



Exogenous Dopamine Improves Reproductive Efficiency and Hatchability in Genetically Divergent Japanese Quail Lines

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ABSTRACT

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Dopamine is a neurotransmitter that plays an essential role in functions in birds and mammals such as motivation, mood, attention, memory, and movement coordination. This study aims to assess the impact of dopamine injection in two quail lines, namely brown and black Japanese quail breeds, on productive, sexual, and hatchability traits. Furthermore, the third generation was reared to receive dopamine treatment, administered intramuscularly into the breast muscle at a dose of 0.2 mL per bird to a final concentration of 20 μ M. The treatments were applied as follows: group T1 was the control group, and group T2 was the dopamine injection group. A total of 24 birds were randomly allocated to the previously mentioned treatments, each consisting of three replicates, with four birds in every replicate at a sex ratio of (3 females: 1 male) for each genetic line. Accordingly, the findings revealed notable superiority ($p \leq 0.05$) of dopamine injection over the control group in most sexual traits, including age at sexual maturity, which occurred earlier. It also improved fertility percentage and hatchability percentage and reduced embryonic mortality compared with the control group. It also produced the highest fertility rate in brown quail (100%) and the highest hatchability rate in black quail (97.04%). The results showed genetic differences between the lines, evidenced by higher egg production, better feed conversion, faster sexual maturity, and increased hatchability. We conclude that dopamine's positive effect comes from its role in inhibiting prolactin, reducing brooding, and supporting continuous production.

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Introduction

Among avian species, Japanese quail are among the most commonly reared birds for both meat and egg production. It is also among the most frequently used laboratory animals in scientific research due to its numerous advantages: small body size, disease resistance, dual-purpose use (meat and eggs), and low rearing costs compared to other poultry, as well as high egg production, with shorter generation intervals, early sexual maturity, and higher growth rate than other birds (Ahmed, 2022; Kayang *et al.*, 2004; Minvielle, 2004; Molino *et al.*, 2015). The reproductive traits of poultry, such as egg production, are of significant economic importance in modern poultry production. Studies have shown that the reproductive performance of female poultry is subject to numerous environmental factors, ranging from various nutritional aspects, such as varying feed quantities (Pereira *et al.*, 2020; Yin L *et al.*, 2023), to lighting conditions where the duration of the light period (long or short) is extremely critical for egg production (Lewis *et al.*, 2004; Oso *et al.*, 2022; Shi *et al.*, 2020). Increasing the genetic economic value of birds through the selection of multiple traits is the ultimate goal for all poultry breeders (Narinc *et al.*,

2014). Modern poultry production aims to increase egg production and inhibit broodiness behavior; therefore, numerous investigations have been conducted on the genetic basis underlying egg production and incubation via the analysis of candidate genes, particularly for the prolactin (PRL) gene (Zhou *et al.*, 2022). It is recognized to be essential for initiating and maintaining incubation behavior in birds. In addition, other factors such as dopamine exert important effects on PRL secretion. (Ben-Jonathan and Hnasko, 2001). Despite the important genetic and physiological role of dopamine, applied studies on the effects of direct injection of dopamine on the reproductive and productive performance of quail remain limited. The dopamine receptor D1 (DRD1) is involved in the regulation of reproductive behavior in chickens, although the prolactin (PRL) gene remains essential for initiating and maintaining these reproductive behaviors in birds. In quail, dopamine has complex and sometimes contradictory effects on behavior, primarily regulating sexual activity, aggression, and reward-seeking. The specific outcome depends on whether dopamine activates D1 or D2 receptors and the brain region it activates dopamine also has been implicated in the regulating of appetite as well as numerous other functions of which include motor activity, movement regulation, cognition emotion, reward, motivation and positive reinforcement of food intake, memory, and neuroendocrine functions within the central nervous system. In addition, it modulates the secretion of pituitary hormones such as prolactin and alpha-melanocyte-stimulating hormone, as well as influencing cardiovascular and renal functions and gastrointestinal motility. (Ikemoto, 2007; Beaulieu, 2011; Ben-Jonathan & Hnasko, 2001). Thus, the reason for our study was to look into the effect of dopamine injection and its association with productive performance and hatching traits for two local quail lines.

