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Effect of guanidinoacetic acid supplementation on production performance of breeder Japanese quails#

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Abstract

The present study was conducted to evaluate the effect of guanidinoacetic acid (GAA) supplementation of breeder Japanese quails. A total of 240 birds (180 females and 60 males) were distributed into five dietary treatments using a completely randomized design, with each treatment consisting of four replicates, each replicate comprising 9 females and 3 males (3 female: 1 male). The birds fed with the basal diet, consisting of maize and soybean meal, provided 22 per cent of crude protein and 2650 kcal/kg of metabolizable energy. The treatments were: T1 (0 % GAA), T2 (0.05 % GAA), T3 (0.10 % GAA), T4 (0.15 % GAA) and T5 (0.20 % GAA). The results revealed that supplementation of GAA had no significant (P> 0.05) impact on body weight, feed intake and feed conversion efficiency. Dietary level of 0.15 % GAA had significant (P < 0.05) improvement in egg production during 15 to 18 weeks of age compared to control. Egg quality traits remained similar among the different treatment groups. The study suggests that supplementation of 0.15 % GAA in the diet improves egg production without compromising the growth performance of the birds.

Keywords: *Guanidinoacetic acid, Japanese quail, production, egg quality*

Over the past decade, India's poultry industry has seen rapid growth, fuelled by rising demand for poultry products due to population growth, higher incomes, and changing dietary habits. While broiler chickens and layer hens dominate, there is growing interest in Japanese quails valued for their rapid growth, early maturity and shorter generation interval. However, quails managed for reproduction often face inconsistent egg production, often linked to nutritional deficits impacting energy metabolism. Creatine, crucial for muscle function and cellular energy metabolism (Wyss and Kaddurah-Daouk, 2000), is naturally low in quails, especially since typical plant-based poultry diets lack creatine. A promising solution is the supplementation of synthetic GAA, a creatine precursor. The GAA is stable, cost-effective (Baker, 2009), and easily absorbed, boosting the creatine pool and enhancing production performance. Supplementing with synthetic GAA can conserve dietary arginine (Michiels *et al.,* 2012), which is crucial for growth and immune function, enhancing the overall performance of breeder quail in intensive production settings. This makes GAA a valuable addition to their diet for improved efficiency. In view of this, the current study was conducted to evaluate the effect of dietary supplementation of GAA on production performance of the breeder Japanese quails.

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Materials and methods

Experimental design

A total of 240 Japanese quails (180 female quails and 60 male quails) at 10 weeks age were randomly selected from the University Poultry and Duck Farm, Mannuthy. The birds were allocated to five dietary treatment groups, with each treatment having four replicates. Each replicate consisted of 12 quails, maintaining 3:1 female to male ratio. The allocation of birds to different treatments and replicates was done randomly. The birds were reared in cages (61 × 48 × 28 cm) of a 2-tier California cage system in a semi-monitored roofed house with open side walls. The birds received *ad libitum* feed and water, and a photoperiod of 16 hours per day was maintained from 10 to 22 weeks of age. The basal diet, formulated mainly based on maize and soybean meal, contained 22% crude protein (CP) and provided 2650 kcal/kg of metabolizable energy (ME). The five dietary treatments were: T1 (basal diet), T2 (basal diet + 0.05% GAA), T3 (basal diet + 0.10% GAA), T4 (basal diet + 0.15% GAA), and T5 (basal diet + 0.20% GAA). The birds were fed the experimental diet from 10 to 22 weeks of age. The GAA was procured from Novosynth Healthcare Private Ltd, Bengaluru, Karnataka (99.99 percent).

Growth, production performance and egg quality

Body weight and feed consumption were recorded every four weeks, and the feed conversion ratio (FCR) was calculated as the amount of feed (kg) consumed per dozen eggs produced. Daily egg production was recorded, with hen-housed and hen-day egg production estimated. For assessing the egg quality, five eggs from each reach replicated was collected for three consecutive days at four – week interval and analysed for both external and internal characteristics. External traits, including egg weight, length, and width, were measured using a digital scale and callipers. Shell thickness, without the shell membrane, was measured at the equatorial region, narrow, and broad ends with a digital screw gauge (0.001 mm accuracy), and the average was calculated. For internal traits, eggs were carefully broken onto a flat surface to measure albumen height using an Ame's tripod micromjeter, and yolk diameter was measured with callipers. The Haugh unit (HU) was calculated using the formula: HU = 100 log $[H - 1.7W^{0.37} + 7.6]$, where H is albumen height (mm) and W is egg weight (g) (Haugh, 1937). Albumen index was determined as the ratio of albumen height to the average of length and breadth (mm). The yolk index was determined as the ratio of yolk height to yolk diameter. Yolk colour was compared using Roche yolk colour fan. Shape index was calculated as a ratio of the length to the diameter of the egg. After breaking the egg, the yolk was gently separated and weighed, while the albumen was transferred into a Petri-dish for weighing. Additionally, shell weight was determined after drying, and the shell-to-egg weight ratio was calculated to assess shell quality. All measurements were conducted under controlled environmental conditions to ensure consistency.

