RESEARCH ARTICLE

Effect of L-Glycine on Growth Performance and Economics of Commercial Broiler Chicken

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Abstract

Study was conducted for six weeks on 240, day-old Cobb-430Y strain broiler chicks randomly assigned to four groups (60 chicks per group) containing three replicates. Group 'A' was Negative Control (NC) contained 3% low protein (LP) than Positive Control (PC) group 'B'. Group B contained normal protein (NP) [22.50, 21.00, and 19.50% CP for broiler pre-starter (BPS), starter (BS) and finisher (BF) phases, respectively] as per strain requirement. Group 'C' (NC+Gly1) was formed by adding 0.640, 0.810, and 0.630% L-Glycine in NC diet to arrive 2.30, 2.30, and 2.00% Digestible (Dig.) Gly + Ser levels, while group 'D' (NC+Gly2) was formed by adding 0.755, 0.985, and 0.740% L-Glycine in NC diet to arrive 2.40, 2.40, and 2.10% Dig.Gly + Ser levels in BPS, BS, and BF diets, respectively. Dig. Gly + Ser levels of NC group were 1.71, 1.56, and 1.43%; and of PC group were 2.02, 1.91, and 1.76%, respectively, for BPS, BS and BF diets. Ratio of Dig. Met, Thr, Trp, Arg, and Val. to Lys. were balanced (AA-balanced) in all diets. All diets were isocaloric (3010, 3100, and 3200 Kcal ME/kg feed for BPS, BS, and BF, respectively). Results showed that the L-Glycine supplementation in AA-balanced 3% LP diet significantly ($p \leq 0.05$) improved overall BW, WG, and FCR in broilers. Dig. Gly + Ser levels of 2.30, 2.30, and 2.00% in AA-balanced 3% LP diets (0.640, 0.810, and 0.630% L-Glycine) in BPS, BS, and BF phases, respectively, were found to be cost-effective for improving BW, WG, and FCR with less feed intake. Study concludes that the L-Glycine is recommended to maintain Dig. Gly + Ser levels of 2.30, 2.30, and 2.00% in BPS, BS, and BF phases for cost-effective formulation with a reduction of 3% CP in a standard commercial broiler diet.

Key words: Broiler chicken, Dig. Gly + Ser, L-Glycine, Low-CP.

Ind J Vet Sci and Biotech (2024): 10.48165/ijvsbt.20.5.02

Introduction

Poultry nutritionists have made many attempts to reduce feed costs by formulating a balanced diet to achieve the optimum performance of modern broilers without affecting welfare and environmental problems. For optimum performance of broiler birds, protein quality in terms of amino acids is more important than the quantity included in the diet. Glycine is the smallest proteinogenic non-essential amino acid and has no isomeric form. Glycine and serine are interconvertible, and their interconversion is not limited to metabolism. Therefore, glycine and serine are assessed together in poultry nutrition studies. Insufficient glycine levels in feed impair growth; hence, it is considered conditionally essential in birds (Wang *et al*., 2013). The reduction of the CP content in poultry diets with a desirable effect on performance was shown to be limited even when the requirement of essential amino acids was considered (Siegert *et al*, 2018). Chicken-fed conventional diets cannot produce enough glycine to meet metabolic needs (Baker 2009). Takahashi *et al. (*2008) confirmed that a practical corn-soya diet responds to glycine addition. Glycine enhances protein utilization and essential amino acids' metabolic and functional efficiency, particularly sulfur-containing AAs like cysteine, threonine, and arginine (Akinde, 2014). Hence, for further decrease in CP content in the broiler diet, non-essential amino acids like glycine and serine need to be considered. Feeding broilers with reduced CP in all vegetable diets limit the concentration of glycine (Corzo *et al.,* 2004;

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How to cite this article: Shisodiya, M. M., Lonkar, V. D., Kadam, A. S., Mote, C. S., Jadhav, S. N., & Kadam, B. R. (2024). Effect of L-Glycine on Growth Performance and Economics of Commercial Broiler Chicken. Ind J Vet Sci and Biotech. 20(5), 9-14.

Source of support: Nil

Conflict of interest: None

Submitted 21/04/2024 **Accepted** 01/06/2024 **Published** 10/09/2024

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Dean *et al*., 2006; Lee Rochell, 2022). Hence, the currently formulated corn-soy diet must be supplemented with synthetic glycine (L-glycine), which is available. Glycine has a positive impact on increasing the effectiveness of protein utilization in low CP diets. A low CP diet supplemented with L-glycine improves broiler performance (Jiang *et al.,* 2005; Dean *et al*., 2006). By considering the above facts, the experiment was conducted to study the effect of L-glycine supplementation in a commercial broiler diet containing low protein on their growth performance and economics.

