Vietnam Journal of Agricultural Sciences

p-ISSN 2588-1299
e-ISSN 3030-4520

VJAS 2025; 8(3): 2659-2666
https://doi.org/10.31817/vjas.2025.8.3.08

Effects of Guanidinoacetic Acid (GAA) Supplementation on the Growth Performance and Meat Quality in Ross 308 Broiler Chickens

Dinh Thi Yen, Dang Thai Hai, Nguyen Thi Chau Giang, Pham Thi Thu Ha, Nguyen Thi Vinh & Bui Huy Doanh*

Faculty of Animal Science, Vietnam National University of Agriculture, Hanoi 12400, Vietnam

Abstract

This study investigated the effects of dietary guanidinoacetic acid (GAA) supplementation on the growth performance, carcass characteristics, and meat quality in Ross 308 broilers. A total of 270 one-day-old chickens were randomly assigned to three dietary groups: treatment 1 (0.6 g GAA kg^{-1} feed), treatment 2 (1.2 g GAA kg^{-1} feed), and a control group (no GAA). GAA supplementation had no significant effect on the survival rate or feed intake (P >0.05). However, it tended to improve the cumulative body weight gain, average daily gain, and feed conversion ratio (FCR) in treatments 1 and 2 during the finishing phase (P <0.05), with the 1.2 g GAA kg^{-1} feed achieving the lowest overall FCR (1.33). Furthermore, GAA supplementation increased the carcass yield, breast meat yield, and thigh meat yield, and reduced breast meat toughness; however, most of these differences were not statistically significant (P >0.05). These results indicate that dietary GAA supplementation may have the potential to enhance the growth performance and meat quality in Ross 308 broiler chickens.

Keywords

Guanidinoacetic acid (GAA), growth performance, carcass traits, feed additive

Received: July 3, 2025
Accepted: September 24, 2025

Correspondence to
Bui Huy Doanh
bhdoanh@vnua.edu.vn

ORCID

Bui Huy Doanh
https://orcid.org/0000-0003-2500-7818

Nguyen Thi Vinh
https://orcid.org/0000-0003-4881-7506

Introduction

In recent years, advancements in genetic selection, nutritional science, and large-scale production technologies have markedly enhanced the growth performance of broiler chickens. Among the various poultry species, broiler chickens—particularly the Ross 308 strain—stand out for their high productivity and superior meat quality. The demand for chicken meat continues to rise, especially in developing countries, where access to protein-rich food sources is crucial for improving living standards. This growing demand poses a challenge for scientists and poultry producers to optimize nutritional strategies that can enhance the growth performance and meat quality without increasing production costs or harming the environment. According to a report by the Department of Livestock Production – MARD (2025), the yield of white broiler meat has continued to expand, reaching approximately 1.2 million tons at the end of 2024, an increase of 3% compared to the previous year.

Guanidinoacetic acid (GAA), a derivative of amino acids and a direct precursor of creatine, plays a crucial role in energy metabolism (Mori *et al.*, 1996; Ostojic, 2014). Creatine can be synthesized endogenously in humans and animals; however, the efficiency of this process is relatively low, particularly in poultry (Komoto *et al.*, 2003). Notably, creatine's thermal sensitivity poses a major limitation to its use as a dietary supplement in poultry, especially due to the heat treatment involved in feed processing (Vraneš *et al.*, 2017). Guanidinoacetic acid, the direct precursor of creatine, has emerged as a promising feed additive for poultry owing to its high thermal stability (Vraneš *et al.*, 2017), which enables it to remain stable during pelleting. Due to the instability of creatine during processing and its relatively high production cost, GAA has been investigated as a viable alternative in dietary supplementation (Khajali *et al.*, 2020; Asiriwardhana & Bertolo, 2022). It has been evaluated as a feed additive aimed at improving energy efficiency and promoting the growth performance in poultry, swine, cattle, and lamb production (Asiriwardhana & Bertolo, 2022; Soares *et al.*, 2025; Zhang *et al.*, 2025). Furthermore, GAA supplementation in combination with methionine has been shown to enhance growth, and it may also function as an arginine-sparing agent in avian species (Yi *et al.*, 2025). Studies have demonstrated that GAA supplementation in swine diets can lead to increased weight gain and improved feed efficiency, especially in growing-finishing pigs (Jayaraman *et al.*, 2018; Wang *et al.*, 2022). GAA supplementation has also been shown to improve weight gain and feed efficiency in broilers (Portocarero & Braun, 2021; Asiriwardhana & Bertolo, 2022). Wang *et al.*, (2022) reported that the dietary inclusion of 0.1-0.15% GAA improved broiler growth rates by 10-15% and reduced the feed conversion ratio (FCR). Guanidinoacetic acid supplementation has been shown to positively influence meat quality parameters in pigs and poultry (Jayaraman *et al.*, 2018; Wang *et al.*, 2022; Xiao *et al.*, 2025). Similarly, GAA supplementation enhanced meat quality by increasing the protein content and reducing the fat content, which aligns with growing consumer demand for high-quality poultry products (Majdeddin *et al.*, 2020; Xiao *et al.*, 2025). In duck production, a report showed that the dosage of 600 mg kg^{-1} GAA improved liver and breast muscle fat deposition, lipid levels, and lipid metabolism-related gene expression (Wu *et al.*, 2024).