Dopamine

Dopamine is a neurotransmitter and hormone in the body that functions to transmit signals between neurons. It plays a role in functions such as motivation, mood, attention, memory, learning, and the coordination of movements. It is a chemical substance synthesized in the brain and kidneys, acting as a neurotransmitter to relay messages between nerve cells and as a hormone affecting various parts of the body. Chemically, dopamine belongs to the catecholamine and phenethylamine groups and is synthesized from the amino acid "tyrosine" (Gregory, 2017). Dopamine is secreted in pleasant situations, such as happiness or upon seeing food, which motivates the individual to seek these rewards. It plays a role in the ability to think and plan, helps with concentration and attention, and is linked to mood and behavior; imbalances in its levels may be associated with conditions such as Attention Deficit Hyperactivity Disorder (ADHD) (Ben-Jonathan & Hnasko, 2001; Ikemoto, 2007). Dopamine has a molecular weight of 153.18 g/mol and is represented by the chemical formula $C_8H_{11}NO_2$, consisting of a catechol structure attached to an ethyl chain. The chemical formula shows indicating that a dopamine molecule is composed of 8 carbon (C) atoms, 11 hydrogen (H) atoms, one nitrogen (N) atom, and two oxygen (O) atoms. It was named to refer to its chemical structure, as the compound is derived from its precursor, dihydroxyphenylalanine (DOPA); since dopamine also contains a functional amine

group, the full name becomes "dopamine" (Fahn, 2008). Dopamine possesses five receptor subtypes (DRD1–DRD5), which are traditionally classified into two main groups: D1-like receptors (DRD1 and DRD5) and D2-like receptors (DRD2, DRD3, and DRD4), according to their pharmacological, biochemical, and physiological characteristics. (Xu *et al.*, 2010). In birds, dopamine plays an essential role in prolactin secretion, the place it promotes its launch by using D1 receptors in the hypothalamus, whilst inhibiting its secretion via D2 receptors (DRD2) in the pituitary gland, involving a vasoactive intestinal peptide (Xu *et al.*, 2011a). Prolactin is a negative regulator of avian reproductive activity, such as broodiness behavior; pituitary secretion of prolactin is inhibited by (DRD2), which prevents broodiness activities and improves production (Reddy *et al.*, 2007)

Materials and Methods

Study Location and Duration:

From February 1, 2024, to April 1, 2025, this study was conducted at the Department of Animal Production chicken farm, Agriculture and Forestry College/ Mosul University.

Ethical Approval:

The experiment was conducted after obtaining the necessary ethical approvals from the Research Ethics Committee at the University of Mosul (Approval No. um.VET.2021.5).

Purification of the birds:

The study included, prior to the initiation of dopamine injection, rearing the two quail lines for two successive generations for the purpose of flock purification, starting from the day of hatching until 14 weeks of age (growth and egg production phases), in order to purify the birds in terms of feather color after observing many color segregations in the hatched birds. The third generation was reared to apply the dopamine injection treatment to the birds of the study.

Experimental Animals and Treatments:

The experiment was set up to provide evidence of the effect of dopamine injection on two lines of local Japanese quail. The study included two treatments as follows

T1: served as the control group and received 0.2 mL of normal saline.

T2: served as the dopamine treatment group and received 0.2 mL of dopamine using the same injection procedure.

At three weeks of age 24 birds had been randomly allotted for the redress described above, 3 replication were used in each treatment and each replicate containing four birds at a sex ratio of (3 females to 1 male) . for each replicate of each genetic line (Brown line and Black line).

Dopamine Injection Procedure:

Dopamine was injected into the breast muscle (Pectoralis major) in two stages:

1. **Stage One (Pre-Sexual Maturity):**) Injections were initiated at 5 weeks of age using a final dopamine concentration of 20 μ M in a volume of 0.2 mL per bird after appropriate dilution. The concentration was determined experimentally based on a preliminary practical trial. The solution was administered intramuscularly using a short-needle insulin syringe. The injection was repeated four times, with one day of rest between each dose.

