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Article

Effect of Dopamine Injection on Productive Performance Traits in Female Japanese Quail of Two Genetic Lines

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Abstract: The study was conducted in the Department of Animal Production, College of Agriculture and Forestry, University of Mosul, during the period from 1/2/2024 to 1/4/2025. The experiment aimed to inject birds from two lines of Japanese quail with dopamine. The study was designed to include two treatments as follows: T1 (control group) and T2 (dopamine injection group). Twenty-four birds were randomly allocated to the aforementioned treatments, which included three replicates per treatment, with four birds per replicate at a sex ratio of (3 females: 1 male) for each replicate from each genetic line. The results showed a significant superiority ($p \leq 0.05$) of the dopamine injection group compared with the control group in the overall mean of most productive traits, such as female body weight during the egg production stage, feed intake (g/female), feed conversion ratio (g feed/g egg), and egg mass (g). The present study aimed to investigate the effect of dopamine injection on the productive performance of female Japanese quail from brown and black lines, as well as on egg quality traits and some female reproductive system characteristics. Dopamine injection in birds resulted in the superiority of the black quail line in egg production performance compared with the brown quail line; therefore, selection programs for egg production can be adopted for this genetic line. A significant improvement in overall productive performance was also observed in birds injected with DOP compared with control birds. In contrast, the brown quail showed superiority in albumen height, Haugh unit, and number of large follicles.

Keywords: Dopamine, Neurotransmitter, japanese quail, sexual maturity and egg production

Introduction

Reproductive traits in poultry, such as egg production, are of significant economic importance in modern poultry production. Many environmental factors, including variation in feed availability and photoperiod length, are critically important for egg production [1]. However, recent studies have shown that reproductive traits also depend on genetic factors[2];[3].

Japanese quail represent an important source of meat and eggs and have played a major role in meeting the increasing human demand for animal protein in parallel with population growth in most countries worldwide. Its domestication and commercial improvement have increased due to its rapid growth rate, early sexual maturity (5–6 weeks), high egg production rate (250–300 eggs/year), short generation interval (3–4 cycles per year), small body size requiring limited rearing space, and low production costs in terms of housing and feeding compared with other farm animals[4];[5];[6]. In addition, its resistance to diseases, especially epidemic ones, and rapid return on investment have led to its widespread rearing worldwide [7].It is also used as a valuable model in scientific research and commercial production [8]. The average lifespan of quail ranges from two to two and a half years. A typical egg weighs about 10 g, representing approximately 8% of the bird's total body weight.

Due to its nutritional composition of proteins, vitamins, fats such as phospholipids, and polyunsaturated fatty acids, quail eggs are considered a functional food[9]. One of the main challenges in genetic improvement research is identifying genes associated with phenotypic and productive traits and determining gene polymorphisms responsible for these traits, which allows prediction of genetic effects on phenotypes. Therefore, reliance on molecular genetics is more effective than phenotypic selection, as all genetic information becomes available at early ages, enabling early selection and reducing production costs [10]. This approach has been widely used in behavioral, physiological, genetic, and biomedical studies[11]; [12]. The high nutritional value of quail eggs and meat makes them highly valuable[13]. Quail eggs have superior nutritional properties compared with other types of eggs and are rich in antioxidants, minerals, and vitamins [14]. They are widely consumed, especially in Asian countries. Despite their small size, their nutritional value is three to four times higher than that of chicken eggs. Regular consumption of quail eggs helps prevent various diseases and strengthens the immune system. Reports indicate that quail eggs contain higher levels of fat, protein, iron, riboflavin, vitamin B12, and docosahexaenoic acid (DHA) compared with chicken eggs[15]. In addition to their nutritional value, quail eggs are recognized in traditional medicine as a natural remedy for several respiratory and digestive system diseases[16]. Quail also serves as an excellent animal model for studying neuroendocrine control mechanisms in reproductive physiology and behavior within its social environment[17].