Therefore, the present study was conducted to evaluate the effects of dietary GAA supplementation on the growth performance, carcass traits, and meat quality in Ross 308 broiler chickens. It was hypothesized that dietary GAA supplementation would enhance growth efficiency and improve the carcass and meat quality parameters in broilers.

Materials and Methods

Animals and experimental design

The experiment was conducted with 270 Ross 308 broiler chickens raised from day 1 to 35 days of age at the experimental farm of the Faculty of Animal Science, Vietnam National University of Agriculture, from March 2025 to May 2025. Chickens were allocated to nine pens with three replicates of 30 birds each and fed three different diets. The dietary treatments were as follows: G0 (Control): Basal diet with no guanidinoacetic acid (GAA) supplementation; G0.6: Basal diet supplemented with 0.6 g GAA kg^{-1} feed; and G1.2: Basal diet supplemented with 1.2 g GAA kg^{-1} feed (**Table 1**). The basal diets were formulated according to a three-phase feeding program as follows: starters (days 1 to 14), growers (days 15 to 28), and finishers (days 29 to 35). The ingredient and nutritional compositions of these basal diets are presented in **Table 2**. Chickens were housed in pens ($2 \times 1 \times 0.5$m) maintained at a temperature of 25-28°C and equipped with feeders and drinkers.

Table 1. Experimental design

Items	G0	G0.6	G1.2
GAA (g kg^{-1} feed)	0	0.6	1.2
Birds pen^{-1}	30	30	30
Replications	3	3	3

Table 2. Ingredient and nutritional composition of the basal diet for the experimental broilers

Ingredient, g kg^{-1}	1-14 days	15-28 days	29-35 days
Corn	545	584	626
DDGS corn	60	60	60
Palm oil	21	24.7	24,3
Limestone	10.65	9.00	9.05
Soybean meal	246	251	210
Extruded soybean	90	50	50
Monocalcium phosphate	5.3	1	0
Salt	2.3	2.2	2.2
Methionine 98%	2.9	2.9	3.2
Threonine 98%	0.9	1	1.6
Lysine HCL 98.5%	3.1	3,3	4.6
Tryptophan	0.1	0.15	0.4
Choline chloride 60%	1	1	1
Premix	11.75	9.75	7.65
Total	1000	1000	1000
Nutrient			
ME (Kcal kg^{-1})	3000	3050	3100
Crude Protein (%)	21.0	19.0	18.0
Crude fiber (%)	4.0	4.2	5.0
Calcium (%)	0.9	0.9	0.9
Phosphorus (%)	0.8	0.75	0.7
Methionine (%)	0.45	0.4	0.38
Lysine (%)	1.1	1.05	1.0

The diets and water were provided *ad libitum* throughout the experiment. The guanidinoacetic acid was supplied by Ecovet Co., Ltd.

Growth performance measurements

Chicks were individually weighed weekly in the morning before adding feed using a digital balance to obtain their body weight (BW). The body weight gain (BWG), feed intake (FI), and FCR were calculated weekly and for the entire period of the trial (from 1 to 35 days of age). The number of dead chickens in each diet treatment was recorded daily to calculate the mortality rate throughout the experimental period.