2. **Stage Two (Peak Production):** The injection process was repeated at 13 weeks of age, which represents the period of peak egg production.

Dopamine Specifications:

The dopamine used in this study was **Dopamine Hydrochloride** purchased from **Solarbio Life Science**. Its chemical specifications are: **Chemical Formula:** $C_8H_{11}NO_2 \cdot HCl$ was used with a molecular weight of 189.64 and a purity level of not less than 98%, as presented in Figure 1.



Figure(1): Dopamine

Traits studied during the growth and production stages

Growth stage:

1. **Live body weight:** Body weights of the birds were measured at the start of weeks 4 and 5, and 6 on an individual basis / sex / replicate using a digital balance.

2. **Weight gain:** The weekly weight gain (g) of birds for each replicate was calculated in accordance to the following equation:

Weight gain= Final body weight at the end of the week minus initial body weight at the beginning of the week. (Ibrahim, 1987).

3. **Feed consumption:** Feed consumption refers to the amount of feed consumed. were recorded weekly (g/bird) according to the following equation (Ibrahim, 1987):

Feed intake

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

4. **Feed conversion ratio** was used to be calculated the use of the following equation Arif *et al.* (2022)

$$\text{Feed conversion ratio (g feed/g weight gain)} = \frac{\text{Feed intake per week}}{\text{Average weekly weight gain}}$$

Egg production stage:

1. **Sexual maturity age:** It was measured in females as the age at first egg laying for each genetic line.

2. **Female body weight at the time of sexual maturity.**

3. **Weight of the first egg.**

4 **Number of eggs produced:** The number of eggs was recorded weekly for each replicate after collection twice daily, in the morning and evening. The average number of eggs per female per replicate was obtained by dividing the total eggs collected during the week by the number of females within the same replicate.

5. The weight of eggs: Egg weight was recorded at collection (morning and evening) for each replicate using a sensitive digital balance over each week. The mean egg weight per replicate was determined by dividing the total egg weight by the number of eggs in each replicate.
6. Hen day egg production (H.D.P.%): it was calculated according to the following formula, as reported by (North,1984):

$$\text{H. D. P \%} = \frac{\text{Number of eggs produced during the week}}{\text{Number of females per replicate} \times \text{Number of days per week}} \times 100.$$

Hatch qualities:

1. **Fertilized egg percentage %:** After completion of incubation, the unhatched eggs were broken to determine fertility percentage according to the equation reported by (Al-Zagzaji & Ibrahim,1982):

$$\text{Fertile egg percentage (\%)} = \frac{\text{Number of fertile eggs}}{\text{Total number of eggs}} \times 100.$$

2. **Hatchability % :** Hatchability percentage was determined using the following equation:

$$\text{Hatchability percentage of fertile eggs (\%)} = \frac{\text{Number of hatched chicks}}{\text{Number of fertile eggs}} \times 100.$$

3. **The mortality embryos percentage %:** It was determined according to the following equation:

$$\text{Embryonic mortality percentage (\%)} = 100 - \text{hatchability percentage of fertile eggs}.$$

Management and Feeding:

The birds were fostered in battery cages with an ad libitum diet of 2900 kcal/kg of metabolizable energy and 18% crude protein. Ad libitum food and water were given as well, and a 16L:8D light cycle was used to promote laying.

Statistical Analysis:

The data have been laid out in a Completely Randomized Design (CRD) in a 2×2 factorial design (two genetic lines, two dopamine treatments). The GLM procedure of the SAS program (2002) was used to analyze the effects of the factors studied and their interactions, and Duncan's Multiple Range Test was used to assess the significance of mean differences at the level of ($P \leq 05$).

Results and Discussion

Purification of the birds:

Previous studies indicate that domestication in Japanese quail has led to the emergence of different strains with diverse feather colors and patterns (Mizutani, 2002). Feather color has also been associated with several productive and reproductive traits, including body weight (Bedhom *et al.*, 2012), reproductive traits (Al-Kaisi, 2025), and egg quality traits (Minvielle *et al.*, 2004). Therefore, purification of the feather-color lines was necessary to obtain relatively uniform genetic groups before applying the experimental treatments.

