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Original Article

# Growth Performance, Egg Production, and Egg Quality Characteristics of Japanese Quail Lines Obtained by Selection According to Feather Color

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■Keywords

Egg production, egg quality, growth perfomance, Japanese quail.



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## ABSTRACT

This study aimed to investigate the feed intake, feed conversion ratio, growth performance, first laying age, and egg quality of Japanese quail lines. The study material consisted of Yamtar-I and Yamtar-II Japanese quail lines bred on a private farm in Karaman province, along with a control group derived from these lines. From 0-5 weeks of age, Yamtar-II showed higher live weight than the control group at 5 weeks, though averages were similar during the first four weeks of age ($p<0.01$). Growth and fattening analysis revealed significant differences in live weight gain and daily live weight gain between 3-4 and 4-5 weeks of age ($p<0.05$), while feed intake and feed conversion ratios were similar. Egg production was monitored from first laying to 93 days of age, with quails housed in 1:2 (male/female) single mating cages. At 10 weeks of age, egg quality characteristics were analyzed using 20 quail eggs per group. The control group showed delayed egg laying ($p<0.01$), and lower egg production ($p<0.05$) compared to the other groups. Significant differences in egg and yolk weights ($p<0.01$) were found among the groups. On the other hand, shape index, shell thickness, shell ratio, yolk ratio, Haugh unit, albumen weight, and albumen ratio were similar. In conclusion, Yamtar-I and Yamtar-II lines, which were obtained by selection by the breeder, showed no significant differences in fattening. Moreover, Yamtar-I have demonstrated better egg production and quality characteristics compared to the control group. These findings suggest that applying a conscious selection strategy could enhance commercial quail breeding potential.

## INTRODUCTION

The process of domestication has resulted in notable enhancements in the body structure and body weight of wild Japanese quails. The live weight of wild quail is reported to vary between 67.6-110 g (McGowan *et al.*, 1995; Chang *et al.*, 2009; Wamuyu *et al.*, 2017). Domestication has brought genetic advances in quail morphology and productivity (Wamuyu *et al.*, 2017; Lukanov & Pavlova, 2020). New quail lines and breeds have emerged from many years of selection (Batki *et al.*, 2023). Selection practices have affected both body structure (Akcapinar & Ozbeyaz, 1999) and productivity (Suda & Okamoto, 2003). As a result of conscious or unconscious selection by breeders, new subtypes called Ukrainian, Mediterranean, Cyprus, Jumbo are being created, and the number of these types increases day by day (Kirikci *et al.*, 2021; Inal *et al.*, 2022). Selection has caused variation in egg production and egg characteristics, along with morphological changes in quails. In studies on egg production, the first egg-laying age of quails was reported at 40-44 days by Batki *et al.* (2023), 43 days by Nazligul *et al.* (2001), 45.72 days by Cerit & Altinel (1998), and 48-61 days by Caglayan & Seker (2015).

Various studies on egg quality in Japanese quails with different feather colors have reported that it can be affected by genetic factors as well as environmental factors ( Yılmaz & Caglayan, 2008; Kanagaraju *et al.*, 2013; Celik *et al.*, 2014; Celik *et al.*, 2015; Bagh *et al.*, 2016; Simsek *et al.*, 2016; Petek *et al.*, 2022; Arslan *et al.*, 2023). This study examined the productivity characteristics of the Yamtar-I and Yamtar-II quail lines obtained through feather color selection. These quail lines result from the combination of different colored quails from Japanese quails bred by a breeder in Karaman province.

## MATERIALS AND METHODS

### *Ethical Approval*

The approval for the procedures performed in this study was obtained from the Ethics Committee of the Experimental Animal Production and Research Centre of the Faculty of Veterinary Medicine of Selçuk University on 20.10.2021, under decision number 2021/112.

### *Animal Material*

The study was carried out in Yamtar Agriculture and Livestock Enterprises, a private enterprise in Karaman province (37° 11' 45.7908" N, 33° 1' 48.4500" E). The control group of the study consisted of 300-day-old Japanese quails without selection. The name Yamtar given to quails was chosen by the breeder because it was the name of the company. The Yamtar-I and Yamtar-II groups were obtained because of the selection of the control group according to feather color by the breeder. For twenty years, the breeder named the animals Yamtar-I and Yamtar-II based on their feather color. As a result of the selection, a flock of 300 quails at the age of 1 day was formed for each quail line. Control, Yamtar I and Yamtar II groups were randomly divided into 100 chicks per group, and three replications were performed.