In male Japanese quail, visual cues appear to play a fundamental role in the perception of social context. The presence of a female, as well as mating activity, is known to rapidly reduce plasma testosterone levels in male quail [18]. In addition to prolactin regulation, dopamine contributes to maternal and other social behaviors such as sexual behavior, social bonding, dominance, and aggression. Prolactin is involved in maternal care in both mammals and birds and is essential for incubation and rearing processes. The dopaminergic system is regulated through dopamine receptor D1 (D1R), which stimulates expression, and dopamine receptor D2 (D2R), which inhibits it. Dopamine (DA) plays a central role in regulating reproductive behaviors in birds by influencing courtship, song, and parental care, although its precise role varies depending on behavior and species. It also regulates the sensitivity of certain behaviors to social and environmental cues [19].

Materials and Methods

This study was conducted at the field of the Department of Animal Production, College of Agriculture and Forestry, University of Mosul, during the period from 1/2/2024 to 13/4/2025, with the aim of investigating the effect of dopamine injection on the productive performance of two local quail lines (brown and black). This was carried out by injecting dopamine into the breast muscle at two stages, before and after sexual maturity. The study included, prior to the initiation of dopamine injection, the rearing of a quail flock consisting of two lines (brown and black) for two successive generations for the purpose of purifying the birds in terms of feather color, after observing the presence of many color segregations in the hatched chicks. The selection process began from the day of hatch and continued until 14 weeks of age (covering the growth and egg production stages) for two successive generations. After that, a third generation was reared for the purpose of applying the dopamine injection treatment to the birds included in the study.

Laboratory analyses were carried out at the University of Mosul with ethical approval number: um.VET.2021.5.

The experiment was designed to include two treatments as follows:
T1: control group.
T2: dopamine injection group.
At three weeks of age, 24 birds were randomly allocated to the above treatments. Each treatment consisted of three replicates, with each replicate containing four birds at a sex ratio of (3 females : 1 male) from each genetic line.
The first injection was administered at 32 days of age (before sexual maturity), after injecting the control birds with physiological saline solution. The injection dose was (0.2 ml/bird), administered intramuscularly in the pectoral muscle. Dopamine was administered after dilution, with four injections given on alternating days to avoid any adverse effects resulting from injection stress. In the same manner, injection was repeated during the egg production stage at 86 days of age, after production had reached its peak (peak production phase), to determine the effect of dopamine injection on egg production as an indicator of continuity. Birds were monitored after injection to prevent and observe any possible side effects.

Neurotransmitter Dopamine:

Dopamine hydrochloride used in this study was purchased from Solarbio Life Science (China). It has the molecular formula $C_8H_{11}NO_2 \bullet HCl$, a molecular weight of 189.64, and a purity of ≥ 98%. The quantity used was 5 g (Solarbio). As shown in the figure below (Figure 1).
Birds were reared in cages under identical environmental conditions and fed the same diet ad libitum, containing 18% crude protein and metabolizable energy of 2900 kcal/kg feed.
A completely randomized design (CRD) with a factorial experiment (2×2) was used, where the first factor represented the genetic strain (brown and black), and the second factor represented the treatment (control and dopamine injection), to study the effects of the main factors and their interaction on the productive traits under investigation.

Traits studied in the study:

1. Egg production stage:

1. **Live body weight:** The body weights of the birds for each genetic line were recorded weekly on an individual basis / sex / replicate using a digital balance.

2. Feed consumption: The quantities of feed consumed were recorded weekly (g/bird) according to the following equation [20];

$$\text{Feed intake} = \frac{\text{Weight of feed offered during the week} - \text{Weight of feed remaining at the end of the week}}{\text{Number of birds per replicate}}$$

3. Egg mass: Egg mass per female was calculated according to the equation reported by[21]. as follows:

$$\text{Egg mass(g/female)} = \frac{\text{Number of eggs produced weekly} \times \text{Average egg weight per week}}{\text{Number of females per replicate}}$$

4. Feed conversion: It was calculated according to the equation reported by[21]:

$$\text{Feed Conversion Ratio (g feed / g egg)} = \frac{\text{Amount of feed consumed during the week (g)}}{\text{Egg mass during the week (g)}}$$

2. **Egg qualitative traits:** Nine fresh eggs were taken from each treatment, with 3 eggs from each replicate and from each genetic line, in order to study egg quality traits as follows:

1. Egg length and width:

After measuring egg weight using a sensitive digital balance, egg length and width were recorded using a Dogmatic caliper (0.001 mm) by placing the egg longitudinally and transversely between the jaws of the caliper.

