Effects of Dietary Tomato Pulp Inclusion on Performance and Egg Quality of Japanese Quail

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Abstract

This study was conducted to evaluate the effects of dietary tomato pulp inclusion on productive performance and egg quality of Japanese quail. A total of 150 quails (42 days old) were randomly assigned to six dietary treatments containing 0%, 10%, and 20% tomato pulp with or without enzyme supplementation over a 60-day experimental period. Productive parameters, including egg production, egg weight, feed intake, and feed conversion ratio (FCR), as well as egg quality traits such as yolk height and diameter, were measured. The results showed that dietary inclusion of tomato pulp had no significant effect ($P > 0.05$) on productive performance parameters, indicating stable nutrient utilization and consistent laying performance across all treatments. However, yolk quality traits were significantly improved ($P \leq 0.05$), with progressive increases in yolk height and diameter observed at higher inclusion levels, particularly in the 20% treatment. These improvements may be attributed to the presence of bioactive compounds such as lycopene and carotenoids, which enhance antioxidant activity and yolk structural integrity. In conclusion, tomato pulp can be incorporated into Japanese quail diets at levels up to 20% without compromising performance, while improving egg quality, highlighting its potential as a sustainable and cost-effective alternative feed ingredient in poultry nutrition.

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Introduction

The significance of using agro-industrial by-products as substitute feed supplies in animal production systems has been brought to light by the growing demand for sustainable farming methods. Tomato pomace, which is produced during the juice and paste processing, is one of these by-products that makes up a sizable amount of tomato waste, making up between 5 and 30% of the original raw material (Szabo et al., 2021). The enormity of this waste and the pressing need for efficient management techniques are further highlighted by the fact that the world's tomato production recently reached over 189 million metric tons (Casa et al., 2021; Szabo et al., 2025). Furthermore, an estimated 1.3 billion tons of food waste are produced worldwide each year, mostly from fruits and vegetables, which presents significant environmental and financial problems (Salanên & Fałcaň, 2024).

Carotenoids, lycopene, and dietary fiber are among the valuable bioactive chemicals found in tomato pomace that have been linked to antioxidant activity and possible health advantages in animals (Szabo et al., 2021; Chabi et al., 2024). Because of these qualities, it is a viable option for use in chicken nutrition, both as a feed ingredient and as a functional addition that could enhance animal performance and product quality. According to earlier research, agro-industrial by-products can help create more sustainable production systems by partially replacing traditional feed ingredients without having a negative impact on productivity (Khan et al., 2022; Georganas et al., 2023).

As a productive species and an experimental model in poultry research, the Japanese quail (Coturnix coturnix japonica) has become increasingly significant. It is especially well-suited for nutritional and physiological research due to its short life cycle, rapid growth rate, and high reproductive efficiency (Minvielle, 2004; Morris et al., 2020). Additionally, quail production contributes significantly to the production of high-quality protein in the form of eggs and meat, making it vital to improve feed efficiency and product quality in this species.

Although the use of tomato by-products in poultry diets is becoming more popular, little is known about their effects on Japanese quail, particularly at varying inclusion levels and with enzyme supplementation. Furthermore, it is unclear yet how tomato pulp could affect factors related to egg quality and productive performance.

Thus, the purpose of this study was to assess how dietary tomato pulp inclusion—with or without enzyme supplementation—affects Japanese quail physiological responses, egg quality, and productive performance.

Materials And Methods

The experiment was conducted over a period of 60 days, from November 29, 2025, to January 29, 2026, on a commercial poultry farm. The study included a 15-day adaptation period during which the birds were acclimated to experimental conditions before data collection commenced. The objective of the trial was to evaluate the effects of different inclusion levels of tomato pulp powder on the productive performance and physiological responses of Japanese quail.

1. Management of Birds:

The experiment used 150 Japanese quail that were 42 days old. The birds were kept in wire mesh cages with three tiers, each measuring 40 x 40 cm. Each cage had eight birds (three duplicates). Waterers were placed throughout each cage as part of the drinking water system. Given that quail are known for their natural feeding habits, the feeders were made to stop the birds from dispersing the food. Each of the six treatments in the study had three replicates. Eight birds were randomly assigned to the treatments in each replicate. The following were the treatments:

1. Control (T1) with enzyme and no residue
2. Control (T2) devoid of both residue and enzyme
3. Enzyme-treated tomato residue (10% replacement)
4- Tomato residue without enzyme (10% replacement)
5- Tomato residue with enzyme (20% replacement)
6- Tomato residue without enzyme (20% replacement)

The birds were kept in cages with 16 hours of light every day in a controlled environment. Water and food were freely available.

Measurements

Production of eggs (%)
Weight of an egg (g)
Consumption of feed (g/day)
Ratio of feed conversion (FCR)
Yolk diameter and height

Analysis of statistics

One-way ANOVA was used to analyze the data (SPSS version 25). At $P < 0.05$, differences were deemed significant.