### *Care and Breeding Conditions*

The animals utilized in the experiment were subjected to a 16-hour light and 8-hour dark cycle throughout the duration of the research period. Heat was provided by heaters for the first three weeks. The quails were fed 20% CP and 3000 kcal ME for the first 5 weeks, and 16% CP and 2850 kcal ME from the age of 5 weeks until the end of the experiment. All groups were provided feed and freshwater *ad libitum*. The density of the quail cages was set at 200 $cm^2$ per animal. The quails were reared under the same care and feeding conditions.

### *Growth Performance*

To determine the growth and fattening performance of the quail groups, 10 quails from each replicate and a total of 30 quails from each group were randomly selected up to 5 weeks of age, and weekly live weight averages were determined by individual weighing (0.01 g KERN PFB 1200). Weekly feed consumption and feed conversion ratios were determined by weighing the feed consumption of the experimental groups for the same weeks. The feed conversion ratio was determined following the equation 1.

$$\text{Feed conversion ratio} = \frac{\text{Weekly feed consumption}}{\text{Weekly live weight gain}} \quad (1)$$

### *First Egg-Laying Age, Egg Production and Egg Quality Characteristics*

To determine the first egg-laying age, egg quality characteristics, egg production and hatching performance, 20 female and 10 male quails from each group were placed in mating cages at the age of 5 weeks. The ages of the first egg laying were recorded and calculated as a group average. The egg production of quails was determined by taking daily records between 35-103 days of age and calculated as the group average. To determine the quality characteristics of the eggs, 20 eggs obtained from quails that had reached 10 weeks of age from each group were examined. Egg quality characteristics were determined using a digital caliper with 0.01 mm precision and a digital scale with 0.01 g precision. Equations 2 to 7 were used to determine the egg quality characteristics of the experimental groups (Dere and Guler, 2021):

$$\text{Albumen weight (g)}:\text{Egg weight} - (\text{Yolk weight} + \text{Shell weight}) \quad (2)$$

$$\text{Shape index (\%)}: (\text{Egg width}/\text{Egg length}) \times 100 \quad (3)$$

$$\text{Albumen ratio (\%)}: (\text{Albumen weight} / \text{Egg weight}) \times 100 \quad (4)$$

$$\text{Yolk ratio (\%)}: (\text{Yolk weight} / \text{Egg weight}) \times 100 \quad (5)$$

$$\text{Shell ratio (\%)}: (\text{Shell weight} / \text{Egg weight}) \times 100 \quad (6)$$

$$\text{Haugh Unit}: 100 \log[\text{Albumen height} - (1.7 \times \text{Egg weight}^{0.37}) + 7.57] \quad (7)$$

### *Statistical Analysis*

Statistical analysis of the data was performed using the SPSS 25.0 software. Data normality examinations were performed using the Shapiro-Wilk test.

Variance analysis was used in the statistical analysis of data on egg yields, egg quality characteristics, growth and fattening performance. The significance of the differences between groups was determined by applying the Duncan Test.

## RESULTS

Live weights of experimental groups up to 5 weeks of age are shown Table 1.

**Table 1 –** Live weights of experimental groups up to 5 weeks of age (x±Sx).

| Week | Groups | N | Live Weight |
|---|---|---|---|
| Hatching | Control | 30 | 7.32±0.12 |
| | Yamtar-I | 30 | 7.15±0.14 |
| | Yamtar-II | 30 | 7.16±0.12 |
| | Total | 90 | 7.21±0.07 |
| *p*-value | | | 0.586 |
| 1 | Control | 30 | 25.63±1.22 |
| | Yamtar-I | 30 | 26.57±0.74 |
| | Yamtar-II | 30 | 25.57±0.91 |
| | Total | 90 | 25.92±0.56 |
| *p*-value | | | 0.722 |
| 2 | Control | 30 | 54.13±1.95 |
| | Yamtar-I | 30 | 58.90±1.64 |
| | Yamtar-II | 30 | 54.90±1.75 |
| | Total | 90 | 55.98±1.04 |
| *p*-value | | | 0.134 |
| 3 | Control | 28 | 93.68±2.35 |
| | Yamtar-I | 28 | 91.32±2.57 |
| | Yamtar-II | 29 | 92.48±2.89 |
| | Total | 85 | 92.49±1.50 |
| *p*-value | | | 0.82 |
| 4 | Control | 30 | 137.20±3.67 |
| | Yamtar-I | 30 | 136.83±2.30 |
| | Yamtar-II | 30 | 140.73±2.84 |
| | Total | 90 | 138.26±1.72 |
| *p*-value | | | 0.597 |
| 5 | Control | 30 | 164.20±3.31[b] |
| | Yamtar-I | 30 | 171.33±3.13[a, b] |
| | Yamtar-II | 30 | 185.37±3.71[a, b, c] |
| | Total | 90 | 173.63±2.15 |
| *p*-value | | | *** |