Following the first hatching, considerable segregation in feather color was observed among the hatched chicks. Therefore, the birds were reared for one generation, and eggs were collected at 14 weeks of age and subjected to a second hatching. Although feather-color segregation was still observed, it was considerably reduced. The chicks were therefore reared for another generation under the same conditions, followed by a third hatching. At the third hatching, the feather-color purity of the

chicks reached approximately 95%. Accordingly, the birds were considered sufficiently purified for the application of the dopamine injection treatment, representing the third generation of both lines.

Growth stage, as indicated by body weight, weight gain, feed intake, and feed conversion ratio.

From Table (1), which illustrates the influence of genetic line, treatments, and their interaction on productive traits during the brooding stage at 5–6 weeks of age; the statistical analysis results indicated that the no significant impact was observed on the genetic line ($p \leq 0.05$). on the average live body weight, as body weight reached 213.29 and 245.38 g for brown quail and 220.75 and 253.63 g for black quail at 5 and 6 weeks of age, respectively. Regarding the effect of dopamine injection, no significant differences were found in the outcome of the DOP injection and control treatments in the average live body weight at 5 and 6 weeks of age, as values reached 223.17 and 212.75 g, and 235.08 and 245.25 g for birds of the DOP and control treatments at weeks 5 and 6, respectively. As for the interaction effect, it was observed in weeks 5 and 6 that brown quail under the DOP treatment had the highest average body weight ($p \leq 0.05$), reaching (223.67) and (254.17) g for weeks 5 and 6, respectively, showing significant superiority over the control treatments of both brown and black quail. Regarding weight gain, which is a consequence of body weight, the results presented in the same table indicated that the Genetic line had no obvious influence. ($p \leq 0.05$), genotype, or their interaction on this trait during weeks 5 and 6 of age. For feed intake, the results in the same table indicated no tremendous impact of the genetic line, cure kind, or their interaction during weeks 5 and 6 of age, except that brown quail under the control treatment consumed lower amounts of feed at 5 weeks of age, showing a significant decrease compared with the DOP-treated black quail.

Overall, feed intake increased with age, which is normal due to increased maintenance requirements and higher activity levels. It was also observed from the same table additionally indicated that no substantial variations ($p \leq 0.05$) were observed in the feed conversion ratio during weeks 5 and 6 of age with respect to the effect of genetic line as well as treatment type. However, regarding the interaction effect between genetic lines and treatment type, A significant improvement ($p \leq 0.05$) was recorded in week 5 for the DOP treatment in the brown quail line, which achieved the highest feed conversion efficiency, with an average feed conversion ratio of 4.36 g feed consumed per g weight gain. In contrast, during week 6, no significant differences ($p \leq 0.05$) were found in feed conversion ratio attributable to genetic line, treatment, or their interaction.

Table (1): Effects of Treatments, Genetic Group, and Their Interaction on Productive Features at the Broiler Stage (5–6 Weeks of Age) (Mean ± SE):

Factors		Body Weight (g)		Weight Gain (g)		Feed Consumption (g)		FCR (g feed / g gain)		
		week 5	week 6	week 5	week 6	week 5	week 6	week 5	week 6	
Genetic line	Brown	213.29±3.10 a	245.38±3.18 a	46.40±3.43 a	32.08±0.83 a	227.38±2.60 a	236.67±1.26 a	5.28±0.53 a	7.43±0.19 a	
	Black	220.75±2.10 a	253.63±3.20 a	48.70±2.18 a	32.88±1.82 a	231.44±1.41 a	258.38±16.80 a	4.86±0.22 a	7.97±0.39 a	
Treatment	Control	212.75±3.39 a	245.25±3.74 a	49.40±4.93 a	32.50±1.89 a	226.38±5.23 a	240.88±1.32 a	4.76±0.37 a	7.50±0.37 a	
	Dopamine	223.17±1.25 a	253.08±1.35 a	48.75±2.48 a	29.92±1.22 a	229.79±1.64 a	239.83±1.68 a	4.77±0.22 a	8.10±0.39 a	
Interaction	Brown	Control	213.00±7.51 bc	245.17±6.65 bc	52.00±10.41 a	32.17±0.93 a	217.50±7.55 b	238.92±0.68 a	4.47±0.72 b	7.44±0.22 a
		Dopamine	223.67±0.88 ab	254.17±2.62 ab	53.27±2.09 a	30.50±1.80 a	231.42±1.21 a	239.00±3.21 a	4.36±0.15 b	7.90±0.53 a
	Black	Control	212.50±1.04 bc	245.33±5.09 bc	46.80±2.51 a	32.83±4.11 a	235.25±0.88 a	242.83±2.09 a	5.06±0.27 ab	7.59±0.79 a
		Dopamine	222.67±2.60 ab	252.00±1.04 ab	44.23±2.46 a	29.33±1.96 a	228.17±3.06 ab	240.67±1.76 a	5.18±0.22 ab	8.29±0.65 a