2. Albumen height (mm):

The egg was broken from the broad end using a fine scalpel and placed on a flat glass surface to measure albumen height by taking two readings: the first from the highest point of the thick albumen and the second from the thin albumen region, and then calculating the average of the two readings[21].

3. Yolk diameter (mm): After separating the yolk from the albumen and weighing each of them using the same sensitive balance, yolk diameter was recorded by placing the yolk between the jaws of the vernier caliper from two directions, and the average of the two readings was taken.

4. Yolk height (mm): Yolk height was measured by inserting the pointed end of the vernier caliper from the highest point of the yolk while it remained in its position, with high precision.

5. Shell weight (g) and shell thickness (mm): The shell of each egg, including its membranes, was weighed using the same digital balance. Shell thickness was then measured using a vernier caliper at three points: the broad end, the narrow end, and the middle, and the average of the three readings was calculated.

6. Egg shape index: It was calculated according to the equation reported [21]. As follows:

$$\text{Egg shape index (\%)} = \frac{\text{Egg width (mm)}}{\text{Egg length (mm)}} \times 100$$

7. Yolk index: It was calculated according to[2] as follows:

$$\text{Yolk index (\%)} = \frac{\text{Yolk height (mm)}}{\text{Yolk diameter (mm)}} \times 100$$

8. Haugh unit: It was calculated according to[21].

$$\text{Haugh unit} = 100\ \log(H\ + 7.57\ - 1.7\ w^{0.37})$$

Weight and measurements of parts of the female reproductive system:

The weights and lengths of certain parts of the female reproductive system were measured after being removed from the abdominal cavity of female carcasses.

1. Carcass weight (g): Carcass weight was measured using a sensitive balance after removing the head, wings, legs, and feathers.

2.Oviduct weight (g): The oviduct was weighed using a sensitive balance.

3. Oviduct length (cm): The length of the oviduct was measured using a metal ruler graduated to 50 cm.

4. Number of large follicles.

5. **Weight of large follicles (g):** The follicles were weighed using a sensitive balance.

6. **Number of mature follicles**.

7. Number of less mature follicles.

Result

Bird purification:

After the first hatch, many variations in feather color were observed among the hatched chicks; therefore, a purification process was carried out by rearing the birds for a complete generation. Eggs were collected at 14 weeks of age and hatched again for a second time. After hatching, variations in feather color were still observed, but they were relatively fewer. Therefore, the hatched chicks were reared for another generation for the same period, and eggs were collected and hatched again. At hatch, it was observed that the purity of feather color in the chicks reached 95%. Accordingly, the chicks became ready for the application of the injection treatment, representing the third generation of both lines. Previous studies have indicated that domestication processes in Japanese quail have led to the emergence of multiple strains exhibiting a wide range of feather colors and patterns[22]. It has also been found that feather color is associated with certain productive traits, including body weight[23], as well as reproductive traits[24], and egg quality traits[25].

Egg production stage, represented by the following traits: live body weight, feed intake, egg mass, and feed conversion ratio.