*** Difference between values with different letters in live weights of the same week of age ($p$<0.01).

In the initial four-week period, the live weights of the control, Yamtar-I and Yamtar-II lines of the experimental groups were similar. However, in the fifth week, it was observed that the Yamtar-II line exhibited a higher live weight than the control group ($p$<0.01) (Table 1).

Live weight gain (LWG), daily live weight gain (DLWG), daily feed consumption (DFC), and feed conversion ratio (FCR) by week are shown in Table 2.

**Table 2 –** Live weight gain (LWG), daily live weight gain (DLWG), daily feed consumption (DFC) and feed conversion ratio (FCR) by week (x±Sx).

| Week | Groups | LWG (g) x̄±Sx | DLWG (g) x̄±Sx | DFC (g) x̄±Sx | FCR x̄±Sx |
|---|---|---|---|---|---|
| 0-1 | Control | 18.32±2.08 | 2.62±0.30 | 3.21±0.35 | 0.82±0.08 |
| | Yamtar-I | 19.41±1.84 | 2.77±0.26 | 2.92±0.16 | 0.95±0.10 |
| | Yamtar-II | 18.41±2.35 | 2.63±0.34 | 2.39±0.18 | 1.11±0.18 |
| | Total | 18.71±1.89 | 2.67±0.27 | 2.84±0.42 | 0.96±0.17 |
| | *p*-value | 0.587 | 0.587 | 0.051 | 0.088 |
| 1-2 | Control | 28.50±1.34 | 4.07±0.20 | 10.56±0.63 | 2.60±0.20 |
| | Yamtar-I | 32.33±0.75 | 4.62±0.11 | 7.40±1.10 | 1.60±0.27 |
| | Yamtar-II | 29.33±1.79 | 4.19±0.26 | 7.28±1.95 | 1.74±0.48 |
| | Total | 30.06±2.11 | 4.29±0.30 | 8.41±1.99 | 1.98±0.55 |
| | *p*-value | 0.050 | 0.050 | 0.066 | 0.066 |
| 2-3 | Control | 39.63±2.98 | 5.66±0.74 | 21.82±4.59 | 3.94±1.20 |
| | Yamtar-I | 31.73±0.96 | 4.53±0.14 | 7.52±3.00 | 1.65±0.61 |
| | Yamtar-II | 39.70±0.69 | 5.67±0.10 | 10.29±4.17 | 1.82±0.75 |
| | Total | 37.02±4.77 | 5.29±0.68 | 13.21±7.42 | 2.47±1.35 |
| | *p*-value | 0.059 | 0.059 | 0.061 | 0.066 |
| 3-4 | Control | 43.44±9.67 | 6.21±1.38 | 27.75±6.92 | 4.45±0.30 |
| | Yamtar-I | 45.62±6.54 | 6.52±0.94 | 13.64±1.19 | 2.13±0.41 |
| | Yamtar-II | 48.23±4.84 | 6.89±0.69 | 16.40±3.38 | 2.38±0.43 |
| | Total | 45.76±6.65 | 6.54±0.95 | 19.26±7.56 | 2.99±1.15 |
| | *p*-value | 0.957 | 0.957 | 0.079 | 0.061 |
| 4-5 | Control | 27.00±2.76[b] | 3.86±0.39[b] | 24.77±5.11 | 6.42±1.17 |
| | Yamtar-I | 34.50±4.00[b] | 4.93±0.57[b] | 19.62±4.50 | 4.03±1.08 |
| | Yamtar-II | 44.63±5.98[a] | 6.38±0.85[a] | 20.13±9.25 | 3.32±1.93 |
| | Total | 35.38±8.58 | 5.05±1.22 | 21.51±6.25 | 4.59±1.88 |
| | *p*-value | 0.027 | 0.027 | 0.393 | 0.177 |

[a, b] Differences between values with different letters in the same column are significant ($p$<0.05).

