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Performance of Japanese quail (*Coturnix coturnix* Japonica) Subjected to Selection through Exchange of Male

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Original Research Article

Abstract

The research was undertaken to develop quails for high egg producer's large sized egg using selection through exchange the male. From the base population (100 male and 400 female) the foundation stock and their next generations produced keeping a steady state population (10 male and 40 female) through the Osborne selection index. The selection criteria in the selection index were the egg production and egg weight. In addition, other traits like age and weight at sexual maturity, mature live weight, feed intake, mortality and different egg quality traits were also studied. It observed that the male attained earlier maturity than female and female were heavier than male. From an initial population for successive generations subjected to selection both egg production (72.97±6.28 to 150±4.70/quail/year) and egg weight (8.37±0.0614 to 9.95±0.047g) has been improved. Fertility and hatchability of quails in all generations was enhanced and the incubation period was 19 days. Among the egg quality characteristics the albumin and yolk ratio was 1:1 and the shape index and the Haugh unit stayed 79 to 86 and 89 to 96%, respectively. The correlations of live weight with other traits showed positive. It could be seen that subjected to select in the successive generations the traits of Japanese quails improved.
Keywords: Correlation, generation, Japanese quail, selection and traits.

INTRODUCTION

Quail lay bright color tiny egg having weight ranges from 7 to 12g [1]. The clutch size of quail can vary between one to 12 eggs, based on the species of quail and quail chicks hatch out of their eggs. Minvielle et al. [2] developed four Japanese quail lines using 13 generations using reciprocal recurrent or within line selection for high egg number. Lotfi et al. [3] showed that the selection index consists of body weight, egg weight and eggshell strength is the best breeding strategy for the genetic improvement of egg quality and quantity in Japanese quail. Therefore, it quantified that reciprocal crossing and index selection for multiple traits could be the best option for developing a line of quail for large size high egg producers. Reciprocal crossing has the effect of retained heterosis and widely used for creation of new lines. For the of the best individual an effective approach is the selection index [4], which is a weighted linear function of selection criteria and breeding value for each trait in the breeding objectives with weights reflecting their relative importance. However, in case of poultry Osborne selection index [5] was best that considered into account for individual production and average performance of their full and half sibs.

Quail eggs are much richer in vitamin B_2, iron, potassium, calcium and phosphorus than chicken eggs. If the size of the quail egg can increase at least 1.5 times this will contributes more nutrient and egg mass. Egg size, color and weights are dependent on the factors of genetic and nutrient. Among these options, genetic is permanent and if a large size egg quail line developed by breeding, which will be the best solution to meet-up the nutrient demand of the nation. Therefore, the study has designed to develop quails for larger size, high **p**roducer's egg by reciprocal crossing subjected to selection and this paper reports the performances of three generations of quail's using Osborne selection index by exchange the male.

MATERIALS AND METHODS

Experimental birds, their feeding and breeding: Initial population (GI) was formed by purchased a total of 400 females and 100 males of Japanese quail (*Coturnix coturnix*, *japonica*) from the other farm at the age of one month. After purchasing they kept separately for 15 days in quarantine then they distributed at a ratio of 1:3 (male and female) in the cage for random mating. The breeding strategy was straightbreeding. The feederer, waterer and egg laying nest were provided in the cage. The selection criterion of this study was egg number and egg size (egg weight). Therefore, from the onset of lay the monthly egg production and egg weight were recorded up to end of lay. The hatching eggs were collected from the egg production at month three and 7 to 10 days eggs were hatched using an electric incubator. The best 10 male and 40 female from GI were selected based on the individual performance and a foundation stock (G0) was created. In the foundation stock, the monthly egg production and individual egg weight were recorded up to the end of lay. From this G0, 7 to 10 days eggs were collected and hatched using an electric incubator. Then the male was exchanged from one pen to another and allowed them for random mating with female. Again, after one month 7 to 10 days eggs were collected and hatched. The population size of G1 consists of 100 male and 160 female. The best 10 male and 40 female from G1 was selected using Osborne selection index [5] to produce second generation (G2) and recorded their monthly average egg production and individual egg weight up to end of lay. Similarly, the best 10 male and 40 female from G2 was selected. The population size was maintained in a steady state in all three generations (foundation, first generation and second generation) and rate of inbreeding (ΔF) existed 0.016 and the effective population size (Ne) was 32. The baby quails were brooded via maintaining standard brooding temperature. During the laying period lighting hours kept 16 in all successive generations under normal management and environmental conditions. All the quails were fed with the grower and layer ration, having the nutrient composition shown in Table 1. The feed ingredients were used in the ration: broken corn 34 to 42 %), broken wheat (22-27%), soybean meal (10-16%), rice polish (6 -14%), fish meal (9 -12%), soybean oil (0.5%), oyster shell (1-5%), vitamin-mineral premix (embavit) (0.25%) and common salt (0.25%). The quails were allowed for ad-libitum feeding.

