Research Article

Effect of Adding Malic Acid into Feed and Water on Productive Performance Traits of Japanese Quail

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Abstract | This study assessed the impact of incorporating 0.8 g of malic acid into feed and water on the production of Japanese quail. A total of 120 unsexed Japanese quail chicks (7 days old) were randomly allocated into four experimental groups, each comprising three replicates of 10 birds. The quails were housed in cages of 50 cm by 100 cm, with four experimental treatments: (T1) control group with no additives, (T2) malic acid supplementation at 0.8 g/kg of feed, (T3) malic acid supplementation at 0.8 g/L of drinking water, and (T4) malic acid supplementation at 0.4 g/kg of feed and 0.4 g/L of drinking water. All birds had *ad libitum* assess to feed and water. The trial lasted for 48 days. The results demonstrated a significant modulation ($p \leq 0.05$) in productive performance viz., weight gain, final live weight, feed intake, and feed conversion rate (FCR) in all malic acid supplemented groups as compared to the control group. Similarly, carcass characteristics including carcass weight, dressing percentage, breast yield and thigh yield was increased ($p \leq 0.05$) in treated groups as compared to the control group. Treatments 3 and 4 exhibited the highest ($p \leq 0.05$) rates of improvement in performance variables (weight and FCR) relative to the other treatments. In conclusion, the incorporation of 0.8 g of malic acid into the feed and water resulted in optimal performance characteristics in Japanese quails.

Keywords | Japanese quail, Malic acid, Productive performance, Charcass, Weight gain

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INTRODUCTION

There is a growing interest in alternatives to antibiotic growth promoters due to their association with health concerns and the emergence of antimicrobial resistance (Roy *et al*., 2002). Consequently, researchers are focusing on mitigating microbial contamination in poultry farms, as the efficiency of poultry production and nutrient utilization is closely linked to the composition and activity of intestinal microorganisms (Huyghebaert *et al*., 2011). An effective, non-pharmaceutical antimicrobial agent that can be incorporated into feed or drinking water may enhance poultry performance. However, the use of organic acids may also pose a risk of water contamination if not properly managed (Chaveerach *et al*., 2004; Krug *et al*., 2012; Araujo *et al*., 2019).

Formic acid has been utilized since the early 1980s to improve broiler performance (Vogt *et al*., 1981). More recently, organic acids have gained attention for their potential to enhance avian productivity and protect feed from microbial degradation. Among these, malic acid plays a significant role in improving growth performance through nutritional and physiological mechanisms. By counteracting infections, it alleviates immune stress, thereby increasing nutrient availability for productive processes such as growth. Moreover, maintaining a low pH in the crop and proventriculus may improve protein digestibility (Ma *et al*., 2021; Al-Kuhla *et al*., 2023).

In addition, organic acids such as malic acid have been reported to enhance meat quality by supporting intestinal integrity and improving antioxidant status (Cai *et al*., 2025; Ma *et al*., 2021). Tomato seed powder, which is rich in malic acid, has been shown to help broilers maintain a balanced gut microbiota, reduce inflammation, combat oxidative stress, and improve meat quality (Mohamed and Bahnas, 2009; Qiu *et al*., 2022).

Therefore, administering malic acid through both feed and drinking water is expected to improve the sanitary quality of the rearing environment and enhance growth performance in poultry. This study aims to determine the effect of malic acid on the productive traits of Japanese quail when incorporated into feed, drinking water, or both.

MATERIALS AND METHODS

Animal housing and nutrition

All experimental procedures were conducted in accordance with national and international animal ethical guidelines. The experiment was carried out at the Poultry Farm, Department of Public Health, College of Veterinary Medicine, University of Basra, from September 15, 2023, to October 31, 2023.

A total of 120 unsexed Japanese quail chicks aged 7 days were used in this study. The birds were randomly allocated into four treatments, each with three replicates, and each replicate contained 10 birds. The quails were reared in a cage breeding system with cage dimensions of 100 × 50 cm.

The brooding temperature was maintained at 35°C during the first three days, reduced to 32°C for the following four days, and then gradually decreased to 24°C, which was maintained for the remainder of the 48-day experimental period. Throughout the trial, all birds had ad libitum access to feed and fresh water, and continuous 24-hour lighting was provided.

The birds were fed a basal diet containing 23% crude protein and 2921 kcal/kg metabolizable energy, formulated according to the National Research Council (1994) requirements. Based on findings from previous studies, 0.8 g of malic acid was identified as the optimal supplementation level. Therefore, this experiment compared the effects of adding malic acid to feed, drinking water, or both.

The treatments were as follows:

T1: Control group (no malic acid).

T2: 0.8 g malic acid per kg of feed.

T3: 0.8 g malic acid per liter of drinking water.

T4: 0.4 g malic acid per kg of feed + 0.4 g malic acid per liter of drinking water.

