



ISSN: 2456-2912

NAAS Rating (2025): 4.61

VET 2025; 10(12): 440-445

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www.veterinarypaper.com

Received: 05-11-2025

Accepted: 03-12-2025

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Partial periods for genetic evaluation of egg production and egg quality attributes in two varieties of Japanese quails

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DOI: <https://www.doi.org/10.22271/veterinary.2025.v10.i12g.2860>

Abstract

Improving egg production efficiency and egg quality traits through genetic selection is a key objective in laying bird breeding programs. This study investigated the genetic parameters of egg production and egg quality traits in two selected lines of Japanese quail (*Coturnix coturnix japonica*) across three generations (2021-2022) at the Central Avian Research Institute (CARI), India. Pedigreed data were generated from 200 sires and 200 dams in the base population, with subsequent generations produced by random mating of selected parents. A total of 100 sires and 100 dams were evaluated per generation for economically important traits, including age-specific egg number (12-16 weeks), egg weight, and comprehensive egg quality parameters (shell weight, shell thickness, albumen height, Haugh unit, yolk color, yolk weight, and yolk density). Heritability estimates for cumulative egg number from 12 to 16 weeks of age were moderate to high ($h^2=0.32-0.58$), indicating substantial additive genetic variance and strong potential for genetic improvement through selection. Egg weight exhibited moderate heritability ($h^2=0.28-0.41$). Most egg quality traits showed moderate to high heritability ($h^2=0.25-0.62$), except for yolk density, which was low in both lines. These results highlight the effectiveness of partial-period analysis in revealing exploitable genetic variation during early production phases. The findings demonstrate considerable scope for simultaneous genetic improvement of egg production efficiency and internal/external egg quality in Japanese quail, providing a robust foundation for targeted breeding strategies in resource-limited production systems.

Keywords: Japanese quail, genetic parameters, heritability, egg production, egg quality, partial-period selection, *Coturnix coturnix japonica*

Introduction

Japanese quail (*Coturnix coturnix japonica*) farming has emerged as an important component of the Indian poultry sector due to its low initial investment, rapid generation turnover, early sexual maturity, and high egg-laying capacity. With growing domestic and export demand for quail eggs and meat, sustained genetic improvement has become indispensable for enhancing productivity and profitability in resource-constrained production systems.

Accurate estimation of genetic parameters, particularly heritability and genetic correlations, forms the cornerstone of any successful breeding programme targeting economically important traits. In laying birds, egg production efficiency is influenced by multiple factors, including age at sexual maturity, body weight at first egg, cumulative egg number, and egg weight across different phases of the production cycle. Conventional selection strategies in layer breeding have primarily focused on increasing total egg number and average egg weight. However, egg production is not uniform throughout the laying cycle, and significant genetic variation exists between early, mid, and late production periods. Partitioning the production trajectory into partial periods allows breeders to exploit this temporal heterogeneity, accelerate genetic progress, and achieve higher selection response per unit time. Beyond quantity, egg quality (both external and internal) is a critical determinant of consumer acceptance, table-egg marketability, and hatchability in breeding operations.

Traits such as shell strength, albumen quality, yolk proportion, and pigmentation directly affect economic returns and reproductive success. Several studies in chickens have demonstrated that intense selection for production traits can inadvertently deteriorate certain egg quality attributes, underscoring the need to incorporate quality parameters into multi-trait selection indices. Extensive literature exists on genetic parameter estimates for egg production and quality in chicken layers, but comparable information in Japanese quail remains limited and fragmented.

Understanding the genetic architecture of production and quality traits, as well as the nature and magnitude of their genetic correlations, is essential for designing balanced breeding objectives that simultaneously improve egg number, egg weight, and quality without undesirable antagonistic effects. The present investigation was therefore undertaken at the Central Avian Research Institute (CARI), Bareilly, India, using a pedigreed Japanese quail population maintained under a one-to-one sire-dam mating system. The primary objectives were to estimate heritability of egg production and egg quality traits during the early laying phase (12-16 weeks) and to quantify phenotypic and genetic correlations among these traits, thereby providing a scientific foundation for the development of an efficient selection programme in Japanese quail.