Table 2 shows that the experimental groups were similar in terms of LWG, DLWG, DFC and FCR during the first four weeks, but there was a difference between the experimental groups in LWG and DLWG values at 4-5 weeks of age ($p$<0.05). In the fifth week, LWG values of the experimental groups were respectively 27.00 g, 34.50 g, 44.63 g in control, Yamtar-I and Yamtar-II quails; and DLWG values were calculated as respectively 3.68 g, 4.93 g and 6.38 g ($p$<0.05). The 0–5-week average DFC (g) and FCR values of the experimental groups were calculated to be 21.51 g and 4.59 respectively, and the groups were found to be similar in the first five weeks of age among the experimental groups.

Egg production and quality characteristics of the experimental groups are shown in Table 3.

**Table 3 –** Egg production and quality characteristics of the experimental groups (x±Sx).

| | Control n = 20 | Yamtar-I n = 20 | Yamtar-II n = 20 | Total n = 60 | *p*-value |
|---|---|---|---|---|---|
| First laying age | 41.8±0.81[a] | 35.8±0.25[b] | 35.8±0.25[b] | 37.8±1.31 | ** |
| Egg yield/68 days (%) | 48.35[b] | 72.07[a] | 71.91[a] | 64.11 | ** |
| Egg weight(g) | 11.10±0.19[b] | 12.75±0.19[a] | 12.55±0.16[a] | 12.13±0.14 | ** |
| **External Quality Characteristics** | | | | | |
| Shape Index | 73.27±3.2 | 78.83±0.72 | 76.79±0.65 | 76.3±1.13 | - |
| Shell Thickness (mm) | 0.12±0.00 | 0.12±0.00 | 0.08±0.00 | 0.11±0.00 | - |
| Shell Ratio (%) | 9.65±0.82 | 10.96±0.62 | 8.60±1.02 | 9.74±0.50 | - |
| **Internal Quality Characteristics** | | | | | |
| Haugh Unit | 86.56±0.7 | 84.41±0.86 | 86.4±0.99 | 85.8±0.5 | - |
| Albumin Weight (g) | 6.82±0.25 | 7.5±0.39 | 7.68±0.22 | 7.33±0.17 | - |
| Albumin Ratio (%) | 61.39±1.8 | 58.78±2.89 | 61.11±1.91 | 60.43±1.29 | - |
| Yolk Weight (g) | 3.36±0.1[a] | 4.25±0.12[a] | 3.99±0.1[c] | 3.85±0.08 | * |
| Yolk Ratio (%) | 28.95±1.73 | 30.26±1.73 | 29.97±1.65 | 29.73±1.14 | - |

[a, b, c]Differences between values with different letters in the same row are significant (*<0.05; **<0.01).

The mean first laying ages of the control, Yamtar-I and Yamtar-II groups were found to be 41.8±0.81 days, 35.8±0.25 days and 35.8±0.25 days, respectively. While Yamtar-I and Yamtar-II groups were found to be similar, a difference was found between them and the control group ($p$<0.01). The egg yield of the control group was lower than that of the other groups ($p$<0.01). The egg yields in the control, Yamtar-I and Yamtar-II groups were respectively 48.36%, 72.07 and 71.98 (Table 3). As shown in Table 3, the difference between the groups in terms of egg weight was significant ($p$<0.01), and other external egg quality characteristics were similar between the groups. It was found that yolk weight, yolk height and yolk width were different among the experimental groups ($p$<0.01), but there was no difference among the other parameters.

## DISCUSSION

### Growth Performance

The live weights of quails at five weeks of age were 161.33, 164.33, and 183.17 g in the control, Yamtar-I, and Yamtar-II quail lines, respectively. The Yamtar-II quail line was identified as the heaviest group ($p$<0.05) (Table 1). Mahmoudi Zarandi *et al.* (2023) reported live weight values for Japanese quails at 45 days of age of 214.29-243.38 g. The difference observed at the high values might be due to age difference.

The live weights of the experimental groups at 3 weeks of age were calculated between 91.32-93.68 g, and the live weights of the groups were found to be similar. These values are high compared to the value of 79.96-82.13 g reported by Mahmoudi Zarandi *et al.* (2023) for 20-day-old Japanese quails, and low compared to the value of 199 g reported by Cullere *et al.* (2023) for 25-day-old meat type quails. This difference may be due to differences in genotype, care, and feeding.

The fifth week live weights of the control, Yamtar-I, and Yamtar-II lines were found to vary between 164.20 and 185.37 g. The Yamtar-II quail line exhibited a greater weight in this week ($p$<0.01). The discrepancy in the live weight of Yamtar-II quails from the selected subtypes may be attributed to the moderate heritability of meat yield (Darden & Marks, 1988) or the observation that animals with yellow feather coloration tend to be heavier (Guler *et al.*, 2022).