The statistical analysis results presented in Table (1) showed a significant superiority ($p \leq 0.05$) in favor of females of the black line compared with those of the brown line in body weight, which recorded values of 329.68 g and 314.78 g, respectively. Regarding the treatment effect, a significant superiority ($p \leq 0.05$) was observed for the DOP treatment compared with the control group, with values of 329.35 g and 307.25 g, respectively. For the interaction between treatments and genetic lines, a significant superiority ($p \leq 0.05$) was observed in mean body weight in favor of the DOP treatment in brown quail, which reached 336.70 g compared with the control group of both brown and black quail, as well as the dopamine-treated black quail. Regarding total feed intake, the same table indicated a significant difference ($p \leq 0.05$) between the brown and black lines, with higher values recorded in black quail compared with brown quail. However, no significant effect of genotype was observed on overall feed intake. In contrast, the interaction effect was significant ($p \leq 0.05$), where control black quail consumed the highest amount of feed (3400.00 g), significantly exceeding the control brown quail, which recorded

3218.92 g. A significant superiority ($p \leq 0.05$) was also observed in egg mass for black quail compared with brown quail, with mean values of 181.42 g and 175.67 g, respectively. The overall means of egg mass were 195.59 g and 134.45 g for the DOP and control treatments, respectively. Regarding the interaction between genetic line and treatment, the DOP-treated black quail achieved the highest egg mass (198.65 g), showing a significant superiority ($p \leq 0.05$) over both control groups of the two genetic lines (139.75 g and 129.59 g) as well as the dopamine-treated brown quail (192.52 g). Table (1) also illustrates the overall mean of feed conversion ratio (g feed/g egg). No significant differences were observed between the genetic lines. However, a significant effect ($p \leq 0.05$) of treatment was observed, where the DOP treatment showed better efficiency compared with the control group, recording values of 2.95 and 4.28 g feed/g egg, respectively. Regarding the interaction effect, the DOP treatment improved feed conversion efficiency in both genetic lines compared with the control. The values were (2.98 and 4.39) and (2.92 and 4.17) g feed/g egg for DOP and control groups in brown and black quail, respectively, with a general superiority of the black control group compared with the brown control group.

Table 1. Effect of genetic line, treatments, and their interaction on productive traits during the production period (mean ± standard error.

Factors			Female live body weight (18 weeks)	Total feed intake (g/female)	Egg mass (g/female) overall mean	Feed conversion ratio (g feed/g egg) overall mean
Genetic line		Brown	7.36±314.78 b	27.10±3299.58 b	175.67±8.19 b	0.18±3.38 a
		Black	5.58±329.68 a	22.68±3369.25 a	181.42±7.35 a	0.15±3.33 a
Treatment		Control	11.32±307.25 b	49.74±3309.46 a	134.45±3.06 b	0.06±4.28 a
		Dopamine	11.64±329.35 a	36.10±3330.96 a	195.59±1.94 a	0.04±2.95 b
Interaction	Brown	Control	5.66±294.03 b	61.20±3218.92 b	129.16±4.02 d	0.08±4.39 a
		Dopamine	23.80±336.70 a	50.23±3327.17 ab	192.52±1.24 b	0.06±2.98 c
	Black	Control	20.84±320.47 a	20.68±3400.00 a	139.75±1.62 c	0.04±4.17 b
		Dopamine	7.57±322.00 a	63.08±3334.75 ab	198.65±2.80 a	0.05±2.92 c

Different superscript letters within the same column indicate significant differences at ($p \leq 0.05$).

Egg quality traits, including the following characteristics: egg weight, yolk weight, albumen weight, albumen height, shell thickness, shell weight, yolk index, shape index, and Haugh unit

The statistical analysis results of Table (2) regarding egg weight indicated that there was no significant difference ($p \leq 0.05$) between the brown and black quail lines, with values of 13.83 g and 14.00 g, respectively. Regarding the treatment effect, a significant superiority ($p \leq 0.05$) was observed for the DOP injection group compared with the control group, with mean values of 12.33 g and 14.50 g, respectively. For the interaction effect, the DOP-treated brown quail showed the highest egg weight ($p \leq 0.05$), reaching 15.00 g, significantly exceeding the control groups of both brown and black quail, as well as the DOP-treated black quail, which recorded 14.00 g. The lowest egg weights were recorded in the control groups of brown and black quail, with values of 12.00 g and 12.67 g, respectively. Regarding yolk weight, there was no significant effect ($p \leq 0.05$) of genetic line. However, a significant superiority was observed for the DOP treatment compared with the control group, with mean values of 3.87 g and