Table-1: Nutrient composition of the grower and layer ration of quails

Nutrient's composition	Grower ration	Layer ration
Energy (kcal/kg)	2913	2900
Crude Protein (g/kg)	24.4	19.5
Ash	3.45	6.71
Calcium	1.44	3.87
Phosphorus	1.09	1.72
Lysine	0.85	0.68
Methionine	0.32	0.27

For choosing the best mate [5], selection index has constructed. By this procedure, the female was selected on the basis of an index that, took into account for individual production and average performance of its' full and half sibs. Optimum weights were assigned to those components that entered into the index. Likewise, the male was selected based on the performances of their full and half sibs. The formulae for both male and female index are as:

Female index,

$$I_F = \left(P - \bar{P}\right) + b_1\left(F_d - \bar{P}\right) + b_2\left(F_S - \bar{P}\right) \quad (1)$$

Male index,

$$I_M = \left(F_d - \bar{P}\right) + b_3\left(F_S - \bar{P}\right) \quad (2)$$

Where,

P= production of the individual

$\bar{P}$ =flock average

F_d=female (dam) family average (full sib average)

F_s= male (sire) family average (half sib average)

b_1= weightage factor for dam family mean in female selection.

b_2= weightage factor for sire family mean in female selection.

b_3= weightage factor for dam family mean in male selection.

Calculation of b1, b2 and b3 was as:

$$b_1 = \frac{2_n(1-h^2)}{4+(n-2)h^2}$$

$$b_2 = \frac{4nd(1-\bar{h}^2)(2-h^2)}{\left\{4+\left(\bar{n}-2\right)h^2\right\}\left[4+\left\{\bar{n}(1+d)-2\right\}h^2\right]}$$

$$b_3 = \frac{2d\left(2-h^2\right)}{4+\left\{\bar{n}(1+d)-2\right\}h^2}$$

Where,

n= number of progeny per dam

$\bar{n}$ = Average number of progeny per female (dam) within a sire= $\left(\frac{\text{total no of progeny of a sire}}{\text{no. of dam}}\right)$

d= number of dams per sire

h^2= heritability of the traits under selection (used cited values)

According to the index value top scored /ranked quails were selected.

Parameter studied

In addition to the egg production (number) and egg weight other traits such as fertility, hatchability, age and weight at sexual maturity, feed intake and feed conversion ratio (FCR), and egg quality traits were also studied. Fertility of eggs was calculated by candling the eggs at day 9th and 14th of the incubation period and hatchability of fertile eggs was calculated by the number of egg set and the number of hatched out eggs. Age and weight of each quail were recorded at laying of the first egg for calculating the age and weight at sexual maturity. Monthly egg production (no) of the quails from all generations was recorded in a clutch from the onset of lay. The mortality of the quails from all generations was recorded when death occurs. The eggs were collected daily from different pen and weighted by an electrical balance. For egg quality traits: the weight of egg yolk (g), albumin (g), egg shell (g) was taken by an electric balance and recorded. In addition to these traits, the egg length (mm) and widths (mm), yolk height (mm) and width (mm), albumen height (mm) and shell membrane thickness were also measured by slide calipers and micrometer respectively. From the collected data the egg shape index, yolk index and haugh unit [6] was calculated. The feed was supplied to the quail twice daily and the feed intake was calculated from the differences between the supply and leftover and feed conversion ratio was calculated as kg feed: kg live weight.