Materials and Methods

An experiment was conducted for a period of six weeks on 240, day-old straight-run commercial broiler chicks of Cobb-430Y strain. Chicks were randomly assigned to four groups, *viz*., A to D, containing 60 chicks in each group subdivided into three replicates of 20 chicks each. Group 'A' was the Negative Control (NC) contained 3% low protein (LP) [19.50, 18.00, and 16.50% CP for broiler pre-starter (BPS), broiler starter (BS), and broiler finisher (BF) phases, respectively] than Positive Control (PC) group 'B'. Group B contained normal protein (NP) [22.50, 21.00 , and 19.50% CP for BPS, BS, and BF phases, respectively] as per the strain requirement. No L-Glycine was added to NC and PC diets. Group 'C' (NC+Gly1) was formed by adding 0.640, 0.810 , and 0.630% L-Glycine in BPS, BS, and BF diets, respectively, in the NC diet to arrive at 2.30, 2.30, and 2.00% Digestible Gly + Ser levels in respective diets. Group 'D' (NC+Gly2) was formed by adding 0.755, 0.985, and 0.740% L-Glycine in BPS, BS, and BF diets, respectively, in the NC diet to arrive at 2.40, 2.40, and 2.10% Digestible Gly + Ser levels in respective diets. The Dig. Gly + Ser levels for BPS, BS, and BF diets of NC group (A) were 1.71, 1.56, and 1.43%, and of PC group (B) were 2.02, 1.91, and 1.76%, respectively. The ratio of Dig. Met, Thr, Trp, Arg, and Val to Lys were balanced (AA-balanced) in all the experimental diets. All the experimental diets were isocaloric, containing 3010, 3100, and 3200 Kcal/kg of metabolic energy (ME) for BPS, BS, and BF feed, respectively.

Parameters like body weight and weight gain, feed consumption, feed efficiency and economics were estimated as per standard methods in practice.

Statistical Analysis

The data generated in a completely randomized design was analyzed by one-way ANOVA with the help of IBM SPSS Software-20. The Duncan Multiple Range Test (DMRT) post-hoc analysis was done to test the significant mean differences between the groups with significance levels defined at $p<0.05$ (Snedecor and Cochran, 1994).

Results and Discussion

Body Weight and Body Weight Gain

The broilers' day-old, first-week, and second-week body weight did not differ significantly among different groups (Table 1). The third to sixth weeks body weights differed significantly ($p \leq 0.05$) among different groups. At the end of the third, fourth and sixth week, broilers from groups B, C, and D recorded significantly higher ($p \leq 0.05$) body weight than group A. During the fifth week, significantly higher ($p \leq 0.05$) body weight was observed in group B followed by group C than A and D. The body weight of broilers from the NC group fed with the LP diet was significantly ($p \leq 0.05$) depressed than that of the PC group. The addition of L-Glycine to the LP diet (C and D) achieved body weight similar to that of PC (B) and lowered to that of NC (A) during the third and fourth weeks. Ospina-Rojas *et al*. (2013) reported that Glycine supplementation resulted in positive responses during the grower phase (21-35 d) with low protein levels and suggested that the requirement of dietary Gly+Ser could be higher than the maximum level studied (1.77% dig Gly+Ser) for broilers during the grower phase fed diets with low CP (16.8% & 3200 Kcal/kg ME). Jiang *et al*. (2001) demonstrated that Glycine supplementation to a low CP diet helped diminish growth depression. In the present study, during the fifth and sixth week, broilers from the NC+Gly2 group did not achieve body weight like the PC group. The body weight of broilers from groups NC+Gly1 and NC+Gly2 was similar to the PC and significantly higher than NC. Aguihe *et al*. (2022) showed that the maintenance of a minimum of 0.6% supplemental Glycine provided 2.36% Gly + Ser level, which was shown to support the reduction of CP content from 22 to 19% in the broiler diet at 21 days of age, without undermining their cumulative growth performance. In the present study, the body weight results were inconsistent with the NC+Gly2 level. Hence, the NC+Gly1 level was more beneficial than the NC+Gly2 level. Sohail *et al.* (2003) found that adding 0.05 or 0.1% Glycine did not influence body weight. Like present study, Dean *et al.* (2006) included a 2.44% Gly + Ser level in a low CP diet (16.21%), resulting in optimal broiler growth, and concluded that adding Glycine to an AA-supplemented 16% CP diet would support growth equal to broilers fed a typical 22% CP diet. The requirement for Glycine seems to be higher in low CP diets than in high CP diets. This requirement seems to be not less than 2.32% Gly + Ser for broilers from 0 to 17 d post-hatching (Dean *et al*., 2006). Elahi *et al*. (2020) confirmed that protein could be reduced by 4.5% with optimal glycine supplementation in the corn-soybean meal-based broiler chicken diet. Salim *et al.* (2021) also reported that LP diet supplementation with Glycine significantly improved the body weight of broilers.

