



## Interactive effects of quail strain and dietary arginine on the chemical composition of the breast and thigh meat

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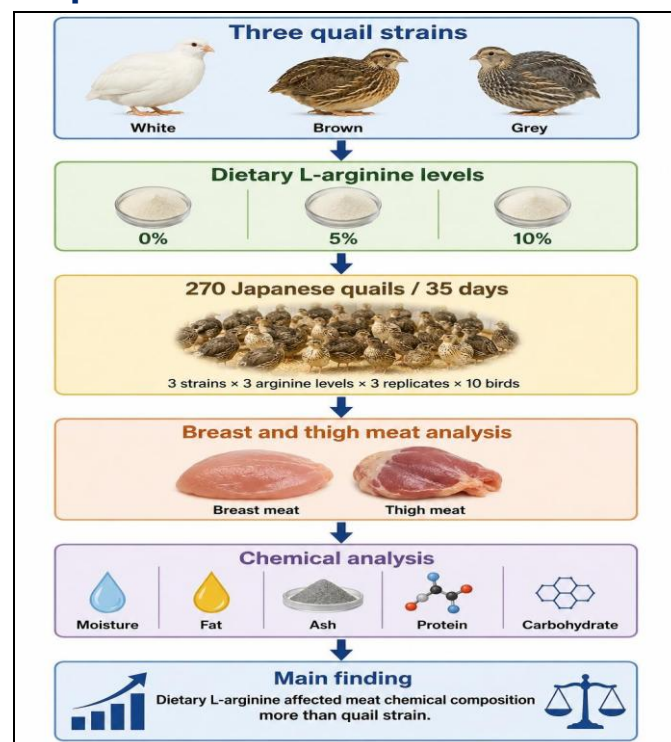
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### Abstract

This study was conducted to evaluate the interactive effects of quail strain and dietary L-arginine levels on the chemical composition of breast and thigh meat. A total of 270 one-day-old Japanese quail chicks from three strains (white, brown, and grey) were randomly assigned to a 3×3 factorial experimental design. The birds were fed diets supplemented with three levels of L-arginine (0%, 5%, and 10%) for a period of 35 days. The results indicated that dietary L-arginine significantly influenced the chemical composition of the meat. In breast meat, the 10% arginine group showed a significantly higher fat content (1.977%) compared to the 0% and 5% groups. Ash and carbohydrate contents in the breast were also significantly affected by arginine levels ( $p \leq 0.05$ ). In thigh meat, the 5% arginine level resulted in the highest protein content (25.542%), while the 10% level was associated with the highest fat (19.401%) and ash (0.43%) contents. In contrast, the quail strain did not significantly affect the chemical features of either breast or thigh meat, including moisture, fat, ash, protein, and carbohydrate levels. These findings suggest that nutritional intervention through arginine supplementation is a more dominant factor in determining meat quality than genetic strain under uniform environmental conditions. The study concludes that optimizing arginine levels, specifically at moderate concentrations, is essential for enhancing the nutritional value and production efficiency of Japanese quail.

**Keywords:** Japanese quail. L-arginine. Breast. Thigh.

### Graphical Abstract



Source: Own authorship.

### Introduction

Japanese quail (*Coturnix coturnix japonica*), which grows quickly and reproduces in poultry production as well, is one of the best [1,2] kinds of meat for health

reasons, which is high in protein and fatty components, which are favourable amino acids [3,4]. The chemical composition of quail meat (including breast and thigh meat) is one of the main factors in determining its nutritional value and economic quality, as reported by Noaman et al. [5], along with its genetic and nutritional composition. Different quail strains show differences in meat performance across various characteristics, including growth, meat colour, and nutrient concentration. So, identifying strain-related differences plays an important role in optimising meat production. Genetic factors do not solely determine diet; the amino acid composition is also vital for muscle growth and meat quality [6].

Arginine is a vital amino acid in poultry that is not involved in the urea cycle, thereby increasing blood flow and nutrient delivery to the body [7,8]. Furthermore, diets rich in arginine have been shown to promote beneficial growth traits and produce high-quality meat throughout the quail body [9,10]. Moreover, these facts are inhibited, and protein accretion is more rapid with arginine and fat deposition [11]. The birds' genetic background may influence the response to arginine supplements. A strain-acute amino acid response is an important yet little-studied aspect of nutrition in birds, but not the only answer.