4.60 g, respectively. For the interaction, the DOP-treated brown quail achieved the highest yolk weight (4.74 g), showing a significant superiority over the control groups of both genetic lines, which recorded 3.65 g and 4.08 g for brown and black quail, respectively. The statistical results also indicated no significant differences ($p \leq 0.05$) between genetic lines in albumen weight. However, a significant effect of treatment was observed, where DOP treatment showed higher albumen weight than the control group, recording 8.57 g and 7.29 g, respectively. Regarding the interaction, the highest albumen weight ($p \leq 0.05$) was recorded in DOP-treated brown quail (8.85 g), which significantly exceeded the control brown group (7.18 g) as well as the DOP and control black quail groups (8.28 g and 7.40 g, respectively). The results also showed a significant superiority ($p \leq 0.05$) of brown quail eggs over black quail eggs in albumen height, with values of 4.51 mm and 3.58 mm, respectively. No significant effect of treatment was observed for this trait. Regarding interaction, the highest albumen height was recorded in DOP-treated brown quail (5.00 mm), which was significantly higher than the black quail and the control brown group. For shell thickness, no significant differences ($p \leq 0.05$) were observed between the brown and black lines. Similarly, neither treatment nor interaction had a significant effect on this trait. Regarding shell weight, no significant differences were observed between genetic lines. However, a significant effect ($p \leq 0.05$) of treatment was recorded, where the DOP group showed higher shell weight than the control group, with values of 1.30 g and 1.14 g, respectively. The interaction showed that the highest shell weight was recorded in DOP-treated brown quail (1.38 g), which was significantly higher than all other groups, while the lowest value was observed in the control brown group (1.13 g). No significant effects ($p \leq 0.05$) of genetic line or treatment were observed for yolk index. However, the lowest value was recorded in the control brown group (35.07%), while the highest value was observed in DOP-treated black quail (38.29%). For egg shape index, no significant differences ($p \leq 0.05$) were found between genetic lines or treatments. However, the interaction effect showed that the highest value was recorded in the control brown group (80.98), which was higher than the control black group (74.15) as well as both DOP-treated groups. Regarding Haugh unit, a significant superiority ($p \leq 0.05$) was observed in favor of brown quail compared with black quail, with values of 88.04 and 82.36, respectively. No significant treatment effect was detected. However, the interaction showed that the highest Haugh unit was recorded in DOP-treated brown quail (90.14), which was higher than the control and DOP-treated black quail groups, while not differing significantly from the control brown group.

Table 2. Effect of genetic line, treatment, and their interaction on egg quality traits (mean ± standard error)

Factors			Egg weight (g)	Yolk weight (g)	Albumen weight (g)	Albumen height (mm)	Shell thickness (mm)	Shell weight (g)	Yolk index (%)	Egg shape index	Haugh unit
Genetic line		Brown	13.83±0.37 a	4.36±0.14 a	±0.20±8.18 a	4.51±0.19 a	0.61±0.01 a	1.26±0.03 a	39.5±1.75 a	77.16±1.14 a	88.04±1.06 a
		Black	14.00±0.28 a	4.42±0.10 a	±0.18±8.29 a	3.58±0.10 b	0.57±0.01 a	1.26±0.03 a	36.94±0.51 a	76.28±0.78 a	82.36±0.54 b
Treatment		Control	12.33±0.21 b	3.87±0.15 b	7.29±0.08 b	3.73±0.34 b	0.57±0.02 a	1.14±0.01 b	36.21±1.03 a	77.56±1.86 a	84.40±2.07 a
		Dopamine	14.50±0.34 a	4.60±0.14 a	8.57±0.20 a	4.38±0.31 a	0.62±0.01 a	1.30±0.04 a	37.98±1.05 a	77.19±1.86 a	86.82±1.70 a
Interaction	Brown	Control	12.00±0.00 c	3.65±0.10 c	7.18±0.12 d	4.24±0.56 bc	0.58±0.05 a	1.13±0.02 d	35.07±1.87 a	80.98±1.24 a	87.73±3.19 ab
		Dopamine	15.00±0.58 a	4.74±0.24 a	8.85±0.32 a	5.00±0.20 a	0.63±0.02 a	1.38±0.03 a	37.68±1.94 a	76.00±3.68 bc	90.14±1.21 a
	Black	Control	12.67±0.33 c	4.08±0.22 bc	7.40±0.10 d	3.22±0.11 d	0.55±0.02 a	1.15±0.02 c	37.35±0.71 a	74.15±2.02 c	81.07±0.45 d
		Dopamine	14.00±0.00 b	4.46±0.16 ab	8.28±0.14 bc	3.76±0.22 bcd	0.61±0.02 a	1.23±0.03 b	38.29±1.29 a	78.38±1.53 b	83.50±1.39 cd