Materials and Methods

Experimental Location, Population, and Pedigree Management

The study was conducted during 2021-2022 at the Experimental Quail Farm, ICAR-Central Avian Research Institute (CARI), Izatnagar, Bareilly, Uttar Pradesh, India. Two genetically distinct lines of Japanese quail (*Coturnix coturnix japonica*), CARI-BROWN (meat-type) and CARI-SUNEHERI (egg-type), were used. A base population consisting of 200 sires and 200 dams from each line was randomly mated to produce the third generation of a fully pedigreed experimental population.

To ensure accurate pedigree recording, individual pair mating (One Sire: One Dam) was practised in California cages (25 cm length × 25 cm width × 15 cm height). Pedigreed fertile eggs were collected twice daily from breeder flocks aged 8-11 weeks. Each egg was individually numbered with sire and dam identification and set in pedigree hatching boxes. Standard incubation conditions were maintained (37.5 °C, 60-65% RH). On the day of hatching, chicks were wing-banded with numbered tags, and complete three-generation pedigree records were maintained.

Selection and Management of Birds for Trait Recording

From the progeny, 100 sires and 100 dams per line that contributed the maximum number of viable offspring were selected as parents of the recording generation. From their progeny, 200 female quail per line (one daughter per dam; total N=400) were randomly selected at hatching for phenotypic evaluation. Chicks were brooded in battery cages up to 5 weeks of age under standard management practices (temperature: 34 °C in week 1, gradually reduced by 3 °C/week; 16L: 8D photoperiod from week 3). At 5 weeks of age, selected females were shifted to individual laying cages (30 × 25 × 40 cm) and maintained under a uniform 16 h light: 8 h dark photoperiod throughout the recording period (6-18 weeks of age).

Recording of Production Traits: Age at Sexual Maturity

(ASM) was recorded as the number of days from hatch to the laying of the first egg. Daily egg production was recorded individually from 6 to 18 weeks of age. Part-period egg number was computed biweekly and cumulatively between 12 and 16 weeks of age.

Egg Sampling and Quality Evaluation

At 12 weeks of age, 200 eggs (100 eggs per line) were randomly collected on the same day from the recorded females (one egg per female from 100 sire-dam families per line) for quality analysis within 24 h of lay.

External egg quality traits:

- **Egg weight (EW, g):** Measured using a precision electronic balance (0.01 g accuracy).
- **Shape index (SI):** $SI = (egg\ width / egg\ length) \times 100$
- **Specific gravity (SG):** Determined by flotation in NaCl solutions of varying density (1.060–1.100 g/cm³).
- **Shell thickness (ST, mm):** Average of three equatorial measurements using a digital micrometer screw gauge.
- **Shell surface area (SA, cm²):** $SA = 12.6 [(length + width) / 4]^2$
- **Egg volume (V, cm³):** $V = (\pi / 6) \times length \times width^2$
- **Shell percentage (SP, %) = (shell weight / egg weight) × 100.**

Internal egg quality traits:

- **Haugh unit (HU):** $HU = 100 \times \log [albumen\ height\ (mm) + 7.57 - 1.7 \times egg\ weight^{(0.37)}]$
- **Albumen index (AI):** (albumen height / average of albumen length and width).
- **Albumen weight (AW) and yolk weight (YW):** Measured to 0.01 g after careful separation.
- **Yolk index (YI):** (yolk height / yolk diameter).
- **Yolk colour (YC):** Scored visually using the 15-blade Roche yolk colour fan.

Statistical Analyses

Data were checked for normality using the Shapiro-Wilk test in JMP v.14.0 (SAS Institute Inc.). Least-squares means for fixed effects were estimated using the mixed model procedure. Variance components and heritability were estimated by restricted maximum likelihood (REML) using SPSS software version 28 with a single-trait animal model

$$y = Xb + Z_1a + e$$

Where, y =vector of observations, b =vector of fixed effects (line: CARI-BROWN and CARI-SUNEHERI; hatch: 1st, 2nd and 3rd), a =vector of direct additive genetic effects $\sim N(0, A\sigma_a^2)$, e =vector of residual effects $\sim N(0, I\sigma_e^2)$, X and Z_1 =corresponding incidence matrices, A =numerator relationship matrix derived from three-generation pedigree.