Different letters within each column indicate significant differences between treatments ($p \leq 0.05$).

Egg production stage, as indicated by age at sexual maturity, body weight at sexual maturity, and first egg weight.

Table (2), which displays the effects of genetic line, therapies, and their combination on female quail's age, body weight, and first egg weight at sexual maturity, makes this clear. The results showed that the genetic line had no discernible impact on the number of days needed for brown and black quail to reach sexual maturity (35.42 and 35.25 days, respectively). Regarding the effect of treatment type, significant differences ($p \leq 0.05$) were observed between the treatments, as the birds treated with DOP attained sexual maturity at 35.67 days, while the control birds reached sexual maturity at 36.83 days. Regarding the interaction effect between genetic line and treatment type, females under the DOP treatment in the black line matured earlier than females in the control treatment of the black line. Additionally, Table (2) showed that neither treatment method nor genetic line significantly affected the average body weight of females at sexual maturity (first egg laying). Regarding the interaction effect between genetic line and treatment type, brown quail females under the DOP treatment had the highest body weight ($p < 0.05$), reaching 256.27 g, whereas black quail females under the DOP treatment had the lowest average body weight at first egg laying compared to the other treatments, reaching 246.70 g. The statistical analysis results, as presented in Table (2), also showed no significant effects of genetic line, treatment type, or their interaction on the average first egg weight.

Table (2): Effects of Treatments, Genetic Line, and Their Interaction on Certain Reproductive Features (mean $\pm$ S.E.)

Factors		ASM(day)	WSM(gm)	WFE(gm)
Genetic line	Brown	35.42 $\pm$ 0.36 a	236.03 $\pm$ 6.69 a	9.42 $\pm$ 0.19 a
	Black	35.25 $\pm$ 0.49 a	246.01 $\pm$ 5.52 a	9.42 $\pm$ 0.15 a
Treatment	Control	36.83 $\pm$ 0.31 a	251.82 $\pm$ 2.68 a	9.50 $\pm$ 0.22 a
	Dopamine	35.67 $\pm$ 0.49 b	251.48 $\pm$ 11.90 a	9.50 $\pm$ 0.22 a
Interaction	Brown	Control 36.33 $\pm$ 0.33 ab	250.70 $\pm$ 4.90 ab	9.67 $\pm$ 0.33 a
		Dopamine 36.00 $\pm$ 0.58 ab	256.27 $\pm$ 13.92 a	9.67 $\pm$ 0.33 a
	Black	Control 37.33 $\pm$ 0.33 a	252.93 $\pm$ 3.28 ab	9.33 $\pm$ 0.33 a
		Dopamine 35.33 $\pm$ 0.88 b	246.70 $\pm$ 22.17 ab	9.33 $\pm$ 0.33 a

Significant differences between groups at a probability level ($p \leq 0.05$) are indicated by different letters arranged vertically within each comparison.

ASM = Age of sexual maturity, WSM = Weight at sexual maturity, WFE = Weight of first egg,

Egg production stage, represented by the traits of average number of eggs/female, egg weight/female, and egg production percentage/female.