Different superscript letters within the same column indicate significant differences at ($p \leq 0.05$).

Carcass weight and some weights and measurements of the reproductive system, represented by the following traits: oviduct weight, oviduct length, number of large follicles, weight of large follicles, number of mature follicles, and number of less mature follicles.

Table (3), which presents some female reproductive system traits, shows no significant differences in carcass weight between the brown and black quail lines. However, regarding the effect of treatment, the statistical analysis indicated a significant superiority ($p \leq 0.05$) in carcass weight for the DOP treatment compared with the control group, with values of 223.42 g and 204.33 g, respectively. No significant differences were observed in carcass weight due to the interaction between genetic line and treatment. With respect to oviduct weight, no significant effect of genetic line or treatment was observed. However, the interaction effect was significant, as the control brown quail showed the highest oviduct weight (9.67 g), significantly exceeding the DOP-treated brown and black quail as well as the control black quail. Regarding oviduct length, neither genetic line, treatment, nor their interaction showed any significant effect on this trait. For the number of large follicles, a significant superiority ($p \leq 0.05$) was observed in brown quail compared with black quail, with values of 1.21 and 0.92, respectively. However, no significant effects were observed for treatment or interaction. As for the weight of large follicles and the number of mature follicles, the statistical analysis showed no significant effects of genetic line, treatment, or their interaction on these traits. The treatment had a significant effect on the number of less mature follicles, where the DOP treatment recorded the highest number (32.33 follicles), significantly exceeding the control group. Regarding the interaction, the highest number of less mature follicles was observed in DOP-treated brown quail (36.50 follicles), whereas the lowest values were recorded in the control groups of brown and black quail, with 23.50 and 26.00 follicles, respectively. The superiority of dopamine treatments may be attributed to findings from previous studies, which indicated that dopamine (DA) plays a crucial role in prolactin (PRL) secretion through D1 dopamine receptors (DRD1) at the hypothalamic level, while it inhibits prolactin secretion via D2 receptors (DRD2) at the pituitary level through the action of vasoactive intestinal peptide (VIP)[26];[27];[28]. It has also been reported that dopamine influences neuronal activity and regulates the reproductive system by affecting VIP secretion, which in turn stimulates prolactin release[29]. A significant relationship has been reported between the genetic structure of the dopamine receptor D1 gene and egg production traits[30]. In addition, several neurotransmitters, including dopamine, serotonin, and gamma-aminobutyric acid (GABA), play key roles in regulating feed intake in birds [31],[32],[33],[34],[35].In general, dopamine reduces physiological and metabolic processes, and dopamine injection decreases intestinal contractions and motility in injected chicks[36]. The superiority of black-feathered quail eggs over brown-feathered quail eggs in terms of albumen height and Haugh unit may be attributed to the significant superiority in egg mass and feed conversion ratio of black quail compared with brown quail.