The overall weight gain of broilers for a period of six weeks is depicted in Table 1. The broiler's weight gain from PC, NC+Gly1, and NC+Gly2 was significantly higher ($p \leq 0.05$) than the NC group. Similar to the present findings Awad *et al*. (2017) reported significantly depressed (p<.0001) weight gain of broliers fed NC diets compared to PC diet. Hofmann *et al*. (2019) also reported a decrease in the daily gain of broilers fed low CP. The present study indicated that the supplementation of L-Glycine significantly (p≤0.05) improves the body weight gain when broilers are fed with a balanced 3% LP diet. A significant interaction between CP and glycine levels on weight gain was recorded by Paschal *et al*. (2021). Kriseldi *et al*. (2017) reported that Glycine has more pronounced effects than nitrogen contribution on the body weight gain of broilers during starter and grower periods. They further suggested that adequate total Gly+Ser and nitrogen concentrations may be necessary for broilers when 2.4% points reduced dietary CP content is fed for a 6-week broiler production period. Corzo *et al*. (2004) found maximized body weight gain at 0.98% dietary Gly (1.76% Gly+Ser), which corroborated with present findings. The glycine supplementation improved the metabolism and performance (Manukyan *et al*. (2022) similar to PC.

The overall results indicated that 3% LP diet (NC) lowered body weight and weight gain in commercial broilers. The L-Glycine supplementation beneficially improves broilers' body weight and weight gain fed with AA balanced 3% LP diet. Moreover, supplementation of L-Glycine in NC+Gly1 group fed with AA-balanced 3% less CP was significantly (p≤0.05) beneficial to improve the final body weight and weight gain of commercial broilers than NC+Gly2 group fed with AA-balanced 3% less CP.

Feed Consumption and FCR

The overall feed consumption of broilers for a period of six weeks is depicted in Table 2. Although the overall feed consumption was statistically comparable among groups, the overall feed consumption from groups C and D was numerically lowered compared to groups A and B. The similar metabolic energy (ME) content of pre-starter, starter, and finisher diets in all the groups indicated that the AA-balanced 3% LP diet and NP diet; and or the addition of L-Glycine having AA-balanced 3% LP diet in NC+Gly1 and NC+ Gly2 did not have any effect on feed consumption of broilers. Namroud *et al*. (2010) observed a decline in feed intake of broilers fed with CP below 19.0% during 0-28 days. In the present study, the CP content of the NC diet was 19.5, 18.0, and 16.5% for pre-starter, starter, and finisher diets, respectively. However, the AA was balanced, though the CP was low in NC. Adding L-Glycine to an AA-balanced 3% LP diet, *i.e.,* NC+Gly1 and NC+ Gly2, caused numerically less feed consumption than AA-balanced NC and PC groups without L-Glycine. The L-Glycine added broiler diets might be efficient in utilizing the feed compared to NC and PC diets containing no added L-Glycine with or without reduction in dietary crude protein level. The present findings agreed with Lee and Rochell (2022), who reported that the broilers fed reduced CP diets had higher feed consumption, while increasing Gly + Ser tended to reduce feed consumption. In contrast to the present findings, Harn *et al*. (2018) reported no change in feed consumption of broilers fed with low protein diet (17.7% and 16.5% CP in grower and finisher, respectively) with increasing concentrations of Glycine+Serine ranging from 1.24% to 1.57% and 1.14% to 1.49% in grower and finisher diets, respectively. Similarly, Sohail *et al*. (2003) also reported no influence on feed consumption when synthetic Glycine in diets was deficient in amino acids. Laudadio *et al*. (2012) also found that protein levels did not affect feed consumption. It was concluded that the commercial broiler diets might be formulated with AA balanced (Dig. Met, Thr, Trp, Arg, and Val) 3 % less CP for pre-starter, starter, and finisher phases with the addition of L-Glycine without changing the dietary ME.