Table 1 presents the composition of the basal diet.

Productive performances

Live body weight (LBW) was recorded at both the beginning and the end of the experimental period using an electronic price computing scale. Based on these measurements, feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) were calculated.

The parameters were determined as follows:

Body weight gain (BWG, g):

$$\text{BWG} = \text{Final live body weight} - \text{Initial live body weight}$$

Feed intake (FI, g):

$$\text{FI} = \text{Feed offered during a specific period} - \text{Feed remaining at the end of that period}$$

Feed conversion ratio (FCR):

$$\text{FCR} = \frac{\text{Feed consumed (g)}}{\text{Body weight gain (g)}}$$

Carcass trait

At 48 days of age, 12 birds (6 males and 6 females) were randomly selected from each treatment group for carcass analysis. The birds were weighed individually, euthanized using the Islamic method of slaughter, and their carcass weights were recorded after evisceration. The yield of carcass cuts, including breast and thigh, was calculated as a proportion of the total carcass weight.

The dressing percentage (DP) was determined according to Brake *et al*. (1993) using the following formula:

$$\text{Dressing Percentage (DP)} = \frac{\text{Dressed weight (g)}}{\text{Live body weight (g)}} \times 100$$

Table 1: Basal diet composition provided to quails during the experiment.

Ingredients	Mize	Wheat	Soybean meal (48%)	Protein concentrate (44%)	Di calcium phosphate	Limestone	Minerals premix	Sodium chloride	DL Methionine	Total	Calculated composition[2]	Metabolizable energy	Crud protein	Crud fat	Crud fiber	Calcium	Phosphorus available
Basal diet (%)	50	8.75	34	5	0.5	1	0.3	0.3	0.15	100		2921	24	2.97	2.54	0.84	0.36

Statistical analysis

Data were statistically analyzed using one-way analysis of variance (ANOVA), and mean differences were compared using the least significant difference (LSD) test. Differences were considered statistically significant at P < 0.05. All analyses were performed using SPSS software (version 2021).

RSULTS AND DISCUTION

Live weight and total weight gain

Table 2 illustrates the effect of incorporating malic acid into water and feed on the final body weight and weight gain of growing Japanese quail. Significant differences (p ≤ 0.05) were observed among treatments in both final body weight and weight gain. Treatments 3 and 4 showed the highest values compared to the other groups, whereas the control group exhibited the lowest final body weight and total weight gain. Specifically, the treatment groups (T1, T2, T3, T4) recorded final body weights of 180.36 g, 186.44 g, 192.20 g, and 192.26 g, respectively, with corresponding weight gains of 153.26 g, 159.30 g, 165.10 g, and 165.06 g.

Table 2: The influence of adding malic acid into feed and water on productive performance of Japanese quail (mean ± standard error).

Treatments	IBW (g)	FBW (g)	WG (g)
T1	27.10 ± 0.04	180.36 ±0.47[c]	153.26 ±0.48[c]
T2	27.14 ±0.09	186.44 ±1.06[b]	159.30 ±1.10[b]
T3	27.10 ±0.10	192.20 ±1.39[a]	165.10 ±1.45[a]
T4	27.20 ±0.00	192.26 ±1.13[a]	165.06 ±1.13[a]
Sig.	N. S	*	*

abc: superscripts on the means in the same column indicate that there is a significant difference at p≤ 0.05, *: p≤ 0.05, T = treatment effect, IBW: initial body weight, FBW: final body weight, WG: weight gain.

The growth-promoting effects of organic acids are attributed to their ability to modulate the gastrointestinal microbiota, enhance gut morphology, stimulate the immune system, and increase the production of digestive enzymes (Chukwudi *et al*., 2025; Nguyen *et al*., 2018). Acidified water can lower gastrointestinal pH in poultry, promoting the proliferation of beneficial bacteria while reducing intestinal pathogen colonization (Ali et al., 2020; Christian *et al*., 2023; Van Bunnik *et al*., 2012). This, in turn, improves nutrient digestion and assimilation. Furthermore, the use of organic acids has been shown to enhance weight gain and nitrogen retention (Hamid *et al*., 2018; Desai *et al*., 2007). The intestinal microbiota plays a crucial role in both immunological and digestive functions, thereby supporting improved growth performance (Pandit *et al*., 2018). Organic acids have also been reported to increase villus height in the duodenum, further enhancing nutrient absorption (Ma *et al*., 2021; Al-Kuhla *et al*., 2023).

Feed consumption and feed conversion ratio

Table 3 shows a significant reduction (p ≤ 0.05) in feed intake and feed conversion ratio (FCR) in the additive-treated groups compared to the control, which exhibited the highest feed consumption and FCR. The treatment groups (T1, T2, T3, T4) recorded daily feed intakes of 154.44, 144.36, 142.14, and 142.71 g, respectively, with corresponding FCRs of 1.007, 0.906, 0.860, and 0.864.