Carcass traits and meat quality

At the end of the experiment, on day 35, six chickens from each treatment (1 male and 1 female from each pen) were randomly selected and had their BW measured via a digital balance. The processes of slaughtering were performed according to standard procedures. The carcass was weighed, and the dressing percentage was calculated according to Bui Huu Doan *et al*.

(2011). The meat quality parameters were evaluated following the method described by Le Bihan-Duval *et al*. (2001), including pH15, pH24, lightness, tenderness, and drip loss during storage and cooking.

Statistical analysis

The data were compiled and analyzed using Excel and Minitab 16 statistical software. Differences among treatments were considered statistically significant at P <0.05 using Tukey's test within the framework of one-way ANOVA. The estimated parameters included the mean and standard error (SE).

Results and Discussion

Growth performance

The survival rates of the Ross 308 broiler chickens fed the experimental diets from day 1 to day 35 were consistently above 99%, and there were no statistically significant differences among the treatment groups (P >0.05) (**Table 3**). These survival rates were higher than those reported for Ross 308 broilers raised to 42 days of age in Thai Nguyen, which ranged from 90% to 92% (Tu Trung Kien *et al*., 2021). Moreover, the results were comparable to the survival rates of Ross 308 broilers from day 1 to day 35 reported by Bui Huy Doanh *et al.* (2023), which also exceeded 99%. Michiels *et al.* (2012) reported that GAA supplementation at 0.6 and 1.2 g kg^{-1} feed led to mortality rates between 1.0% and 2.6% from day 1 to 39.

According to **Table 4**, no significant cumulative growth differences were observed among the groups from day 1 to 14 (P >0.05). This finding suggests that GAA has a limited effect during the early growth phase, differing from DeGroot *et al*. (2019), who reported improved body weight gain and energy utilization in broilers supplemented with GAA. Such variation may relate to the age at supplementation, diet composition, or physiological status, and GAA's benefits could be more evident at later growth stages. From day 14 to 21, chickens feeding on the diet supplemented with 1.2 g GAA kg^{-1} feed (G1.2)

Table 3. Survival rates of the experimental chickens (%, n = 3)

Stage (days)	G0	G0.6	G1.2
1-7	100	100	100
7-14	100	100	100
14-21	100	100	100
21-28	100	98.89	100
28-35	100	100	98.89
Mean	100	99.78	99.78

Table 4. Average weight of the experimental chickens at different stages (g $bird^{-1}$)

Stage (day)	G0	G0.6	G1.2
1	47.04 ± 0.54	46.62 ± 0.55	48.36 ± 0.69
7	192.96 ± 3.06	191.04 ± 2.94	195.69 ± 4.87
14	531.01 ± 7.74	530.69 ± 7.83	556.90 ± 11.20
21	960.40^{b} ± 15.40	976.10^{ab} ± 18.40	1024.60^{a} ± 21.60
28	1699.01 ± 26.10	1709.80 ± 39.01	1780.30 ± 39.80
35	2239.70 ± 39.40	2313.60 ± 39.70	2357.10 ± 45.80

Note: Means within the same row with different superscript letters differ significantly (P <0.05).