The mean of the different traits was analyzed using Proc GLM and Proc MIXED of SAS [7] following completely randomized design (CRD). The mean differences were compared using least significant difference (LSD) test [8] at the 5% level of significance.

RESULTS AND DISCUSSION

Age and weight at sexual maturity: The age and weight at sexual maturity and mature live weight (mean ±standard error) of quails in different generations are presented in Table 2. It was seen that the male attained earlier maturity than female in all generations and there were no significant differences found among generation (Table 2). Similar results were obtained for weight at sexual maturity in both sexes'.

Nonetheless male weight was poorer than female. The results of age at sexual maturity in the current study were harmony with the results obtained by Akinola *et al.* [9] but inferior to Daikwo *et al.* [10], they observed age at first egg was 47.01 days.

On the other hand, the weight at sexual maturity of both sexes was lower in the present study in comparison to the findings of Camci *et al.* [11] and Daikwo *et al.* [10] they reported the mean body weight at first egg was 145.68 g and 148.5 g, respectively. The low weight might be due to the effect of genetics and nutrition. Mature live weight of both sexes showed significant differences (P<0.05) among generation and female was heavier than the male. With the subjected to select the quail in the successive generations' body weight was increased. The same results of mature live weight of quail were found elsewhere [12] as the current study. However, higher live weight for female than male was recorded by Taskin *et al.* [13], who determined 160g for female and 149g for male. The weight differences among sex were obtained due to sex and also genetics.

Table-2: Age and weight at sexual maturity and mature live weight (mean ±standard error) of quails in different generations

Traits	Sex	Generations				P value
		GI	G0	G1	G2	
Age at sexual maturity (d)	M	55.6±5.34	56.4±5.25	54.52^{x}±1.85	53.44^{x}±1.85	0.179
	F	58.6 ±7.25	59.4±4.23	58.75^{y}±0.83	57.67^{y}±0.71	0.434
P value		0.115	0.067	0.043	0.021	
Weight at sexual maturity (g)	M	139.38^{x}±2.13	141.20^{x}±1.35	142.82^{x}±1.35	143.20^{x}±1.35	0.066
	F	150.86^{ay}±1.05	155.23^{by}±0.53	157.20^{bcy}±0.43	158.24^{cy}±0.52	0.033
P value		0.028	0.004	0.00065	0.0007	
Mature weight	M	145^{ax}±1.59	149^{bx}±1.91	156.25^{cx}±1.56	155.2^{cx}±1.53	0.0001
	F	155.25^{ay}±0.74	158.72^{by}±0.56	159.52^{by}±1.53	160.02^{by}±1.49	0.0045
P value		0.0077	0.0091	0.0056	0.0088	

Legends: GI= Initial population; G0= Foundation stock; G1=Generation one; and G2= Generation two. Means with different superscripts between column and row are differed significantly at P<0.05.

Feed Intake and Feed Conversion Ratio

Weekly average feed intake (g, mean ± standard error) and the feed conversion ratio of quails in different generations are presented in Table 3. The feed intake of both sexes increased with the age of quails in different generations (Table 3). The gradual increase of the feed intake of quails with the increases of age have been studied by Dudua *et al.* [12], who stated that feed intake increased with increases of age from 3.12±0.09g (week 0-1) to 15.16±0.08g at 5-6 weeks. During the first week of age, the feed intake (chicks/day/g) of male quail was significantly differed from GI and G2. However, at the 6 weeks of age, the same results were observed for both sexes but no differences found for the other weeks. The variation of feed intake might be occurred due to the age variation of the quails and feed quality. Feed conversion ratio (FCR) of all generations was alike for the female quail; on the other hand, differences were obtained in case of the male. The average value of FCR for quail in all the generations were obtained in this study for both sexes at the 8 weeks of age; and it was found 6.21 and 6.47 for male and female, respectively. Similar findings for FCR value of quail at the same age was reported by Robie *et al.* [14] and Vali [15].