Therefore, it was important to study the interaction between strain and arginine levels to optimise the feeding plan and meat quality. The present study examined the interaction between quail strain and arginine levels (measured in the diet) and their association with the chemical composition of breast/thigh meat.

## Materials and Methods

The current study used 270 one-day-old Japanese quail chicks from three strains: white, brown, and grey. The birds were randomly distributed in a 3 × 3 factorial experimental design, including three quail strains and three dietary L-arginine levels: 0%, 5%, and 10%. Each treatment combination included three replicates, with 10 birds per replicate. Therefore, the total sample size was 270 birds. This sample size was selected to provide adequate replication for comparing the effects of quail strain, dietary L-arginine level, and their interaction on the measured traits.

The experiment lasted for 35 days under standard management and environmental conditions, and feed and water were provided ad libitum. The studies were intended to be isoenergetic and isonitrogenous, according to the advice of the National Research Council [12], with L-arginine at different levels in the food (L-arginine 1,2 protein and protein 2,3 amino acid protein), according to the recommended quantities

provided in the trial and diet sequence used in this paper. The temperature of the food samples in a wet oven was recorded from a pre-clinical temperature (30 days for each trial) to 21 days after the original age at which they were bred in Japan, and fat and ash were stored at -20 °C in a dry room. The plant in the samples was distilled and dried using the same time system as before, and a variety of food chemicals were used to calculate the chemical composition.

Data were analyzed using SAS software, version 8.2 [13]. The experiment was arranged as a 3 × 3 factorial design, including three quail strains and three dietary L-arginine levels. Two-way analysis of variance (ANOVA) was used to examine the main effects of strain, arginine level, and their interaction. When statistically significant differences were detected, Duncan's multiple range test was used to compare means at  $p \leq 0.05$  [14]. Results are presented as mean ± standard error.

## Results

Based on the results of Table 1, L-arginine supplementation has had a relatively different effect on the quail breasts. Moisture content does not vary substantially across treatments, since the 5% arginine group (77.747%), despite the numerically lower arginine level (15.08%), did not have a positive impact on the meat's water-holding capacity. Similarly, protein content did not differ significantly across treatments. However, the control group was about 2-3 kg (23.138% and 10% arginine groups), indicating that arginine supplements did not increase protein levels in the breast. Protein content was significantly more sensitive to fat ( $p \leq 0.05$ ). At 10% arginine, 1.977 was much higher than 0% and 5% in terms of weight (0.744% and 0.647% groups).

Therefore, the presence of too much arginine may promote the presence of fatty proteins in breast muscle. The ash content was strongly affected ( $p \leq 0.05$ ), with the highest in the control group (0.266 ash content), followed by the 10% group (0.227 ash content). The 5% group (0.097 ash content), therefore, had lower mineral content, possibly due to dilution effects relative to tissue composition. The carbohydrate content was significantly affected by arginine ( $p \leq 0.05$ ), and it was significantly lower than in the 5% arginine comparison between the 0% & 10% groups (although still significantly low in general for muscle tissue).

Table 1. The effect of adding different levels of L-arginine on the chemical compositions of the quail breast meat (Mean ± Standard Error).

Composition	0% Arginine	5% Arginine	10% Arginine	Sig.
Moisture %	75.732±0.645	77.747±0.704	75.454±0.645	N.S.
Fat %	0.744±0.329 b	0.647±0.360 b	1.977±0.329 a	*
Ash %	0.266±0.010 a	0.097±0.011 c	0.227±0.010 b	*
Protein %	23.138±0.655	21.398±0.718	22.219±0.655	N.S.
Carbohydrate %	0.121±0.003 a	0.110±0.004 b	0.123±0.003 a	*

a-c Means within the same row with different superscripts differ significantly (p≤0.05). N.S.: Non-significant. Source: Own authorship.