Statistical analysis

Statistical analysis was performed using SPSS software to evaluate the data collected. Descriptive statistics, including means and standard deviations, were calculated for all parameters. A one-way ANOVA was performed to compare the means across different treatments, followed by post hoc tests used to identify significant differences between specific groups. Statistical significance was set at a p-value of less than 0.05 for all tests.

Results and discussion

Growth performance

Supplementing breeder Japanese quails' diets with GAA had no significant impact on growth performance, feed intake or feed conversion ratio during the experimental period and listed in Table 1. This lack of effect is likely due to the birds' mature age at the start of the experiment, as they had already reached their growth plateau by 10 weeks. The quails' metabolic focus at this stage is more on maintenance and reproduction rather than growth, limiting the potential influence of GAA. These findings are consistent with other studies involving mature birds, such as those by Rahmawati and Hanim (2022) and Taljaard (2022), where GAA supplementation did not significantly affect growth, feed intake, or feed conversion ratio. However, the results differ from studies involving younger birds, such as those by Ringel *et al*. (2007), Pradeep *et al*. (2016), Ren *et al*. (2018) and Ayssiwede *et al*. (2024), where GAA has been shown to improve growth and FCR. This highlights the importance of considering the growth stage when supplementing poultry diets with GAA.

Egg production

Hen housed and hen day egg production were presented in Table 1 and 2, respectively. Egg production was consistent across the different dietary treatments, with no significant differences observed during most of the experimental periods. This aligns with previous studies by Murakami *et al*. (2014), Carpena *et al*. (2015), and Sharideh *et al*. (2016), which also reported no substantial impact of GAA supplementation on egg production in various poultry species. However, a significant improvement in hen-day egg production was observed during weeks 15 to 18, with 0.05, 0.15, 0.20 per cent dietary level of GAA. This suggests that GAA supplementation may have a period-specific effect on egg production. The improvement seen during this specific period could be attributed to the potential optimization of energy metabolism, as GAA is a precursor to creatine, which is vital for energy storage and transfer

Table. 1 Effect of different levels of GAA in the diet on growth, production performance of breeder Japanese quails

Particulars	Treatments					F-value	p-value
	T1 (0% GAA)	T2 (0.05% GAA)	T3 (0.10% GAA)	T4 (0.15% GAA)	T5 (0.20% GAA)		
Body weight (g)	247.94±2.17	244.10±2.99	247.56±1.99	243.18±4.30	247.42±2.44	0.59	0.68
Feed consumption (g)	30.25±0.46	29.52±0.32	29.86±0.73	29.21±0.23	28.78±0.48	1.42	0.28
Feed conversion ratio (kg feed/dozen eggs)	0.42±0.003	0.42±0.013	0.44±0.013	0.39±0.011	0.39±0.014	2.95	0.06
Hen housed egg production (%)	87.67±1.55	85.92±3.21	83.66±1.20	90.31±0.78	89.49±1.55	2.12	0.13

Mean values based on four replicates with SE

Table 2. Effect of different dietary levels of GAA in the diet on hen day egg production of breeder Japanese quails, %

Age (weeks)	Treatments					F-value	p-value
	T1 (0% GAA)	T2 (0.05% GAA)	T3 (0.10% GAA)	T4 (0.15% GAA)	T5 (0.20% GAA)		
11-14	88.83±2.19	86.81±3.88	86.11±2.64	90.78±0.57	89.33±2.26	0.56	0.69
15-18	88.22^{ab}±0.51	89.11 ^{a}±2.38	84.12^{b}±1.38	92.24^{a}±0.69	92.17^{a}±1.14	5.82	0.005
19-22	87.67±4.54	81.84±7.29	85.02±2.5	90.46±1.66	89.75±2.03	0.73	0.59
11-22	88.40±1.89	85.92±3.21	85.02±1.36	91.17±0.92	90.40±1.31	1.99	0.15