The overall FCR of broilers (Table 2) was significantly (p≤0.05) improved in groups B, C, and D than in group A. The addition of L-Glycine in AA balanced 3% LP diet, *i.e.* NC+Gly1 and NC+ Gly2, compensated the FCR of broilers fed with NP diet, *i.e.* PC (group B), but improved significantly than AA balanced 3% LP diet *i.e.,* NC (group A). Dean *et al*. (2006) concluded that adding Glycine to an AA-supplemented 16% CP diet might support feed efficiency equal to broilers fed a typical 22% CP diet. Similarly, Awad *et al*. (2017) also found that the NC diet fortification with Glycine significantly improved (p<0.0001) the FCR compared to the NC group and

Table 1: Body weight (g) and overall weight gain (g) of broiler chicken supplemented with L-Glycine in low protein diet

Groups	Weekly body weight							Overall weight gain (I-VI)
	Day-old	I	II	III	IV	V	VI	
A	42.34 ±0.61	170.38 ±3.56	424.48 ±2.74	803.72^a ±15.23	1225.86^a ±5.57	1791.23^a ±24.44	2385.14^a ±29.68	2342.79^a ±29.75
B	42.59 ±0.07	171.17 ±6.19	451.07 ±14.93	869.68^b ±16.86	1379.70^b ±62.31	2095.19^b ±95.49	2632.52^b ±96.11	2589.93^b ±96.17
C	43.43 ±0.45	173.20 ±1.57	470.01 ±5.14	879.05^b ±17.13	1350.56^b ±6.51	1937.36^{ab} ±26.14	2576.09^b ±31.42	2532.66^b ±31.63
D	42.51 ±0.43	171.02 ±1.55	465.98 ±15.62	866.84^b ±12.72	1330.60^b ±3.95	1916.94^a ±5.36	2523.65^{ab} ±7.99	2481.13^{ab} ±8.26
SEm	0.227	1.627	7.194	11.187	22.056	39.173	35.675±	35.649
P-value	0.375	0.954	0.074	0.032	0.039	0.019	0.051	0.052

Means bearing different superscripts within the column differs significantly (p≤0.05) resulted in FCR similar to those birds fed the PC diet. Waldroup *et al*. (2005) also reported that dietary CP level significantly influenced feed efficiency, the FCR worsened as the CP level was reduced. In the present study, the 3% LP diet significantly depressed broilers' FCR without adding L-Glycine when other AA were balanced (Dig. Met, Thr, Trp, Arg, and Val). L-Glycine addition was beneficial in improving the feed efficiency of broilers fed with 3% less protein balanced with other AA (Dig. Met, Thr, Trp, Arg, and Val) in the diet. Similarly, Waldroup *et al*. (2005) also recorded an improvement in FCR when 0.4% additional Glycine was added to 16, 18, and 20% CP diets and suggested that requirements for Glycine suggested by NRC (1994) were inadequate in diets with low CP. Waguespack *et al*. (2009) observed that 1.77% of total Gly + Ser is below the requirement for FCR. Paschal *et al*. (2021) found significant improvement in the FCR of broilers fed reduced CP from 22 to 18% with 0.4% added glycine, while Lee and Rochell (2022) and Mansilla *et al*. (2023) found that increasing Gly + Ser linearly improved FCR ($p<0.001$) of broilers. Young birds may not synthesize enough Glycine endogenously; a minimum amount of content should be provided in the early phases (Mansilla *et al.,* 2023). Kriseldi *et al*. (2017) reported that providing adequate total Gly+Ser might be necessary for broilers when approximately 2.4% points reduced dietary CP content during a 6-week production period. Ospina-Rojas *et al*. (2013) reported that Glycine directly or indirectly influences the proper function of the intestinal mucosa and improves the utilization of dietary energy and is responsible partly for the fact that Glycine supplementation in low-CP diets results in positive responses regarding broiler chicken performance. The findings indicated that adding L-Glycine in the broiler diet helps to improve overall FCR.

