first six weeks.

Feed Consumption: Addition of synthetic glycine (0.05 or 0.1% of feed) to the control diet (Diet 1) had no significant influence (P > 0.05) on weekly or average FC (Table 2). Reducing the amino acids (crude protein) content by 15% from the control diet (Diet 4 or negative control = NC) did not reduce average FC. Addition of synthetic glycine to diets deficient in amino acids (Diets 5 and 6) had no influence (P > 0.05) on FC except during Wk 3 and 4, where FC of broilers fed 0.05% glycine was higher than FC of broilers fed 0.1% or no glycine (P < 0.05). These results were consistent with the findings of Ueda *et al.* (1979) that supplemental glycine to amino acid deficient diets did not increase FC. Increasing methionine and lysine levels equal to the control diet, or adding 0.05 or 0.1% glycine to the deficient diets adequate in methionine and lysine, had no effect on the average FC of chicks. The only exception was a drop (P < 0.001) in FC of broilers fed 0.1% glycine (Diet 9) during Wk 1, which was in agreement with Summers and Leeson (1985) that addition of glycine with supplemental methionine and lysine reduced feed intake due to severity of amino acid imbalance. This may be attributed to an effect of altered amino acid ratio due to supplemental glycine prior to adjustment of chicks to dietary glycine.

Body Weight: Adding 0.05 or 0.1% glycine to broiler diets had no significant influence on BW (Table 3). These results were in agreement with the report of Baker and Sugahara (1970) that glycine inclusion in broiler diets had no influence on BW. Reducing dietary amino acids by 15% resulted in a significant reduction in BW that was not corrected by supplemental glycine. Results of this study were not consistent with other reports that adding glycine in diets deficient in glycine improved growth rate of chicks (Almquist and Gray, 1944; Schutte *et al.*, 1997). Elevating methionine and lysine level in the deficient diet equal to the control diet improved BW of broilers, and there was no significant difference between BW of chicks fed the control diet and BW of chicks fed amino acid deficient diet with added methionine and lysine. The only exception where BW was reduced were, those fed 0.1% glycine (Diet 9). These results partly agree with the results of Fontaine and Reytens (1969), that supplementing glycine reduced growth, but adding glycine with methionine and lysine improved BW.

Table 4: Influence of glycine on feed to gain ratio (FG) of broilers

Treatment	Week			
	1	2	3	6
1 = Control	1.12^{c}	1.31^{d}	1.49^{c}	1.86^{b}
2 = Control + 0.05% glycine	1.14^{bc}	1.32^{d}	1.49^{c}	1.88^{b}
3 = Control + 0.1% glycine	1.21^{abc}	1.33^{d}	1.51^{bc}	1.84^{b}
4 = Control - 15% amino acids	1.24^{abc}	1.47^{ab}	1.59^{bc}	1.90^{ab}
5 = Diet 4 + 0.05% glycine	1.27^{a}	1.55^{a}	1.83^{a}	2.00^{a}
6 = Diet 4 + 0.1% glycine	1.27^{a}	1.44^{bc}	1.62^{b}	1.95^{ab}
7 = Diet 4 + methionine + lysine	1.21^{abc}	1.35^{dc}	1.55^{bc}	1.89^{ab}
8 = Diet 7 + 0.05% glycine	1.18^{abc}	1.36^{dc}	1.55^{bc}	1.88^{b}
9 = Diet 7 + 0.1% glycine	1.25^{ab}	1.44^{bc}	1.62^{c}	1.91^{ab}
SEM	0.026	0.021	0.024	0.024

^{abc} Values within the same column with different superscripts are significantly different at $P < 0.05$.

Feed: Gain: Adding glycine to the control diet had no effect on FG (Table 4). Reducing amino acids 15% from the control diet (negative control = NC) had no effect on FG, except during Wk 2 where FG increased compared to the positive control. Addition of methionine and lysine to the deficient diet (Diet 7) reduced FG in Wk 2, and there were no significant differences in FG of broilers fed the control diet and broilers fed the deficient diet with adequate methionine and lysine. Supplementing 0.05 or 0.1% glycine to the NC increased FG ($P < 0.05$) within one wk over the positive control. Adding glycine 0.05 or 0.1% to diet adequate in methionine and lysine had no effect on FG. This was contrary to the previous reports that low protein corn-soy diets supplemented with indispensable amino acids, glycine and glutamic acid, improved FG ratio, and adding glycine to a low protein diet supplemented with essential amino acids improved FG (Holsheimer *et al*., 1994; Schutte *et al*., 1997).

In summary, adding synthetic glycine (0.05 and 0.1%) to broiler diets with or without a reduction in amino acids (15%) had no significant effect on the performance of broilers. However, when lysine and methionine were added to the amino acid deficient diets, a partial improvement in broiler performance was observed. Addition of glycine (0.05%) to the deficient diet with adequate methionine and lysine did not improve broiler performance. However, addition of 0.1% glycine reduced BW during the first three weeks of age.

Further studies are required to determine the effect of supplementing glycine with other limiting amino acids such as threonine and tryptophan on the performance of broilers.

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