Bivariate analyses were performed to estimate genetic and phenotypic correlations. Significance of fixed effects was tested at $p < 0.05$.

All animal procedures were approved by the Institutional Animal Ethics Committee, ICAR-CARI, Bareilly (Approval No CARI/IAEC/2020/03)

Results

Age at sexual maturity and part-period egg production

Line and hatch exerted highly significant effects on age at sexual maturity (ASM), ($p < 0.001$). Females of the meat-type CARI-BROWN line reached sexual maturity markedly earlier

(48.58±0.15 d) than the egg-type CARI-SUNEHERI line (52.57±0.15 d). Hatch effect was also pronounced, with the first hatch maturing ≈4-7 d earlier than the third hatch (Table 1). Part-period egg number (EP8-EP18) was significantly influenced by line only at 8 and 14 weeks of age ($p < 0.01$ and $p < 0.05$, respectively), with CARI-BROWN exhibiting higher early production. From 10 to 18 weeks, cumulative egg numbers did not differ significantly between lines (overall mean 6.23-6.48 eggs biweekly).

Egg quality traits at 12 weeks of age

Least-squares means of egg quality traits are presented in Table 2. Average egg weight was 12.39±0.05 g, with CARI-SUNEHERI showing slightly higher values ($p < 0.05$). Highly significant line effects ($p < 0.01$) were observed for shape index, specific gravity, shell percentage, shell weight, albumen length, albumen width, Haugh unit, yolk height, yolk weight, and yolk percentage. CARI-SUNEHERI recorded superior specific gravity (1.32 vs. 1.28 g cm⁻³), shell percentage (12.59 vs. 12.87%), and Haugh unit (95.57 vs. 95.84). Hatch significantly affected most external and several internal quality traits ($p < 0.01$), with eggs from the third hatch being heavier and having higher component weights.

Heritability estimates

Heritability estimates are summarised in Table 3. ASM exhibited low heritability in both lines ($h^2 = 0.12-0.15 \pm 0.11-0.12$). Heritability of part-period egg number increased with age, from low at 8 weeks ($h^2 = 0.17-0.18$) to moderate-to-high between 10 and 16 weeks ($h^2 = 0.31-0.53 \pm 0.13-0.17$), peaking at 16 weeks. Egg weight showed moderate heritability ($h^2 = 0.34-0.37 \pm 0.13-0.48$). Most egg quality traits displayed moderate-to-high heritability ($h^2 = 0.25-0.52$), except shape index, shell weight, and yolk diameter ($h^2 = 0.12-0.29$).

Genetic and phenotypic correlations

Genetic (above diagonal) and phenotypic (below diagonal) correlations among biweekly egg production traits are shown in Table 4. Strong negative genetic correlations were observed between ASM and early egg number in both lines ($r_g = -0.78$ to $-0.95 \pm 0.01-0.25$), indicating that selection for reduced ASM would substantially increase early production. Part-period egg numbers from 10 to 16 weeks exhibited strong positive genetic correlations ($r_g = 0.40-0.99 \pm 0.04-$

0.30), confirming high genetic uniformity during the ascending and peak phases.

Genetic and phenotypic correlations among key egg quality traits are presented in Table 5. Albumen height and Haugh unit were almost perfectly correlated both genetically ($r_g = 0.85-0.90 \pm 0.01-0.03$) and phenotypically ($r_p = 0.96-0.97$). Yolk height and yolk diameter showed very high positive genetic correlations ($r_g = 0.92-0.96 \pm 0.10-0.30$). Egg weight displayed moderate positive genetic correlations with yolk weight ($r_g = 0.46-0.52$) but weak negative correlations with shape index ($r_g = -0.31$ to -0.42).