exhibited significantly greater cumulative growth compared to the other groups (*P* <0.05). By day 35, chickens in G1.2 reached the highest cumulative body weight (2357.10g), followed by those in G0.6 and the control group (G0); however, these differences were not statistically significant (*P* >0.05). These results indicate that dietary supplementation with GAA at 1.2 g kg^{-1} may enhance the growth performance during the rapid grower phase, consistent with the findings of Michels *et al*. (2012) and DeGroot *et al*. (2019). Further analysis of daily body weight gain (**Table 5**) revealed that the G1.2 group consistently showed higher average weight gains across most growth stages. However, these differences were not statistically significant (*P* >0.05). In terms of feed utilization (**Table 6**), dietary GAA supplementation had no significant effect on feed intake throughout the experimental period. The average daily feed intake averaged about 92 g $bird^{-1}$ day^{-1}, with similar values across all treatments. However, the FCR was positively affected by GAA inclusion, especially during the finisher phase (days 28-35), where chickens in the G1.2 group achieved the lowest FCR (1.82), followed by G0.6 (1.84), both significantly better than the control (1.94) (*P* <0.05). Similar improvements in the FCR following GAA supplementation have been reported by Li *et al*. (2024), who observed enhanced growth efficiency and nutrient partitioning in broilers under both standard and stress-induced conditions. However, a previous study indicated that diets supplemented with 0.6 g kg^{-1} GAA led to a significant decrease in the FCR of broilers (Zhao *et al*., 2021). Overall, GAA supplementation at 1.2 g kg^{-1} feed resulted in the most efficient feed conversion (1.33) over the 35-day trial, suggesting improved nutrient utilization efficiency associated with GAA. Moreover, the mode of action of GAA has been linked to its role as a precursor of creatine, a compound involved in cellular energy buffering and transport (He *et al.*, 2018; Li *et al.*, 2018). By enhancing the creatine pool, GAA may improve ATP availability in muscle tissues, supporting more efficient growth and metabolism (Michiels *et al.*, 2012; DeGroot *et al.*, 2019).

Carcass traits and meat quality

The carcass traits of the experimental chickens across the three treatment groups (G0, G0.6, and G1.2) showed that there were slight numerical differences among the groups in the percentages of carcass yield, thigh, breast, and fat, but no statistically significant differences were observed (*P* >0.05) (**Table 7**). Specifically, carcass yield was relatively stable, with values between 75.40% and 77.96%. The thigh and breast percentages showed minor variations, and fat content remained consistent across the groups. These results suggest that the treatments did not significantly affect the carcass characteristics of the chickens. However, previous studies have reported that GAA enhances protein deposition by increasing creatine availability, thus supporting muscle growth and lean mass accretion (Michiels *et al*., 2012; DeGroot *et al*., 2021).

The meat quality of the experimental chickens is shown in **Table 8**. In the breast meat, drip loss was higher in G0.6 and G1.2 compared to G0, however, this difference was not statistically significant (*P* >0.05). The pH24 also showed a slight decrease, with a significantly lower value in G1.2 (*P* <0.05). Cooking loss and pH15 were not significantly affected (*P* >0.05) by the treatments. Lightness and yellowness were higher in the treatment groups, while

Table 5. Average body weight gain of the experimental chickens (g $bird^{-1}$ day^{-1})

Stage (days)	G0	G0.6	G1.2
1-7	20.84 ± 0.41	20.63 ± 0.39	21.05 ± 0.65
7-14	48.29 ± 0.73	48.52 ± 0.84	51.13 ± 1.23
14-21	61.24 ± 1.17	63.63 ± 1.64	65.33 ± 2.27
21-28	105.52 ± 1.79	107.11 ± 2.27	107.95 ± 3.09
28-35	77.27 ± 3.77	82.12 ± 3.72	82.40 ± 2.98

Table 6. Feed intake and feed conversion ratios (n = 3)

Stage (days)	Feed intake (g bird^{-1} day^{-1})			Feed conversion ratio		
	G0	G0.6	G1.2	G0	G0.6	G1.2
1-7	21.33 ± 4.42	21.24 ± 4.41	21.08 ± 4.31	1.02 ± 0.21	1.03 ± 0.22	1.00 ± 0.21
7-14	60.95 ± 3.97	60.73 ± 3.95	60.67 ± 3.99	1.26 ± 0.08	1.25 ± 0.08	1.18 ± 0.07
14-21	85.71 ± 6.73	85.24 ± 6.57	85.40 ± 6.62	1.40 ± 0.11	1.34 ± 0.10	1.30 ± 0.10
21-28	144.76 ± 4.04	144.94 ± 4.40	144.29 ± 4.27	1.37 ± 0.04	1.35 ± 0.04	1.33 ± 0.03
28-35	150.48 ± 2.86	150.97 ± 2.44	150.47 ± 2.40	1.94^{a} ± 0.03	1.84^{ab} ± 0.02	1.82^{b} ± 0.02
Mean	92.65 ± 8.69	92.62 ± 8.72	92.38 ± 8.68	1.40 ± 0.07	1.36 ± 0.06	1.33 ± 0.06

Note: Means within the same row with different superscript letters differ significantly (P <0.05).