Table-3: Weekly average feed intake (g, mean ± standard error) and feed conversion ratio of quails in different generations

Week	Sex	Generations				P value
		GI	G0	G1	G2	
1st	M	5.00^{a}±0.02	5.40^{b}±0.03	5.52^{b}±0.02	5.88^{c}±0.03	0.0034
	F	5.42±0.12	5.72±0.32	5.81±0.31	5.93±0.27	0.110
P value		0.046	0.341	0.062	0.076	
2nd	M	8.79^{a}±0.34	8.99^{a}±0.40	9.19^{ab}±0.46	9.79^{b}±0.38	0.05
	F	9.86±0.53	9.92±0.59	10.26±0.76	10.64±0.71	0.732
P value		0.119	0.058	0.098	0.055	
4^{th}	M	12.00^{a}±0.59	12.60^{ab}±0.73	13.20^{b}±0.79	13.76^{b}±0.77	0.041
	F	13.71^{a}±0.82	14.75^{ab}±0.76	15.32^{b}±0.98	15.79^{b}±0.76	0.028
P value		0.049	0.016	0.012	0.043	
6^{th}	M	14.76±1.26	14.56±1.60	14.87±1.72	14.90±1.54	0.065
	F	15.63±1.80	15.98±1.82	16.0±1.90	15.88±1.79	0.052
P value		0.055	0.134	0.065	0.075	
8^{th}	M	15.21±1.56	16.11±1.88	16.53±1.65	16.32±1.98	0.121
	F	16.50±1.77	17.21±1.96	17.4±1.87	17.54±1.63	0.987
P value		0.057	0.098	0.121	0.074	
FCR (feed g: g weight)	M	6.0^{ax}±0.01:1	6.44^{cx}±0.04:1	6.31^{bx}±0.02:1	6.10^{ax}±0.04:1	0.017
	F	6.4^{y}±0.12:1	6.59^{y}±0.05:1	6.50^{y}±0.03:1	6.39^{y}±0.067:1	0.082
P value		0.05	0.032	0.034	0.046	

Legends: FI= Feed intake; M= Males; F= Females; d= Days; FCR= Feed conversion ratio; GI= Initial population; G0= Foundation stock; G1=Generation one and G2= Generation two. Means with different superscripts between column are differed significantly at P<0.05.

Egg production and egg weight:

The egg production per year/quail varied from 73 to 150 and hen day egg production percentage also varied among generation. Egg production increased with the subjected to select of mates in the successive generations (Table 4).

However, the rate of increase of the egg production was slow, due to use of a small number of quails maintained, as effective population size and in this study the population size was a steady state. The population size and selection have a positive effect on egg production of quails [16]. The egg production of the current study was poor than that of previous studies [17] they observed 157 eggs per quail per year. This difference of egg production might be due to the Table-4.

Table-4: Egg production and egg weight (mean ±standard error) of quails in different generations

Traits	Generations				P value
	GI	*G0*	G1	G2	
Monthly egg production (No)	6.08^{a}±0.606	11.0^{b}±0.579	12.50^{c}±0.392	11.75^{b}±0.189	0.0017
Yearly egg production (No)	72.97^{a}±6.28	132^{b}±5.95	150^{c}±4.70	149.6^{b}±2.54	0.0009
Hen day egg production (%)	19.99^{a}±0.05	36.16^{b}±2.43	41.09^{b}±4.57	40.99^{b}±0.66	0.032
Egg weight (g)	8.37±0.0614	9.28±0.089	9.89±0.034	9.95±0.047	0.098

Legends: GI= Initial population; G0= Foundation stock; G1=Generation one; and G2= Generation two. Means with different superscripts between column are differed significantly at P<0.05.