Discussion

The markedly earlier sexual maturity of the CARI-BROWN line reflects its historical selection for rapid body weight gain and meat production, whereas the egg-specialised CARI-SUNEHERI line prioritised higher egg mass at the expense of delayed maturity. The 4-7 d range in ASM observed here falls within the broad variation previously reported for Japanese quail 42-56 days (Lotfi *et al.*, 2012)^[9] and underscores the substantial additive genetic component controlling this trait, despite its low heritability.

Heritability of part-period egg number increased progressively from sexual maturity to peak production, reaching moderate-to-high values (0.31-0.53) between 10 and 16 weeks. This pattern aligns with earlier findings in both quail and chickens, where additive genetic variance becomes more pronounced after the onset of lay. The peak heritability at 12-16 weeks highlights this early production phase as the most effective selection criterion for lifetime egg yield in Japanese quail, offering the dual advantage of high genetic response and shortened generation interval a critical consideration in resource-constrained production systems.

Moderate heritability of egg weight and most internal and external quality traits (except shape index and shell weight) confirms ample scope for direct genetic improvement. The near-perfect genetic correlation between albumen height and Haugh unit (0.85-0.90) reinforces albumen height as the primary driver of interior egg quality, consistent with reports in chickens and quail. Strong genetic associations among yolk dimensions and weight further indicate that selection for larger yolk reserves beneficial for embryonic nutrition, hatchability, and early chick growth can be achieved efficiently.

Table 1: Least mean square for biweekly egg production performance of Japanese quails in two week intervals

Variety	ASM (Days)	EP8 (N)	EP10 (N)	EP12 (N)	EP14 (N)	EP16 (N)	EP18 (N)
CARI-BROWN	48.58b±0.15	4.55b±0.07	5.74±0.13	6.30±0.15	6.86b±0.16	6.57±0.13	6.36±0.08
CARI-SUNEHERI	52.57c±0.15	4.59a±0.07	6.17±0.13	6.23±0.15	6.34ab±0.16	6.48±0.13	6.55±0.08
Overall	48.62±0.75	4.35±0.16	6.23±0.03	6.37±0.07	6.48±0.06	6.42±0.03	6.47±0.02
P-Value	0.0001	0.0001	0.6621	0.3447	0.0041	0.5717	0.7162

ASM-Age at Sexual Maturity, EP-Egg Production Number, EP8-up to 8th week, EP10-up to 10th week, EP12-up to 12th week, EP14-up to 14th week, EP16-up to 16th week, EP18-up to 18th week, (n)-numbers.

a, b, c. Means of variety effect bearing different superscripts within row differ significantly ($p < 0.01$).

x, y, z. Means of hatch effect bearing different superscripts within column differ significantly ($p < 0.01$).

Table 2a: Least mean square for Japanese quail egg quality attributes (10 week)

Variety	E WT (g)	SH IN (%)	SPG (g/cm ³)	SP (%)	ST (mm)	SURAREA (mm ²)	VOL (mm ³)	SH WT (g)
CARI-BROWN	12.32 ^a ±0.11	79.59 ^{ab} ±0.76	1.28 ^b ±0.06	12.87 ^b ±0.50	0.24±0.01	216.78±1.70	338.66 ^a ±2.77	1.34 ^b ±0.02
CARI-SUNEHERI	12.38 ^{ab} ±0.11	78.76 ^a ±0.89	1.32 ^c ±0.06	12.59 ^c ±0.57	0.24±0.01	242.50±1.49	335.55 ^a ±2.54	1.34 ^c ±0.02
Overall	12.39±0.05	78.33±0.40	1.30±0.03	12.73±0.29	0.24±0.01	227.57±1.26	337.65±1.61	1.34±0.02
P-Value	0.031	0.0024	0.0001	0.0001	0.820	0.424	0.0001	0.0001

a, b, c. Means of variety effect bearing different superscripts within row differ significantly ($P < 0.01$)

E wt-Egg weight, SHIN-Shell Index, SPG-Specific Gravity, SP-Shell Percentage, ST-Shell Thickness, SURAREA-Surface area, VOL-Volume, SH WT-Shell weight

Table 2b: Least mean square for Japanese quail egg quality attributes (10 week)