In the last stage of the experiment at 18 weeks of age, Table (3) shows the impact of genetic line, treatment, and their interaction on the overall mean of egg number per female, egg weight per female, egg production percentage per female, and egg mass per female. Black quail females produced more eggs overall than brown quail females, with an average of 81.29 and 79.40 eggs per female, respectively, according to the statistical analysis, which found that the genetic line effect was considerably superior ($p < 0.05$). This may be due to the possibility that black quail are more efficient in follicle recruitment and ovulation with less loss compared with brown quail. Regarding the effect of treatment there was a significant superiority ($p \leq 0.05$) in total egg production over the whole period in favor of the DOP injection treatment compared with the control treatment, where the average number of eggs during the total period was 84.98 and 68.31 eggs per female, respectively. for the DOP and control treatments, respectively. Since DOP is an inhibitor of brooding behavior through its negative effect on the secretion of prolactin from the pituitary gland and its prevention of brooding activities and its improvement of egg production, as reported by Xu *et al.* (2010) and as indicated by M. Gholami *et al.* (2020) regarding the presence of a significant relationship between dopamine and improvement of egg production traits. Regarding the interaction between genetic line and treatment, it was observed that the DOP injection treatment in both genetic lines showed significant superiority ($p \leq 0.05$) compared with both brown and black quail treatments. The same table also presents the effects of genetic line, genotype, and their interaction on egg production

percentage (%) based on hen-day (HD) as an average over the total period.. The statistical analysis results indicated a significant superiority ($p \leq 0.05$) of black quail compared with brown quail in the overall mean. as the production percentage reached (96.77 and 94.52)%, respectively. According to M. Gholami *et al.* (2020), there is a significant correlation between the genetic structures of the dopamine receptor D1 gene and egg production traits. The results showed a significant superiority ($p \leq 0.05$) of the DOP injection treatment compared with the control treatment, with 101.17 and 81.33%, respectively. Regarding the interaction between genetic line and treatment, the results showed that the DOP injection therapy significantly outperformed the control in both lines, with values for the DOP treatment in brown and black quail reaching 99.98% and 102.36%, respectively. This is because dopamine plays a role. According to M. Gholami *et al.* (2020), there is a significant correlation between egg production traits and the genetic structures of the dopamine receptor D1 gene. This suggests that the dopamine receptor D1 gene is polymorphic and may be a candidate locus or linked to a major gene influencing productive traits in chickens. As age increased, the production % often increased until the conclusion of the production period, suggesting persistence following dopamine injection in contrast to the control.

Table (3): Shows how certain reproductive and productive features (Total Egg Production) are affected by genetic line, treatments, and their interactions (Mean $\pm$ S.E.).

Factors		AEN\ Female	EW(gm)	EPR\ Female
Genetic line	Brown	79.40 $\pm$ 2.42 b	13.08 $\pm$ 0.25 a	94.52 $\pm$ 2.89 b
	Black	81.29 $\pm$ 1.90 a	13.22 $\pm$ 0.26 a	96.77 $\pm$ 2.26 a
Treatment	Control	68.31 $\pm$ 1.65 b	11.76 $\pm$ 0.13 b	81.33 $\pm$ 1.97 b
	Dopamine	84.98 $\pm$ 0.56 a	13.72 $\pm$ 0.11 a	101.17 $\pm$ 0.67 a
Interaction	Brown	Control	65.76 $\pm$ 1.64 c	78.28 $\pm$ 1.95 c
		Dopamine	83.98 $\pm$ 0.70 a	99.98 $\pm$ 0.83 a
	Black	Control	70.87 $\pm$ 2.12 b	84.37 $\pm$ 2.52 b
		Dopamine	85.98 $\pm$ 0.33 a	102.36 $\pm$ 0.39 a

Significant differences between groups at a probability level ($p \leq 0.05$) are indicated by different letters arranged vertically within each comparison.

EW = Egg Weight (grams), EPR = Egg Production Ratio per Female, and AEN = Average Egg Number / Female.

Hatching traits, as indicated by fertility (%), hatchability of fertile eggs (%), and embryonic mortality (%).