Guler *et al.* (2022) reported the live weight values of brown and yellow feather-colored quails of 183.07-166.2 g and 192.53-198.62 g, respectively in the fifth and sixth weeks. The same researchers stated that quails with yellow feather color are more suitable for meat production. In this study, the fact that the 5th week live weight of the Yamtar-II quail line with yellow feather color was high supports the hypothesis that the feather color difference may influence live weight. Batki *et al.* (2023) reported a significant difference in live weight between the groups in the fifth week (214-273 g) of the CUM and CUS lines developed by selection at Çukurova University compared to the control group. Baylan (2017) reported that in the fifth week, live weight values (280-299 g) of the M55, R33, and S55 quail lines were higher than the live weights of the lines obtained from individual selection compared to cross selection. The reported live weights in the literature (Baylan, 2017; Batki *et al.*, 2023; Cullere *et al.*, 2023) are higher than the weights found for quail lines utilized in this study. The difference between the fifth week live weight values of this study and those reported in the literature may be attributed to differences in genotype, selection (Minvielle *et al.*, 1999), or care and feeding methods.

The data indicated that the DFC and FCR values determined during the five-week fattening period were comparable between the groups. The FCR values of the groups were 6.42, 4.03, and 3.32, respectively for the control, Yamtar-I, and Yamtar-II genotypes. These values are higher than the 2.84-3.31 value reported by Batki *et al.* (2023), and the 2.78 finding reported by Alkan & Karabag (2021) at 4 weeks of fattening, and are consistent with the finding of Cullere *et al.* (2023) that the FCR value in meat genotypes was 4.31

at 15-35 days. This difference may be due to age and genotype differences.

It can be posited that the Yamtar-II line of quails exhibited a superior growth rate performance in comparison to other groups (Table 2). In this study, the highest LWG was observed between the ages of 3-4 weeks. The LWG was found to be similar between the groups during the initial four weeks of age. However, at four to five weeks of age, the Yamtar-II genotype exhibited a higher LWG than the other groups ($p$=0.027). In a similar vein to the present study, the highest LWG value was reported by Batki *et al.* (2023) in the third and fourth weeks. The only statistically significant difference in DLWG values, such as LWG, was observed for the Yamtar-II genotype at 4-5 weeks of age ($p$=0.027). The high growth rate of the yellow feather colored Yamtar-II supports the findings of Guler *et al.* (2022).

In the study examining the effects of five different egg weight groups on growth and fattening performance up to six weeks of age after hatching in quails, it was reported that feed consumption amounts were similar between the groups, but there was a difference in FCR (Karaman & Bulut, 2018). Similarly, the study revealed no significant difference in feed consumption. In this study, differences in FCR value could not be detected either, which may be due to a divergence in the methodology employed for animal care and feeding, as proposed by Karaman & Bulut (2018).

## Egg Production and Egg Quality Characteristics

The first egg-laying ages of the control, Yamtar-I and Yamtar-II quail groups were found to be 41.8-35.8 and 35.8 days, respectively (Table 3). The first egg laying age of Yamtar-I and Yamtar-II groups was lower than the control group ($p$<0.01), and Yamtar-I and Yamtar-II groups were found to be similar to each other. Batki *et al.* (2023) reported the first egg-laying ages as 40-44 days in all quail groups. On the other hand, the first egg-laying ages of the Yamtar-I and Yamtar-II quail lines used in this study happened earlier than the values reported in the literature (Kayang *et al.*, 2004; Alkan *et al.*, 2010; Batki *et al.*, 2023). Although an earlier age of first egg laying has the advantage of shortening the generation interval through selection, it can also result in the production of a large numbers of small eggs that are not commercially viable.

The egg yields of the Yamtar-I and Yamtar-II lines (72.07% and 71.98%) were higher than those of the control group (48.35%) ($p$<0.01). Batki *et al.* (2023) determined 14-week egg yields to be 74.98%, 75.09, 75.34, 79.13, 69.38 and 78.08 in research groups CUK, CUS, TK, TS, CUM and TM; Kocak *et al.* (1995) observed a 25-week egg yield of 83.9%; Taskin *et al.* (2017) determined the average egg yield as 73.9% and 75.9 respectively in two generations as a result of selection for body weight; and Seker *et al.* (2005) found a 23-week average yield of 76.05%. The control group yielded lower results than those previously reported in the literature. Furthermore, the egg yields of the Yamtar-I and Yamtar-II lines were found to be inferior to those of the lines utilized by Seker *et al.* (2005). The observed differences can be attributed to the genotypes of the animals in question, particularly the presence or absence of selection for egg production in the studied lines.