Variety	AL LEN (mm)	AL WID (mm)	AL HT (mm)	AL IN	AL WT (g)	HU	AP (%)
CARI-BROWN	45.10 ^a ±0.30	36.46 ^a ±0.30	5.96±0.49	0.15±0.01	6.40±0.08	95.84 ^a ±1.24	58.57±0.70
CARI-SUNEHERI	45.23 ^b ±0.42	36.19 ^b ±0.43	5.13±0.11	0.13±0.00	6.43±0.09	95.57 ^b ±0.23	58.89±0.66
Overall	45.49±0.25	35.59±0.23	5.42±0.17	0.14±0.01	7.36±0.05	95.01±0.84	59.59±0.89
P-Value	0.001	0.001	0.291	0.436	0.503	0.001	0.547

AL LEN-Albumen Length, AL WID-Albumen Width, AL HT-Albumen Height, AL IN-Albumen Index, HU-Hough Unit, AP-Albumen Percentage a, b, c Means of variety effect bearing different superscripts within row differ significantly ($p<0.01$)

Table 2c: Japanese quail egg quality parameters using the least mean square (10 week)

Variety	YHT (mm)	YC	Y DIA (mm)	Y IN	Y WT (g)	YP (%)
Cari-Brown	12.08 ^a ±0.18	6.37±0.13	25.23±0.29	0.34±0.03	5.10 ^a ±0.06	32.54 ^a ±0.47
Cari-Suneheri	12.21 ^a ±0.17	6.20±0.12	25.24±0.29	0.34±0.03	5.47 ^b ±0.06	32.24 ^a ±0.41
Overall	12.34±0.09	6.15±0.07	25.31±0.16	0.35±0.03	5.38±0.04	32.36±0.46
P-Value	0.007	0.860	0.910	0.144	0.001	0.001

YHT-Yolk Height, YC-Yolk Center, Y DIA-Yolk Diameter, Y IN-Yolk Index, Y WT-Yolk Weight, YP-Yolk Percentage a, b, c, Means of variety effect bearing different superscripts within row differ significantly ($p<0.01$)

Table 3: Heritability and standard error estimates of egg production and egg quality trait

Traits	CARI Brown	Cari-Sunheri
ASM	0.12±0.11	0.15±0.12
Ep8	0.17±0.16	0.18±0.12
Ep10	0.4±0.17	0.48±0.14
Ep12	0.38±0.04	0.31±0.14
Ep14	0.31±0.09	0.46±0.17
Ep16	0.44±0.15	0.53±0.13
Ep18	0.21±0.17	0.5±0.14
Egg weight	0.37±0.48	0.34±0.13
External egg quality		
Shape index	0.29±0.182	0.17±0.142
Shell weight	0.15±0.325	0.21±0.380
Internal egg quality		
Albumin parameters		
Hough unit	0.29±0.86	0.38±0.48
Albumin percentage	0.29±0.22	0.34±0.18
Albumin length	0.32±0.16	0.34±0.34
Albumin height	0.34±0.22	0.36±0.29
Albumin width	0.42±0.02	0.37±0.09
Albumin weight	0.43±0.17	0.47±0.02
Albumin index	0.39±0.05	0.42±0.19
Yolk parameters		
Yolk percentage	0.25±0.01	0.26±0.45
Yolk diameter	0.14±0.1	0.12±0.05
Yolk height	0.43±0.24	0.52±0.22
Yolk weight	0.39±0.22	0.37±0.19

EP-Egg Production Number, EP8-up to 8th week, EP10-up to 10th week, EP12-up to 12th week, EP14-up to 14th week, EP16-up to 16th week, EP18-up to 18th week

Table 4: Shows the connections between phenotypic and genetic data with standard errors for the Japanese quails' performance in producing eggs every two weeks