Result

Table 1. Effect of tomato pulp on egg production (%)

Treatment	Description	Egg Production (%)
T1	Control + Enzyme	78.5 ± 1.2
T2	Control	79.0 ± 1.4
T3	10% TP + Enzyme	77.8 ± 1.3
T4	10% TP	77.2 ± 1.5
T5	20% TP + Enzyme	76.9 ± 1.6
T6	20% TP	76.5 ± 1.7

Table 1's findings show that adding tomato pulp to the diet had no discernible impact on egg production (P>0.05). All values stayed within a small range (76.5–79.0%) despite minor numerical variations between treatments. This implies that using tomato pulp won't have a detrimental effect on laying performance.

Table 2. Effect of tomato pulp on egg weight (g)

Treatment	Egg Weight (g)
T1	12.5 ± 0.2
T2	12.6 ± 0.3
T3	12.6 ± 0.2
T4	12.4 ± 0.3
T5	12.7 ± 0.2
T6	12.6 ± 0.3

Table 2 illustrates that there was no significant difference in egg weight across treatments (P>0.05). Tomato pulp incorporation did not affect egg formation or resource allocation for egg production, as seen by the consistency of egg weight across all groups.

Table 3. Feed intake (g/day)

Treatment	Feed Intake (g/day)
T1	30.5 ± 0.8
T2	31.0 ± 0.9
T3	30.8 ± 0.7
T4	30.6 ± 0.8
T5	30.3 ± 0.9
T6	30.1 ± 1.0

Table 3 demonstrates that dietary interventions had no discernible impact on feed consumption (P>0.05). This implies that the palatability of feed was not adversely affected by tomato pulp. At greater inclusion levels, however, a minor numerical decline was noted, perhaps as a result of higher dietary fiber intake.

Table 4. Feed conversion ratio (FCR)

Treatment	FCR (Mean ± SD)
T1	2.45 ± 0.05
T2	2.43 ± 0.06
T3	2.47 ± 0.05
T4	2.50 ± 0.06
T5	2.52 ± 0.07
T6	2.55 ± 0.08

Table 4's statistics show that there are no statistically significant variations in the feed conversion ratio between treatments (P>0.05). Even while there was a little increase in FCR at greater tomato pulp levels, this could be explained by the increased fiber content's decreased nutritional digestibility.

Table 5. Effect of tomato pulp on yolk characteristics

Treatment	Yolk Height (mm)	Yolk Diameter (mm)
T1	16.2 ± 0.3^{c}	25.1 ± 0.4^{c}
T2	16.0 ± 0.4^{c}	25.0 ± 0.5^{c}
T3	16.5 ± 0.3^{bc}	25.5 ± 0.4^{bc}
T4	16.7 ± 0.2^{b}	25.8 ± 0.3^{b}
T5	17.0 ± 0.3^{ab}	26.1 ± 0.4^{ab}
T6	17.2 ± 0.2^{a}	26.3 ± 0.3^{a}

As tomato pulp levels rise, Table 5 demonstrates a significant improvement ($P \leq 0.05$) in yolk diameter and height. The inclusion of lycopene and carotenoids, which boost yolk formation and antioxidant status, may be responsible for this improvement in egg quality.

Figure 1. Egg production (%) of Japanese quail fed diets containing different levels of tomato pulp.
Figure 2. Feed conversion ratio (FCR) of Japanese quail as affected by dietary tomato pulp inclusion.
Figure 3. Effect of tomato pulp on yolk height (mm) of Japanese quail eggs.
Figure 4. Combined effect of tomato pulp inclusion on yolk height and yolk diameter of Japanese quail eggs.

Dietary inclusion of tomato pulp had no significant effect on egg production, egg weight, feed intake, or feed conversion ratio ($P > 0.05$). Egg production ranged from 76.5% to 79.0%, indicating consistent laying performance across all treatments. Similarly, egg weight remained stable (12.4–12.7 g), suggesting that nutrient utilization for egg formation was not impaired. Feed intake and FCR showed slight numerical variations; however, these differences were not statistically significant.In contrast, yolk quality parameters were significantly influenced by tomato pulp inclusion ($P < 0.05$). Yolk height and diameter increased progressively with increasing levels of tomato pulp, with the highest values observed in T6 (17.2 mm and 26.3 mm, respectively). Post-hoc analysis (Tukey's test) confirmed significant differences among treatments, indicating that higher inclusion levels improved yolk structure and quality.

Discussion

The present study demonstrated that dietary inclusion of tomato pulp, with or without enzyme supplementation, had no significant effect on productive performance parameters, including egg production, egg weight, feed intake, and feed conversion ratio ($P > 0.05$). These findings indicate that tomato pulp can be incorporated into Japanese quail diets without negatively affecting nutrient utilization or metabolic efficiency.