Table 2 shows that there have been some differences between daily meals in the amino acid content and dietary L-arginine content in quail thigh meat. Although arginine content has a moderate effect on thigh moisture (59.348% of the study group), this is inversely proportional to the control group (60.562%, 10%) and the percentage of thigh (59.813%), as thigh moisture is not significantly affected by arginine supplements. Fat content (p ≤ 0.05) was significantly influenced; in the 10% arginine group, we found the highest (19.401%) and lowest (17.311%), while at 5%, 14.81% of the study group had lower fat content. This indicates that minimal arginine is associated with lower fat mass accumulation, whereas lower arginine increases fat concentration for the same reason. In relation to Ash content, the study group 10% Arginine (0.43%) had the highest abundance as compared with a control (0.339%) and the group 5% Arginine (0.098%). Protein content was significantly affected (p≤0.05 at the outcome level) in the control group (21.592%), which was significantly higher than in both the 5% (25.542%) and 10% (20.154%) groups.

Table 2. The effect of adding different levels of L-arginine on the chemical compositions of the quail thigh meat (Mean ± Standard Error).

Composition	0% Arginine	5% Arginine	10% Arginine	Sig.
Moisture %	60.562±0.852	59.348±0.933	59.813±0.852	N.S.
Fat %	17.311±1.149 ab	14.81±1.259 b	19.401±1.149 a	*
Ash %	0.339±0.022 b	0.098±0.024 c	0.43±0.022 a	*
Protein %	21.592±1.482 a	25.542±1.624 b	20.154±1.482 b	*
Carbohydrate %	0.197±0.005	0.202±0.005	0.200±0.005	N.S.

a-c Means within the same row with different superscripts differ significantly (P≤0.05). N.S.: Non-significant. Source: Own authorship.

The results in Table 3 indicate that quail strain did not significantly change the chemical features of breast meat. Moisture content is consistent among white (76.845%), brown (77.033%), and grey (75.055%) strains (no significant difference). Moreover, fat content is also consistent across the different strains, with very similar numerical values: the brown strain has about 0.902%, and the grey strain has almost 1.338%, with the brown strain in between. They all have very similar minerals, and they would be very

similar whether biological or not. However, the protein content in the grey strain is not necessarily much higher than in the white (21.725%) and brown (21.757%) strains.

Table 3. The effect of quail strains on the chemical compositions of the quail breast meat (Mean ± Standard Error).

Composition	White	Brown	Grey	Sig.
Moisture %	76.845±0.696	77.033±0.696	75.055±0.600	N.S.
Fat %	1.128±0.355	0.902±0.355	1.338±0.306	N.S.
Ash %	0.184±0.011	0.194±0.011	0.211±0.009	N.S.
Protein %	21.725±0.708	21.757±0.708	23.273±0.610	N.S.
Carbohydrate %	0.116±0.004	0.114±0.004	0.125±0.003	N.S.

a-c Means within the same row with different superscripts differ significantly (P≤0.05). N.S.: Non-significant. Source: Own authorship.

The data in the Table 4 will show that the quail strain did not affect the chemical composition of thigh meat. Despite the small differences, moisture content (White 60.462%, brown 59.816%, grey 59.445%) did not differ across all strains, indicating no difference. Also, fat content was the same across all strains, with slight numerical differences; the brown strain had the greatest lipid deposition (18.152%), while the grey strain had the least (16.504%). The ash content of thigh muscle was similar across strains, ranging from 0.283% to 0.293%, and thus the mineral content was relatively similar. Protein content, although higher in the grey strain (23.558%) relative to the white strain (22.193%) and brown strain (21.538%), did not differ significantly because all groups were the same statistical group.

Table 4. The effect of quail strains on the chemical compositions of the quail thigh meat (Mean ± Standard Error).

Composition	White	Brown	Grey	Sig.
Moisture%	60.462±0.920	59.816±0.920	59.445±0.793	N.S.
Fat%	16.867±1.241	18.152±1.241	16.504±1.070	N.S.
Ash%	0.283±0.024	0.291±0.024	0.293±0.021	N.S.
Protein%	22.193±1.601	21.538±1.601	23.558±1.380	N.S.
Carbohydrate%	0.198±0.005	0.199±0.005	0.202±0.004	N.S.

a-c Means within the same row with different superscripts differ significantly (P≤0.05). N.S.: Non-significant. Source: Own authorship.