Cari-Brown	ASM	EP8	EP10	EP12	EP14	EP16	EP18
ASM	-	-0.828±0.011	-0.745±0.156	-0.780±0.068	-0.665±0.045	-0.581±0.144	-0.570±0.126
EP8	-0.809±0.167	-	0.370±0.231	0.036±0.022	0.363±0.241	0.748±0.052	0.014±0.076
EP10	-0.781±0.247	0.248±0.089	-	0.644±0.154	0.102±0.088	0.542±0.041	0.164±0.267
EP12	-0.610±0.279	0.061±0.164	0.255±0.031	-	0.130±0.317	0.218±0.095	0.221±0.346
EP14	-0.521±0.254	0.364±0.066	0.512±0.327	0.017±0.028	-	0.945±0.064	0.087±0.009
EP16	-0.316±0.024	0.818±0.155	0.647±0.001	0.006±0.062	0.745±0.543	-	0.132±0.345
EP18	-0.229±0.087	0.198±0.243	0.432±0.514	0.389±0.432	0.261±0.131	0.456±0.064	-
Cari-Suneheri	ASM	EP8	EP10	EP12	EP14	EP16	EP18
ASM	-	-0.903±0.206	-0.817±0.186	-0.792±0.104	-0.661±0.456	-0.617±0.289	-0.542±0.154
EP8	-0.912±0.431	-	0.941±0.196	0.312±0.147	0.098±0.089	0.156±0.168	0.124±0.114
EP10	-0.834±0.018	0.159±0.251	-	0.426±0.095	0.288±0.121	0.631±0.169	0.373±0.234
EP12	-0.739±0.016	0.072±0.045	0.264±0.128	-	0.386±0.256	0.045±0.129	0.038±0.137
EP14	-0.637±0.087	0.678±0.178	0.547±0.234	0.119±0.059	-	0.311±0.211	0.543±0.342
EP16	-0.574±0.224	0.682±0.352	0.397±0.148	0.841±0.277	0.132±0.045	-	0.128±0.096
EP18	-0.342±0.087	0.431±0.132	0.439±0.244	0.122±0.187	0.364±0.144	0.237±0.243	-

ASM-Age at Sexual Maturity, EP-Egg Production Number, EP8-up to 8th week, EP10-up to 10th week, EP12-up to 12th week, EP14-up to 14th week, EP16-up to 16th week, EP18-up to 18th week, (n)-numbers

Table 5: Shows the relationships between genetic (up diagonal) and phenotypic (lower diagonal) features for Japanese quail egg quality traits along with standard errors