Egg weight is a quality parameter that is important for both consumers and producers (Genchev, 2012). Furthermore, it is a significant factor influencing eggshell quality in quails, which has economic implications (Petek *et al.*, 2022). In studies conducted on quails, egg weight has been reported to be between 10.15-14.45 g, depending on genetic and environmental factors (Celik *et al.*, 2015; Petek *et al.*, 2022; Arslan *et al.*, 2023). As seen in Table 3, the egg weight of the quail experimental groups was observed to be 11.10, 12.75, and 12.55 g in the control, Yamtar-I, and Yamtar-II lines, respectively ($p$<0.01). The egg weight obtained from the quail lines utilized in this study was found to be consistent with the data presented in the literature.

In many studies conducted with Japanese quails, researchers reported that egg weight increased as a result of selection in terms of body weight (Alkan *et al.*, 2008, Baylan, 2017). The fact that the egg weights of the Yamtar-I and Yamtar-II lines, which have high live weights, are also higher than the control group thus supports the literature. In addition, the difference in egg weight among the groups may be due to differences in feather color (Arslan *et al.*, 2023), high correlation between egg weight and live weight, or selection ( Altan *et al.*, 1998; Turkmut *et al.*, 1999; Hanusova *et al.*, 2016).

In this study, shape index was found to be 76.3, shell thickness was 0.11 mm, and shell ratio was 9.74% (Table 3). The relevant findings were found to be consistent with the studies conducted by Bagh *et al.* (2016), Arslan *et al.* (2023), and Hassan *et al.* (2017), but different from the results of Genchev (2012), Sari *et al.* (2012). It is thought that this divergence may be due to environmental factors.

The Haugh unit is generally known as a quality characteristic that affects egg choices among consumers (Arslan *et al.*, 2023). Haugh unit values were between 84.41-86.56, and the groups were found to be similar (Table 3). This finding is consistent with the Haugh unit findings reported in the studies of Kanagaraju *et al.* (2013), who examined 28-week-old Japanese quail eggs; Bagh *et al.* (2016), who investigated the egg quality of quails with different feather colors; and Arslan *et al.* (2023), who studied 23 and 39-week-old Japanese and Jumbo quails.

Egg yolk is a quality parameter that affects the mortality of chicks, especially in the first week (Turkmut *et al.*, 1999). The findings revealed that the egg yolk weight, egg height, and egg width of the control group were significantly lower than those of the Yamtar II group ($p<0.05$), and exhibited similarities to those of the Yamtar I group (Kaminska & Skraba, 1991, Romao *et al.*, 2010).

## CONCLUSION

The analysis of growth and fattening performances only showed differences between the groups in the 5th week ($p<0.01$). It can be said that conscious and controlled selection is an effective method, given the real potential of the Yamtar-I and Yamtar-II lines. Upon evaluation of the differences identified in the study, it was determined that the Yamtar-I line exhibited potential in terms of egg yield and quality characteristics. There is need for a conscious selection that can fully reveal the potential of this line. This study reveals that any selection in quails, whether conscious or unconscious, is a factor that can cause new variations and lead to different effects on yields. In conclusion, the focus for Yamtar-I quails should be on selection or research for egg yield, as these quail lines have a potential for laying. Yamtar-II quails can be developed as a meat genotype, which may be due to their yellow feather color. Applying selection within these lines first and recording the yields of the individuals obtained by subjecting these two lines to experimental crossbreeding at different periods may be useful in revealing their genetic potential.

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## AUTHOR CONTRIBUTIONS

Conceptualization, AE, KK, KZK methodology, AE; software, AE, SMS; validation, AE, SMS, KG, KZK and TM; formal analysis, AE; investigation, AE; resources, AE, SMS, KG; data curation, AE; writing—original draft preparation, AE, KK, SSM, KZK; writing—review and editing, AE, KK, KZK; visualization, AE, KZK; supervision, AE, KK; project administration, KK.

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## DATA AVAILABILITY STATEMENT

The data supporting the findings of this study will not be shared with anyone other than the relevant author.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest of financial, personal or other nature with any other person or organization related to the material discussed in the article.

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