Table 2: Feed consumption (g) and FCR (I-VI week) of broiler chicken supplemented with L-Glycine in low protein diet

Groups	Feed consumption (g)	FCR
A	4087.87 ±129.97	1.74^{b} ±0.03
B	4217.58 ±259.12	1.62^{a} ±0.04
C	3997.12 ±46.90	1.58^{a} ±0.01
D	3993.08 ±78.85	1.60^{a} ±0.02
SEm	70.422	0.023
P-value	0.705	**0.029**

Means bearing different superscripts within the column for a parameter differ significantly ($p \leq 0.05$)

Table 3: Economics of broiler chicken supplemented with different levels L-Glycine with or without low protein diet

Parameters	Groups			
	A	B	C	D
Chick cost (Rs)	40.00	40.00	40.00	40.00
Feed intake (kg)				
Pre-starter feed	0.140	0.135	0.139	0.136
Starter feed	1.002	1.024	0.958	0.930
Finisher feed	2.947	3.058	2.900	2.927
Total FI(kg)	4.088	4.218	3.997	3.993
Feed price per kg (Rs)				
Pre-starter feed	38.68	39.64	40.72	41.24
Starter feed	38.00	39.92	40.71	41.03
Finisher feed	38.72	40.20	40.90	41.32
Feed cost per bird (Rs)				
Pre-starter feed	5.40	5.37	5.68	5.59
Starter feed	38.06	40.89	38.99	38.17
Finisher feed	114.10	122.93	118.61	120.96
Total feed cost per bird (Rs)	157.56	169.18	163.28	164.71
Miscellaneous cost per bird (Rs)	5.00	5.00	5.00	5.00
Net cost of production per bird (Rs)	202.56	214.18	208.28	209.71
Avg. BW at the end of 6^{th} week (g)	2.385	2.633	2.576	2.524
Return on sale of bird @ Rs 86 per kg live BW	205.12	226.40	221.54	217.03
Net profit per bird (Rs)	2.57	12.21	13.27	7.32
Net profit per kg (Rs)	1.08	4.64	5.15	2.90

Economics of Broiler Production

The economics of broiler production supplemented with different levels of L-Glycine with or without a low protein diet is depicted in Table 3. The feed cost of group A for pre-starter, starter and finisher diets was less followed by group B and group D. The 3 % less protein in the AA-balanced diet of group A resulted in low feed cost. The feed cost in L-Glycine added in groups C and D was higher than in positive control group B.

The net profit per bird and net profit per kg live body weight were higher in group C, followed by groups B, D, and A. Though the feed consumption was almost similar in groups C and D, which were added with L-Glycine with AA balanced 3% less CP in both the groups, group C had higher net profit per bird and net profit per kg live body weight than group D. The lower net profit per bird and net profit per kg live body weight in group D was due to the higher inclusion of L-Glycine than group C. The net profit per bird and net profit per kg live body weight in group C was also higher than group B fed with a positive control diet with normal CP. Though the body weight was higher and feed price was lower in group B, its higher feed consumption and inclusion of higher dietary CP *i.e*. normal resulted in less net profit per bird (Rs. 12.21) and net profit per kg live body weight (Rs. 4.64) than group C (Rs 13.27 net profit per bird and Rs. 5.15 net profit per kg live body weight). The literature on dietary Glycine's effect on broiler production economics is scanty.

The overall economics of broiler production indicated the addition of L-Glycine having Dig. Glycine levels of 1.39, 1.48, and 1.25 with respective Dig Gly + Ser levels of 2.30, 2.30, and 2.00 in pre-starter, starter, and finisher diets, respectively, found to be economical in commercial broiler farming with AA balanced 3% less dietary CP.

Conclusion

Present research concludes that the L-Glycine supplementation in broiler chicken fed with AA-balanced 3% low-protein without changing the dietary ME significantly ($p \leq 0.05$) improved overall body weight, weight gain, and feed efficiency and helped efficient protein utilization. Moreover, Dig. Gly + Ser levels of 2.30, 2.30, and 2.00% (L-Glycine levels of 0.640, 0.810, and 0.630%) found to be cost-effective in 3% low protein (19.50, 18.00, and 16.50% CP) for respective broiler pre-starter, starter, and finisher diets for improving body weight, weight gain, and feed efficiency with less feed intake. L-Glycine supplementation is recommended to maintain Dig. Gly + Ser levels of 2.30, 2.30, and 2.00% in pre-starter, starter, and finisher phases for cost-effective formulation with reduction of 3% CP in standard commercial broiler diet.

Acknowledgement

Authors gratefully acknowledge the Associate Dean of the Krantisinh Nana Patil College of Veterinary Science Shirwal, Maharashtra Animal and Fishery Sciences Univerisity Nagpur for providing facilities to carry out this Post Graduate research work.

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