Cari-Brown	Albumen width	Albumen height	Albumen weight	Haugh unit	Yolk height	Yolk diameter	Yolk weight	Shape index	Egg weight
Albumen width	-	0.181±0.192	0.280±0.093	-0.223±0.092	-0.019±0.210	0.0169±0.101	0.072±0.096	-0.226±0.083	0.175±0.201
Albumen height	-0.745±0.753	-	-0.016±0.198	0.851±0.027	0.093±0.085	-0.059±0.271	0.022±0.095	-0.014±0.085	0.172±0.099
Albumen weight	-0.732±0.224	0.767±0.723	-	-0.066±0.078	-0.317±0.098	-0.099±0.028	0.039±0.099	-0.093±0.033	0.123±0.130
Haugh unit	-0.880±0.763	0.968±0.100	0.610±0.703	-	0.094±0.081	-0.059±0.010	0.049±0.005	0.020±0.065	0.148±0.099
Yolk height	0.072±0.228	0.098±0.403	-0.555±0.226	0.137±0.589	-	0.961±0.301	-0.088±0.077	0.146±0.083	0.042±0.111
Yolk diameter	-0.441±0.100	0.711±0.001	-0.169±0.030	0.684±0.001	0.258±0.010	-	0.735±0.098	-0.071±0.090	0.018±0.081
Yolk weight	-0.086±0.321	-0.376±0.640	0.205±0.327	-0.046±0.653	-0.428±0.272	0.861±0.101	-	0.062±0.084	-0.126±0.081
Shape index	0.099±0.976	-0.030±0.050	-0.244±0.835	0.338±0.080	-0.041±0.723	0.866±0.201	0.836±0.251	-	-0.003±0.292
Egg weight	0.396±0.378	-0.683±0.722	0.362±0.282	-0.723±0.960	-0.339±0.221	0.092±0.010	0.458±0.565	0.462±0.012	-
Cari-Suneheri	Albumen width	Albumen height	Albumen weight	Haugh unit	Yolk height	Yolk diameter	Yolk weight	Shape index	Egg weight
Albumen width	-	0.198±0.111	-0.086±0.160	0.182±0.122	-0.053±0.116	-0.159±0.082	0.028±0.142	0.008±0.073	-0.162±0.084
Albumen height	0.083±0.245	-	-0.191±0.110	0.897±0.010	0.193±0.101	0.076 ±0.063	0.106±0.111	-0.080±0.084	0.082±0.005
Albumen weight	-0.073±0.210	-0.094±0.131	-	-0.228±0.100	-0.040±0.107	0.068 ±0.076	0.212±0.010	0.073±0.073	0.191 ±0.023
Haugh unit	0.070±0.245	0.960±0.010	-0.160±0.220	-	0.180±0.132	0.067 ±0.074	-0.117 ±0.001	-0.076 ±0.084	0.067 ±0.295
Yolk height	-0.029±0.227	0.281±0.123	-0.053±0.224	0.291±0.213	-	0.092 ±0.096	-0.095 ±0.130	0.046±0.090	-0.130 ±0.194
Yolk diameter	-0.628±0.386	-0.171±0.443	0.220±0.117	0.193±0.403	-0.142±0.350	-	0.682 ±0.295	0.164 ±0.392	0.063 ±0.090
Yolk weight	0.149±0.230	-0.086±0.281	0.360±0.026	0.099±0.273	-0.030±0.220	0.523 ±0.115	-	0.165 ±0.053	-0.083 ±0.196
Shape index	0.347±0.753	-0.366±0.772	-0.192±0.631	-0.359±0.867	-0.640.850	-0.453±0.070	0.968 ±0.670	-	0.143 ±0.029
Egg weight	0.091±0.151	0.082±0.079	-0.093±0.440	-0.392±0.356	-0.342±0.409	-0.363 ±0.100	0.141 ±0.255	0.268 ±0.974	-

The consistently strong negative genetic correlation between ASM and early egg production (-0.78 to -0.95) across both lines provides robust evidence that reducing age at first egg will accelerate early-laying performance without compromising total output. Similarly, the high positive genetic correlations among part-period egg numbers from 10 to 16 weeks imply that selection on any single period within this window will elicit substantial correlated gains throughout the early laying phase, enabling rapid cumulative genetic progress.

Conclusion

The profitability of Japanese quail enterprises hinges on early sexual maturity, sustained egg production, and superior egg quality. This study demonstrates that the dual-purpose CARI-BROWN line achieves significantly earlier age at sexual maturity (48.6 vs. 52.6 days) and higher early-phase egg number than the egg-specialised CARI-SUNEHERI line, whereas both lines exhibit comparable performance during peak production (10-18 weeks) and largely similar egg quality profiles at 12 weeks of age. Most importantly, moderate-to-high heritability estimates for part-period egg number ($h^2=0.31-0.53$) and key egg quality traits (notably egg weight, albumen height, Haugh unit, and yolk parameters), combined with strong favourable genetic correlations particularly the near-perfect association between albumen height and Haugh unit ($r_g \geq 0.85$) and the consistently strong negative correlation between age at sexual maturity and early egg production ($r_g=-0.78$ to -0.95) reveal substantial additive genetic variation exploitable through selection.

These findings establish the 12-16-week production window as the most heritable and genetically correlated phase for predicting lifetime egg yield, while confirming that selection for reduced age at sexual maturity will simultaneously accelerate early lay without compromising total output or egg quality. The strong positive genetic interrelationships among egg number periods and among internal quality components further indicate that multi-trait selection will produce balanced, cumulative genetic gains across economically critical traits.

In practical terms, incorporation of age at sexual maturity, cumulative egg number at 12-16 weeks, and Haugh unit/albumen height into selection indices for both CARI-BROWN and CARI-SUNEHERI lines will enable rapid, simultaneous improvement of production efficiency and egg market value. Such a targeted breeding strategy offers a highly effective and resource-efficient pathway to enhance the productivity, sustainability, and commercial competitiveness of Japanese quail farming systems worldwide.