## Discussion

This is, in turn, consistent with studies suggesting that protein is taken up more as lipogenic fat in poultry, whereas arginine leads to higher cholesterol and protein [15,16]. Protein content in the control group does not show a significant change. However, the protein content at 10% is not markedly different at the lower levels [16]. In 2018, arginine was shown to influence protein synthesis under both dose and

physiological conditions. Furthermore, shifts in ash and carbohydrate fractions help explain how arginine affects metabolic balance, rather than only major structural components. Similar findings are reported in quail studies by Al-Daraji et al. [17] and Abdel-Fattah et al. [18]; they found that high levels of arginine are crucial, as over-supplementation can affect meat quality.

Therefore, arginine levels increased in muscle tissue in the experimental design, and the change may be metabolic rather than anabolic. The glucose content was not significant across all treatments and was at least low in all groups, similar to muscle tissue. These results are partly in agreement with previous work, which showed that protein is predominantly deposited in poultry by eating arginine rather than by eating meat [15,16]. The substantial reduction in quail fat content after adding 10% arginine has been associated with improved fatty acid metabolism and reduced lipogenesis in these animals with high levels [19].

This lack of a clear positive effect on protein content confirms the insight of Wu et al. [20] that arginine-mediated protein synthesis is dose-dependent and determined by physiologic variables. Similar trends are consistent with quail studies [17,18] showing that adequate allocation of arginine, even when excessive, could affect meat quality. However, excessive arginine contributes to poor quality in animal proteins, including fish and other proteins.

As all treatments are roughly at the same statistical level. Since differences in genetic composition among the strains studied did not significantly influence protein deposition in breast muscle under the experimental conditions of our study, as would be expected for fatty tissue, carbohydrate content had no effect and was very low. These results mean that despite slight numerical variations in strain, quail strain was not an active element in establishing the chemical composition of breast meat. This is quite consistent with previous work indicating that genetic effects may decline when birds are reared under similar nutritional and environmental conditions [1,3]. Protein and fat content in breast meat were found to change substantially in our model [21,22], but since there was no significant difference in protein and fat content in our study and food quality for birds were given similar diet (a more typical factor) to the previous studies, no changes from the breed should have been detectable by genetic analysis. We know of results, also reported in poultry research, indicating that genetic impacts on proximate composition are less and less significant, and thus have much less effect when nutritional intervention is available [23-25].

This indicates that strains did not significantly

influence protein deposition in the thigh muscle. Also, carbohydrate content, though low for all strains, did not vary much among them. This is common in muscle tissue because it has low glycogen content. These study shows that although there was a small numerical difference between strains, quail strain did not have a great impact on the chemical composition of thigh meat and protein content, in line with previous work that indicates that the genetic impact on proximate composition of a bird may be negligible if this bird is raised in a uniform environment [1,3]. Although we find that genotype influences characteristics of this meat, as observed in meat quality as well [21,22], it makes sense that dietary and management factors play a greater role than genetic variation here. In broiler chickens, strain differences in chemical composition were observed to be limited in laboratory experiments [23,26-28].

### Study Limitations

This study was conducted under standard experimental conditions over 35 days. Therefore, the results may not be representative of all production systems or longer rearing periods. The study was also limited to three Japanese quail strains and three levels of arginine in the feed. Furthermore, the evaluation focused solely on the chemical composition of breast and thigh meat, excluding other meat quality characteristics such as sensory characteristics, fatty acid composition, and oxidative stability. Further studies under different conditions are recommended to confirm these findings.

### Conclusion

In conclusion, dietary L-arginine significantly influenced the chemical composition of quail meat, particularly fat and mineral contents, with moderate levels improving meat quality. In contrast, quail strain had no significant effect. These findings highlight the importance of optimising arginine supplementation to enhance nutritional value and production efficiency in Japanese quail.

### CRedit

**Author contributions:** All authors: Conceptualization, methodology, investigation, data collection, laboratory work, formal analysis, data interpretation, writing—original draft. Mohammed Sabah BahaAldeen: Supervision.

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Not applicable.

## Ethical Approval

Not applicable.

## Informed Consent

Not applicable.

## Funding

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## Data Sharing Statement

The datasets created and analyzed during this study are available upon reasonable request from the responsible author.

## Conflict of Interest

The authors declare no competing interests.

## Similarity Check

It was applied by Ithenticate®.

## Application of Artificial Intelligence (AI)

Not applicable.

## Peer Review Process

It was performed.

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