Table 3: The influence of adding malic acid into feed and water on feed intake and feed conversion ratios of Japanese quail (mean ± standard error).

Treatments	FI (g)	FCR
T1	154.44 ±0.36[a]	1.007 ±0.00[a]
T2	144.36 ±0.91[b]	0.906 ±0.00[b]
T3	142.14 ±1.47[b]	0.860 ±0.00[c]
T4	142.71 ±2.06[b]	0.864 ±0.00[c]
Sig.	*	*

abc: superscripts on the means in the same column indicate that there is a significant difference at p≤ 0.05, *: p≤ 0.05, T = treatment effect, FI=feed intake, FCR=feed conversion ratio.

The improvement in FCR, particularly in groups supplemented with malic acid, may be attributed to the ability of organic acids to reduce pathogenic bacteria in the gastrointestinal tract. This reduction enhances intestinal function by creating an acidic environment that suppresses the viability of intestinal pathogens (Ebeid *et al*., 2022). A lower population of pathogenic bacteria reduces their metabolic demands, thereby increasing the availability of dietary energy and nutrients for the host (Parker *et al*., 2006; Ernesto *et al*., 2014; Nguyen and Kim, 2020), consistent with findings by Qiu *et al*. (2022) and Christian *et al*. (2023). The observed reduction in feed intake may also contribute to the improved FCR, as better nutrient utilization supports greater weight gain.

Carcass weight, dressing percentage, breast and thigh yield
Table 4 illustrates the effect of malic acid supplementation in water and feed on carcass weight, dressing percentage, and breast and thigh yields of Japanese quail. Significant differences (p ≤ 0.05) were observed among all treatments. The carcass weights for treatments T1, T2, T3, and T4 were 106.09 g, 112.78 g, 114.50 g, and 114.40 g, respectively. Corresponding dressing percentages were 58.70%, 60.51%, 60.44%, and 60.08%. Breast weights were 30.66 g, 32.29 g, 32.86 g, and 32.29 g, while thigh weights were 13.54 g, 14.28 g, 14.77 g, and 14.29 g, respectively.

Carcass evaluation is a key indicator of meat production and overall broiler performance (Malematja *et al*., 2023). The inclusion of organic acids has been shown to improve

Table 4: Effect of adding malic acid into feed and water on carcass, cuts weight, and dressing % of Japanese quail (mean ± standard error).

Treatments	Live weight (g)	Carcass weight (g)	Dressing %	Breast yield (g)	Thigh yield (g)
T1	180.70±0.86[c]	106.09±0.36[b]	58.70±0.28[b]	30.66±0.27[b]	13.54±0.29[b]
T2	186.33±1.49[b]	112.78±0.34[a]	60.51±0.29[a]	32.29±0.12[a]	14.28 ±0.04[a]
T3	190.45±0.45[a]	114.5 ±0.44[a]	60.44±0.09[a]	32.86±0.23[a]	14.77 ±0.14[a]
T4	190.40±0.64[a]	114.4±0.38[a]	60.08±0.05[a]	32.29±0.62[a]	14.29± 0.09[a]
Sig.	*	*	*	*	*

abc: superscripts on the means in the same column indicate that there is a significant difference at p≤ 0.05, *: p≤ 0.05, T = treatment effect.

growth performance in Japanese chickens and quails, resulting in increased live weight, carcass weight, and meat cuts (Daskiran *et al*., 2004; Nuh *et al*., 2009). Organic acids provide energy to avian tissues and slow glycolysis, thereby reducing lactic acid accumulation and promoting a more gradual post-slaughter pH decline (Ma *et al*., 2021). Overall, malic acid supplementation positively influenced live body weight, carcass weight, and cut yields in growing Japanese quail.

A limitation of the present study is the lack of biological validation, such as enzyme activity measurements or gut microbiota analysis, which could have provided mechanistic insights into the effects of malic acid on growth performance and carcass traits.

CONCLUSION

The results indicate that supplementation of malic acid in feed and water enhances growth performance and carcass characteristics in Japanese quail. Based on these findings, we propose a follow-up study to evaluate its effects on egg production and physiological parameters.

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NOVELTY STATEMENT

The incorporation of 0.8 g of malic acid into feed and water resulted in optimal performance characteristics for Japanese quail.

AUTHOR'S CONTRIBUTION

All the authors contributed equally to complete this paper.

Generative AI and AI-assisted technology statement

During the preparation of this manuscript, the author(s) utilized ChatGPT to paraphrase the initial draft in order to reduce similarity, improve language quality, and enhance readability. Following the use of this tool, the author(s) reviewed and edited the content as necessary and take full responsibility for the accuracy and integrity of the publication.

Conflict of interest

The authors have declared no conflict of interest.

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