Table 3. Effect of genetic line, treatment, and their interaction on some female reproductive system traits (mean ± standard error)

Factors			Carcass weight (g)	Oviduct weight (g)	Oviduct length (cm)	Number of large follicles	Weight of large follicles (g)	Number of mature follicles	Number of less mature follicles
Genetic line		Brown	212.17±3.99 a	9.00±0.25 a	37.60±0.99 a	1.21±0.08 a	3.42±0.12 a	3.13±0.13 a	34.33±1.98 a
		Black	217.83±4.73 a	8.46±0.58 a	±2.21±37.06 a	0.92±0.06 b	3.29±0.23 a	3.46±0.28 a	35.21± 3.3 a
Treatment		Control	204.33±7.77 b	8.92±0.38 a	±1.22±36.46 a	1.00±0.00 a	3.50±0.15 a	3.33±0.22 a	24.75±3.58 b
		Dopamine	223.42±4.38 a	7.92±0.62 a	±2.42±35.92 a	1.00±0.12 a	3.09±0.34 a	3.42±0.4 a	32.33±3.31 a
Interaction	Brown	Control	200.33±9.57 a	9.67±0.49 a	±1.7±36.83 a	1.00±0.00 ab	3.50±0.22 a	3.33±0.21 a	23.50±2.11 d
		Dopamine	228.50±5.74 a	8.50±0.43 bc	±1.78±36.33 a	1.17±0.17 ab	3.60±0.24 a	3.17±0.31 a	36.50±1.95 ab
	Brown	Control	208.33±12.96 a	8.17±0.40 c	±1.91±36.08 a	1.00±0.00 ab	3.50±0.22 a	3.33±0.42 a	26.00±2.44 c
		Dopamine	218.33±6.42 a	7.33±1.17 d	±4.74±35.5 a	0.83±0.17 b	2.67±0.56 a	3.67±0.76 a	28.17±6.12 b

Different superscript letters within the same column indicate significant differences at ($p \leq 0.05$).

Discussion

The present findings demonstrate that dopamine administration can influence the productive performance of female Japanese quail, although the magnitude of the response depends on genetic line and the specific trait evaluated. Dopamine-treated birds showed a significant improvement in female live body weight, egg mass, and feed conversion ratio compared with the control group. In particular, egg mass increased from 134.45 g in the control treatment to 195.59 g following dopamine administration, while the feed conversion ratio improved from 4.28 to 2.95 g feed/g egg. These findings indicate that dopamine may contribute to more efficient utilization of nutrients for productive and reproductive processes. The response may be related to the physiological role of dopamine as an important neurotransmitter involved in neuroendocrine regulation, feeding behavior, and reproductive activity in birds. Previous studies have demonstrated that dopaminergic pathways participate in regulating reproductive behavior and physiological responses through interactions between the hypothalamus and endocrine system [19]. Therefore, the improvement observed in the present study suggests that dopamine administration may modify physiological mechanisms associated with production efficiency rather than merely increasing feed consumption.

Genetic line also contributed substantially to variation in productive performance. The black line exhibited a significantly greater female body weight and egg mass than the brown line, indicating that genetic background remains an important determinant of productive potential even when birds are maintained under identical environmental and nutritional conditions. Earlier research has demonstrated associations between plumage-related genetic variation and productive characteristics such as growth and feed consumption [23], while genotype has also been associated with reproductive parameters and body weight in Japanese quail [24]. The significant line-by-treatment interactions observed in this study further indicate that the physiological response to dopamine is not necessarily uniform across genetic backgrounds. For example, dopamine-treated brown quail exhibited the highest body weight, whereas dopamine-treated black quail produced the highest egg mass. Such differences suggest a possible interaction between dopaminergic regulation and genotype-specific physiological characteristics. Consequently, the productive effects of dopamine should be interpreted together with genetic background rather than as an independent treatment effect.