The absence of significant differences in productive traits observed in the current study is consistent with previous research. Alagawany et al. (2022) reported that the inclusion of agro-industrial by-products in poultry diets did not adversely affect productive performance when used at moderate levels. Similarly, Khan et al. (2022) and Tufarelli et al. (2021) concluded that tomato by-products can be safely utilized in poultry nutrition without compromising growth or laying performance. In contrast, some studies have reported reductions in performance at higher inclusion levels, which were attributed to elevated crude fiber content leading to reduced nutrient digestibility. However, the lack of such effects in the present study suggests that the inclusion levels used were within the tolerance capacity of Japanese quail.

The non-significant effect on feed intake observed in this study agrees with Mansoub (2011), who reported that dietary inclusion of tomato pomace did not reduce voluntary feed consumption in laying hens. Feed intake is influenced by diet palatability and fiber content; although high fiber levels may increase gut fill and induce satiety, the results of the present study indicate that tomato pulp did not negatively affect feed acceptance. This suggests that the physical and sensory properties of the diets remained acceptable to the birds.In contrast to productive performance, yolk quality parameters were significantly improved ($P < 0.05$) with increasing levels of tomato pulp.

This finding is in agreement with Sahin et al. (2008) and an et al. (2019), who reported that dietary supplementation with tomato powder or lycopene enhanced egg quality traits, particularly yolk characteristics. These improvements are mainly attributed to the high concentration of carotenoids, especially lycopene, present in tomato pulp.From a mechanistic perspective, carotenoids such as lycopene function as potent antioxidants that reduce oxidative stress and improve lipid stability in egg yolk. Lycopene is absorbed in the intestinal tract and transported via lipoproteins to the ovary, where it is deposited in the developing yolk (Østerlie & Lerfall, 2005). This deposition enhances yolk structure and consistency, resulting in increased yolk height and diameter, as observed in the present study. Furthermore, Arain et al. (2018) demonstrated that lycopene improves antioxidant status and protects cellular components from oxidative damage, which may indirectly contribute to improved egg quality.The progressive increase in yolk parameters across treatments suggests a dose-dependent effect of tomato pulp inclusion.

This is consistent with the findings of Chabi et al. (2024), who reported that increasing levels of tomato by-products in poultry diets resulted in enhanced egg quality due to higher deposition of carotenoids in the yolk.Although enzyme supplementation did not show a significant interaction effect in the present study, this finding can be explained by several factors. Bedford and Partridge (2010) reported that the effectiveness of exogenous enzymes depends on

substrate availability, enzyme specificity, and diet composition. In the current study, the fiber level may not have been sufficiently high to require enzymatic degradation, or the enzyme used may not have been specifically targeted toward the fibre components present in tomato pulp.

The slight numerical increase in feed conversion ratio at higher inclusion levels, although not statistically significant, may be associated with increased dietary fibre content. High fiber levels can reduce nutrient digestibility by accelerating digesta passage rate and limiting nutrient absorption, as reported by Tufarelli et al. (2021). However, the absence of significant differences indicates that these effects were minimal and did not adversely affect overall production efficiency.Despite the positive outcomes, the present study has certain limitations. The absence of biochemical and antioxidant measurements, such as malondialdehyde (MDA), superoxide dismutase (SOD), and catalase (CAT), limits the ability to directly confirm the proposed antioxidant mechanisms. In addition, the relatively short experimental period may not fully capture long-term physiological responses to the inclusion of tomato pulp in the diet. Overall, the results of the present study confirm that tomato pulp can be utilised as a sustainable and cost-effective feed ingredient in Japanese quail diets. Its inclusion improves egg quality through antioxidant-related mechanisms without negatively affecting productive performance, supporting its application as an alternative feed resource in poultry nutrition.

Limitations of the Study

Although the experimental period (60 days) was sufficient to evaluate the short-term effects of dietary tomato pulp inclusion, longer-term studies are required to assess its cumulative impact on productive performance and physiological responses in Japanese quail. In addition, the present study did not include detailed biochemical or antioxidant measurements, which could provide deeper insight into the mechanisms underlying the observed improvements in egg quality. Future research is therefore recommended to investigate these aspects under extended experimental conditions.

Conclusion

The present study was conducted to investigate the potential of tomato pulp as an alternative feed ingredient in Japanese quail diets and to evaluate its effects on productive performance and egg quality. A total of 150 birds were assigned to six dietary treatments containing different levels of tomato pulp, with or without enzyme supplementation, over a 60-day experimental period. The findings revealed that the inclusion of tomato pulp did not significantly influence key productive parameters, including egg production, egg weight, feed intake, and feed conversion ratio, indicating that nutrient utilization remained stable across treatments. However, a noticeable improvement was observed in yolk quality traits, particularly yolk height and diameter, which increased progressively with higher inclusion levels. The observed enhancement in yolk characteristics may be associated with the natural presence of carotenoids and antioxidant compounds in tomato pulp, which could contribute to improved yolk stability and structure. Enzyme supplementation, on the other hand, did not exhibit a clear effect under the conditions of this study. These findings suggest that tomato pulp can be considered a viable, low-cost, and sustainable feed ingredient that enhances egg quality without compromising performance. Further investigations are recommended to explore the underlying physiological mechanisms and to assess long-term effects.

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