Table 7. Carcass traits of the experimental chickens (n = 6)

Items	G0	G0.6	G1.2
Live weight (g)	2330.30 ± 79.50	2366.70 ± 94.01	2436.50 ± 91.20
Carcass (%)	76.11 ± 0.76	75.40 ± 1.17	77.96 ± 0.49
Thigh (%)	19.02 ± 0.56	19.95 ± 0.85	20.42 ± 0.63
Breast (%)	28.73 ± 1.26	26.49 ± 0.58	27.89 ± 1.14
Fat (%)	2.33 ± 0.23	2.29 ± 0.30	2.37 ± 0.25

Table 8. Meat quality of the experimental chickens (n = 6)

Items	Breast			Thigh		
	G0	G0.6	G1.2	G0	G0.6	G1.2
Drip loss (%)	0.81 ± 0.17	1.37 ± 0.15	1.22 ± 0.18	0.66 ± 0.08	1.07 ± 0.17	0.71 ± 0.07
Cooking loss (%)	14.90 ± 0.92	16.16 ± 0.51	16.06 ± 0.71	22.99^{b} ± 1.34	27.42^{a} ± 1.10	23.75^{ab}±0.72
pH15	6.48 ± 0.05	6.52 ± 0.03	6.46 ± 0.04	6.47 ± 0.02	6.40 ± 0.04	6.45 ± 0.03
pH24	5.73^{ab} ± 0.01	5.75^{a} ± 0.01	5.71^{b} ± 0.01	6.00^{a} ± 0.03	5.93^{ab} ± 0.02	5.87^{b} ± 0.04
Lightness L*	55.57^{c} ± 0.39	61.48^{a} ± 0.50	58.88^{b} ± 0.36	57.34^{b} ± 0.71	61.59^{a} ± 1.07	60.14^{ab}±0.78
Redness a*	12.99^{a} ± 0.46	10.45^{b} ± 0.30	11.98^{a} ± 0.32	13.46^{a} ± 0.37	11.61^{b} ± 0.55	12.93^{ab}±0.38
Yellowness b*	31.39^{b} ± 0.91	35.74^{a} ± 0.57	34.17^{a} ± 0.58	33.69^{a} ± 0.73	29.28^{b} ± 1.85	33.28^{ab}±0.87
Tenderness (N)	36.64^{a} ± 1.84	30.81^{b} ± 0.90	39.14^{a} ± 1.51	30.10 ± 1.31	31.44 ± 1.34	32.02 ± 1.27

Note: Means within the same row and within the same meat part (breast or thigh) with different superscript letters differ significantly (P <0.05).

redness was lower in G0.6 (*P* <0.05). In the thigh meat, cooking loss was significantly higher in G0.6 compared to G0 (*P* <0.05). However, the other traits did not differ among treatments (*P* >0.05). Importantly, tenderness (measured by shear force) improved in birds fed GAA. In the breast meat, shear force was lowest in the G0.6 group (30.81 N) and highest in the G1.2 group (39.14 N) (*P* <0.05). This improvement in tenderness may be attributed to increased muscle energy availability from GAA-induced creatine synthesis, which helps maintain muscle cell integrity and supports post-mortem proteolytic processes. Overall, dietary supplementation slightly influenced the water-holding capacity but had no adverse effects on most of the meat quality parameters.

Conclusions

The present study confirms that dietary supplementation with guanidinoacetic acid

(GAA), particularly at a level of 1.2 g kg^{-1} feed, significantly enhances the growth performance, feed conversion ratio (FCR), and carcass yield in broiler chickens. The most pronounced effects were observed during the rapid growth and finishing stages, as indicated by increased average daily gains, improved FCR, and higher breast muscle yield. Importantly, GAA supplementation did not negatively affect the meat quality parameters; instead, it improved meat tenderness without altering the pH, color, or water-holding capacity. These results indicate that GAA, especially at 1.2 g kg^{-1}, supports more efficient feed utilization and improves meat quality without negative effects on the carcass, emphasizing its potential as a functional feed additive in broiler production. Further research under commercial farming conditions is recommended to evaluate its economic benefits and long-term impacts.

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