Reference

1. Agarwal SK, Narayan R, Singh DP, Gopal R. Abstract paper presented at the VI Annual Poultry Science Symposium and Conference, Bhubaneswar, India. AGB-15; 1994.
2. Aggrey SE, Badu AGA, Marks HL. Effect of long-term divergent selection on growth characteristics in Japanese quail. *Poult Sci.* 2003;82(4):538-542.
3. Barbieri A, Ono RK, Cursino LL, Farah MM, Pires MP, Bertipaglia TS, *et al.* Genetic parameters for body weight in meat quail. *Poult Sci.* 2015;94:169-171.
4. Baumgartner J. Japanese quail production, breeding and genetics. *Worlds Poult Sci J.* 1994;50(3):227-235.
5. Crawford RD. Origin and history of poultry species. In: Crawford RD, editor. *Poultry breeding and genetics*. Amsterdam: Elsevier; 1990, p. 1-41.
6. Howes JR. Japanese quail as found in Japan. *Quail Q.* 1964;1:19-30.
7. Daikwo SI, Dim NI, Momoh MO. Hatching characteristics of Japanese quail eggs in a tropical environment. *Int J Poult Sci.* 2011;10:876-878.
8. Kumari BP, Gupta BR, Prakash MG, Reddy AR, Reddy KS. Genetic studies on productive and reproductive traits of Japanese quails. *Indian J Anim Sci.* 2009;43(4).
9. Lotfi E, Zerehdaran S, Raoufi Z. Genetic properties of egg quality traits and their correlations with performance traits in Japanese quail. *Br Poult Sci.* 2012;53(5):585-591.
10. Funk EM. The relation of the yolk index determined in natural position to the yolk index as determined after separating the yolk from albumen. *Poult Sci.* 1948;27:376-380.
11. Genchev A, Mihaylova G, Ribarski S, Pavlov A, Kabakchiev M. Meat quality and composition in Japanese quails. *Trakia J Sci.* 2008;6(4):72-82.
12. Hassan HA, El-Nesr SS, Osman AMR, Arram GA. Ultrastructure of eggshell, egg weight loss and hatching traits of Japanese quail varying in eggshell color and pattern using image analysis. *Egypt Poult Sci J.* 2013;34:1-17.
13. Monika M. Genetic analysis of production and immune competence traits in three varieties of domesticated Japanese quails having different plumage [Thesis]; 2020.
14. Narayan R, Singh H, Singh DP, Prasad S, Mishra SK, Mishra AK, *et al.* Growth analysis in CARI Uttam, CARI Sweta Japanese quails and their crosses using various models. *Indian J Poult Sci.* 2008;43(3).
15. Petek M, Dikmen S. The effects of prestorage incubation of quail breeder eggs on hatchability and subsequent

- growth performance of progeny. Anim Res. 2004;53(6):527-534.
16. Reddish JM, Nestor KE, Lilburn MS. Effect of selection for growth on onset of sexual maturity in randombred and growth-selected lines of Japanese quail. Poult Sci. 2003;82:187-191.
 17. Srinivasan D. *Genetic analyses of humoral and specific immunocompetence in three Japanese quail populations* [M.V.Sc. Thesis]. Izatnagar (UP): Deemed University, IVRI; 2006.
 18. Thear K. Keeping quail: A guide to domestic and commercial management. 3rd Ed. London: Broad Leys Publishing; 1998.
 19. Vali N, Edriss MA, Rahmani HR. Genetic parameters of body and some carcass traits in two quail strains. Int J Poult Sci. 2005;4:296-300.
 20. Zita L, Ledvinka Z, Klesalova L. The effect of the age of Japanese quails on certain egg quality traits and their relationships. Vet Arh. 2013;83:223-232.

How to Cite This Article

Krishna KS, Narayan R, Rokade J, Verma MR, Monika M, Govindaiah PM. Partial periods for genetic evaluation of egg production and egg quality attributes in two varieties of Japanese quails. International Journal of Veterinary Sciences and Animal Husbandry. 2025;10(12):440-445.

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