Dopamine administration also affected several egg quality characteristics. The treatment significantly increased egg weight, yolk weight, albumen weight, and shell weight, whereas albumen height, shell thickness, yolk index, egg shape index, and Haugh unit were not consistently influenced by treatment. The highest egg weight, yolk weight, albumen weight, albumen height, shell weight, and Haugh unit were generally observed in dopamine-treated brown quail, demonstrating a favorable interaction between dopamine administration and the brown genetic line for several internal egg-quality characteristics. Conversely, the brown line itself exhibited significantly greater albumen height and Haugh unit than the black line. These findings are important because egg quality is a complex phenotype determined by genetic background, reproductive physiology, nutrient utilization, and environmental conditions. Previous research has similarly established relationships between laying characteristics and egg-quality traits in Japanese quail [8], while genetic variation and plumage characteristics have also been associated with differences in productive and egg-quality traits [25]. Thus, dopamine appears to improve selected quantitative components of egg formation, although its effects on structural and internal quality characteristics are more dependent on genetic line.

The reproductive-system measurements provide further evidence that the effects of dopamine extend beyond general productive performance. Dopamine-treated females exhibited significantly greater carcass weight than control birds, while the number of less mature follicles increased markedly following dopamine administration. In contrast, oviduct weight, oviduct length, weight of large follicles, and number of mature follicles were generally unaffected by treatment. The brown line had a significantly greater number of large follicles than the black line, demonstrating that follicular development was also influenced by genetic background. The increase in less mature follicles following dopamine treatment may indicate modification of follicular recruitment or reproductive endocrine activity. Dopamine is known to participate in the regulation of prolactin secretion through D1 and D2 dopamine receptors at hypothalamic and pituitary levels [26], [27]. The dopaminergic system also

changes across reproductive stages in birds [28], supporting the possibility that dopamine administration influences ovarian activity through neuroendocrine mechanisms. Furthermore, genetic variation in dopamine receptor genes has previously been associated with growth and egg-production characteristics [30].

The improvement in productive performance should also be considered in relation to dopamine-mediated regulation of feed intake and gastrointestinal function. Several neurotransmitter systems, including dopamine, serotonin, and gamma-aminobutyric acid, participate in the central regulation of feeding behavior in poultry [31]–[35]. However, dopamine may also reduce gastrointestinal contractions and intestinal motility in chicks [36]. Therefore, the improved feed conversion observed in dopamine-treated quail may reflect changes in metabolic and neurophysiological regulation rather than an increase in feed intake alone. This interpretation is consistent with the present results because treatment did not produce a significant overall increase in feed intake, despite substantial improvements in egg mass and feed conversion efficiency. Accordingly, dopamine may enhance the allocation or utilization of available nutrients toward productive functions. Nevertheless, the mechanisms underlying this response require further investigation using measurements of circulating reproductive hormones, dopamine receptor expression, gastrointestinal activity, and metabolic indicators.

Overall, the findings indicate that dopamine administration and genetic line jointly contribute to variation in productive performance, egg quality, and selected reproductive characteristics of female Japanese quail. The black line demonstrated advantages in important production-related traits, particularly body weight and egg mass, whereas the brown line showed advantages in albumen height, Haugh unit, and the number of large follicles. Dopamine treatment produced particularly pronounced improvements in egg mass, feed conversion efficiency, selected egg components, carcass weight, and the number of less mature follicles. These results support the potential importance of dopaminergic regulation in poultry production and suggest that responses to dopamine may differ according to genetic background. However, because the experiment involved a relatively limited number of birds and evaluated only two genetic lines, the findings should be interpreted cautiously. Further studies involving larger populations, multiple dopamine doses, additional genetic lines, hormonal profiling, and molecular analysis of dopamine receptors are required to clarify the biological mechanisms and determine whether the observed responses can be consistently reproduced under different production conditions.

Conclusion

The results showed a significant improvement in overall productive performance in birds injected with DOP compared with control birds. The brown quail showed superiority in average body weight, egg weight, and albumen height, while shell weight was higher in eggs from the DOP-treated brown quail. It also showed superiority in Haugh unit and number of large follicles. Moreover, the DOP treatment was the best in terms of carcass weight.

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