Table (4) illustrates the effects of the quail's genetic line, treatment type, and their interaction on hatching traits. The statistical analysis results regarding the genetic line effect showed significant differences ($p \leq 0.05$). between the two lines

in the fertility percentage, which reached (97.52% and 95.32%), favoring the Brown line. Conversely, no significant differences were observed in the hatchability percentage of fertile eggs or the embryonic mortality percentage for both the Brown and Black quail lines. Regarding the treatment type, it is noted that the DOP injection treatment significantly excelled ($p \leq 0.05$). over the control treatment in the percentages of fertile eggs, hatching, and embryonic mortalities. The fertility rates were (91.31% and 97.94%), hatching rates were (91.13% and 96.03%), and embryonic mortality rates were (8.87% and 3.97%) for the control and DOP treatments, respectively. As for the interaction effect between the genetic line and treatment, a significant superiority was observed for the DOP injection treatment in the Brown quail line over the control treatments for both Brown and Black quail and the DOP treatment for the Black line; the fertility rate in this group reached 100% compared to 91.31%, 90.06%, and 95.88%, respectively. Regarding the hatchability of fertile eggs, the DOP injection treatment for the Black line achieved the highest hatching rate, reaching 97.04%, significantly surpassing the control treatments for both lines as well as the DOP treatment for the Brown quail, which were 92.20%, 90.07%, and 95.02%, respectively. Finally, for embryonic mortalities, the highest mortality rates were found in the control treatments for the Brown and Black quail at 7.80% and 9.93%, respectively, while the DOP treatment for the Black quail recorded the lowest rate at 2.96%. The improvement observed in birds treated with dopamine is a result of the physiological effect it produces, as mentioned Chang *et al.* (2003) noted that dopamine has a stimulatory effect on plasma luteinizing hormone (LH) and follicle-stimulating hormone (FSH) in Japanese quail, mediated by the release of gonadotropin-releasing hormone (GnRH). As Xu *et al.* (2010) state, dopamine inhibits pituitary prolactin secretion via DRD2, suppresses brooding behavior, and enhances egg production.

Table (4): Implications of Treatments, Genetic Line, and Their Interaction on Hatching Characteristics (mean $\pm$ standard error).

Factors		Fertility %	Hatch. %	Embr.M%	
Genetic line	Brown	97.52±1.31 a	96.16 ±0.98 a	3.84 ±0.98 a	
	Black	95.32±1.37 b	96.04 ±1.33 a	3.96 ±1.33 a	
Treatment	Control	91.31 ±1.89 b	91.13 ±1.45 b	8.87 ±1.45 a	
	Dopamine	97.94±1.38 a	96.03 ± 0.94 a	3.97 ±0.94 b	
Interaction	Brown	Control	90.06 ± 0.70 c	92.20 ± 1.18 cd	7.80 ±1.18 ab
		Dopamine	100.00 ±0.00 a	95.02 ±1.11 bc	4.98 ±1.11 c
	Black	Control	92.56 ± 3.99 bc	90.07 ±2.82 d	9.93 ±2.82 a
		Dopamine	95.88 ± 2.31 b	97.04 ± 1.48 ab	2.96 ±1.48 cd

Significant differences between groups at a probability level ($p \leq 0.05$) are indicated by different letters arranged vertically within each comparison. Hatch. % = Fertile egg and embryo hatchability. M stands for embryonic mortality.

Conclusion

This study provides evidence that dopamine injection significantly improved most productive traits in Japanese quail, particularly by increasing total egg production and improving feed conversion ratio in certain stages.

1. **Acceleration of Sexual Maturity:** Dopamine administration resulted in a significant reduction in the age at sexual maturity, allowing birds to start their production cycle earlier compared to the control group.
2. **Improvement of Hatching Traits:** Dopamine treatments showed a clear superiority in reproductive efficiency, recorded through higher fertility rates and hatching rates (for both total and fertile eggs), along with a notable decrease in embryonic mortality.
3. **Genetic Line Variation:** The study revealed that the Black quail line outperformed the Brown line in total egg production rate, indicating a genetic variation in response to dopamine treatments between the two lines.
4. **Physiological Role:** The positive impact of dopamine is primarily attributed to its role as a physiological inhibitor of prolactin secretion, which effectively prevents broodiness behavior and maintains continuous egg laying.

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INTEREST CONFLICT

The authors state that this publication was not affected by any conflicts of interest.

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