Mean values based on four replicates with SE. Different superscripts (a, b) within a row indicate significant differences between treatments at $p < 0.05$

Table 3. Effect of supplementation of different dietary levels of GAA in the diet on egg quality traits of breeder Japanese quails

Particulars	Treatments					F-value	p-value
	T1 (0% GAA)	T2 (0.05% GAA)	T3 (0.10% GAA)	T4 (0.15% GAA)	T5 (0.20% GAA)		
Egg weight (g)	12.01±0.21	11.87±0.18	11.96±0.21	12.23±0.20	12.08±0.30	0.36	0.83
Shape index	77.91±0.16	77.48±0.42	77.87±0.53	78.06±0.63	77.48±0.36	0.35	0.84
Albumen index	0.112±0.004	0.116±0.004	0.114±0.001	0.116±0.003	0.114±0.001	0.46	0.77
Yolk index	0.450±0.001	0.466±0.003	0.456±0.007	0.456±0.005	0.464±0.005	2.03	0.14
Haugh unit	89.31±0.92	89.86±0.89	89.99±0.19	90.01±0.48	89.49±0.36	0.24	0.91
Yolk colour	4.7±0.02	4.7±0.03	4.6±0.01	4.6±0.03	4.7±0.08	5.63	0.23
Shell thickness	0.213±0.001	0.214±0.002	0.214±0.001	0.214±0.001	0.214±0.001	0.12	0.97
Shell per cent	12.26±0.06	12.16±0.23	12.23±0.19	12.15±0.25	12.24±0.12	0.12	0.97
Albumen per cent	57.96±0.30	57.35±0.56	57.73±0.46	58.09±0.59	57.55±0.59	0.34	0.85
Yolk per cent	29.78±0.29	30.49±0.36	30.04±0.29	29.77±0.35	30.21±0.50	0.68	0.62

Mean values based on four replicates with SE

within cells. This finding is somewhat supported by Raei *et al.* (2020), who reported a significant increase in egg production in laying Japanese quails group supplemented with 0.12 per cent GAA. These results indicate that while GAA may not consistently impact egg production, it could have beneficial effects during certain production phases when provided at appropriate levels.

Egg quality traits

The values of egg quality traits of eggs from breeder quails were presented in the Table 3. Supplementation of GAA did not significantly influence any egg quality traits in breeder Japanese quails across the various treatment groups during the experimental periods. Parameters such as egg weight (11.87 to 12.23 g), shape index (77.29 to 78.82), albumen index (0.111 to 0.118), yolk index (0.446 to 0.472), Haugh unit (89.31 to 90.01), yolk colour (4.6 to 4.8), shell thickness (0.213 to 0.215 mm), shell per cent (12.15 % to 12.26 %), albumen per cent (57.35 % to 58.09%), and yolk per cent (29.77% to 30.49%) showed no significant differences among the treatment groups.

These findings of the current study are consistent with those of Taljaard (2022), Garcia-Gomora *et al*. (2024), and Azizollahi *et al*. (2024), who also reported no significant effects of GAA on egg quality traits of Super Nick white laying hens. However, contrasting results were observed by Raei *et al*. (2020), who reported increase in egg weight, shell weight, albumen weight, and yolk weight in quails fed diets supplemented with 0.6, 1.2, and 1.8 g/kg of GAA. Similarly, Salah *et al*. (2020) found that higher dietary levels of GAA led to linear increase in shell ratio, shell thickness, yolk index, and Haugh units. These discrepancies highlight the variability in responses to GAA supplementation, possibly influenced by factors such as dosage, basal diet, age, bird species, and experimental conditions.

Conclusion

The results of this study demonstrate that GAA supplementation at a dietary level of 0.15% can significantly improve egg production in breeder Japanese quails, without negatively impacting overall growth performance or egg quality traits. Although GAA did not influence body weight, feed intake, or feed conversion ratio, the period-specific improvement in egg production between 15 to 18 weeks of age suggests that GAA supplementation may enhance energy metabolism during critical production phases. Egg quality traits remained consistent across all treatment groups, indicating that GAA supplementation does not compromise egg quality. These findings suggest that GAA supplementation can be a beneficial strategy for improving the reproductive performance of breeder Japanese quails, especially in intensive production settings. Further research is needed to explore the long-term effects of GAA supplementation and its impact across different growth stages.

Conflict of interest

The authors declare that they have no conflict of interest

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