Male effect and genetics of quail and also genotype × environment interaction. The laying period of quails was from May to September and during this period average ambient temperature of Bangladesh was higher 28^{O}C and relative humidity 74% than other periods of the year. The egg weight of quails from the successive generation was increased through selection of the best mates (Table 4). However, other researchers [13, 17, 18] observed slightly higher weighted eggs than the current study and this variation might be due to genetics of quail, effects of feed and season.

Fertility, hatchability, incubation period of eggs and chicken mortality: Fertility, hatchability, mortality (%) and incubation period (days) of quails in different generation are shown in Table 5. The fertility and hatchability percentage of the eggs of quail in the current study were inferior compared to the findings of Khurshid *et al.* [19] Ayasan *et al.* [20, 21], they observed fertility and hatchability was 80.86% and 55.14%, respectively. This difference might be due to the quail variety, nutrition and male and female factors, pre incubation holding period, storage temperature. The incubation period in the current study Table 5.

Table-5: Fertility, hatchability, mortality (%) and incubation period (days) of quails in different generations

Traits	Generations				P value
	GI	G0	G1	G2	
Fertility (%)	60.73^{a}±2.54	66.73^{b}±2.11	68.73^{b}±1.87	62.73^{a}±3.22	0.032
Hatchability (%)	39.40^{a}±2.77	48.30^{b}±2.54	54.24^{b}±1.99	52.60^{b}±3.01	0.001
Incubation period (days)	19.54 ±0.28	19.33±0.26	18.52±0.22	19.01±0.24	0.087
Mortality (%)	5.46±0.44	4.46±0.33	4.87±0.23	5.24±0.32	0.138

Legends: GI= Initial population; G0= Foundation stock; G1=Generation one and G2= Generation two.
Means with different superscripts between column are differed significantly at P<0.05.

Was 18 to 20 days, which was higher than Randall and Bolla [22] and Baylan *et al.* [23] they reported incubation period of quail egg was 17 to 18 days. This difference might be due to the operation of the incubator and also the differences of quail variety. The mortality percentage of quails ranged from 4.5 to 5.5, which was accepted. This mortality % was similar to the experiment conducted by Nanda *et al.* [24]. With the subsequent selection in the successive generation the mortality was lower, that indicated increased survivability. The mortality of quails depends on the season, temperature and disease infestation in the flock.

External and internal quality of eggs

The egg weight and shape index among generations of quails differed significantly (P<0.05) and other traits like egg shell weight and egg shell thickness did not differ (Table 6).

Egg weight is the most important quality trait [25] than other traits for the consumers. The egg shell thickness varies from 0.20 to 0.22 mm. The values obtained for egg shell thickness falls within the range of 0.20 to 0.30 mm reported by other investigators [26, 27] The egg shell thickness is also a very important trait for hatching and table eggs, because it enhances the storage time and prevent breaking of the eggs. In the case of internal quality, yolk height and weight, albumin height and weight egg shell membrane and the Haugh unit were differed significantly (P<0.05) among generations (Table 6). The current value of external and internal egg quality traits was similar with the values of other researchers (Chimezie *et al.* [27]; Abu Tabeekh [1]; Nowaczewski *et al.* [28] elsewhere. However, the egg quality traits values dependent on nutrition, season of the year, the number of eggs laid by the quail and genetics of the quail.

The positive correlations between the live weight with egg production, egg weight and egg quality traits of quail in different generations were seen. The positive correlation was progressively increased in the successive generations (Table 7). With the increases of live weight the egg weight was increased. Similar findings were observed by Testik *et al.* [29] and Alkan *et al.* [30] they observed that live weight has the positive effects on egg weight. Baylan reported average egg weights over 25 weeks was 13.0, 13.0 and 13.0 g in lines selected was applied for body weight at different ages (3, 4,)

Table-6: External and internal quality of eggs (mean ± standard error) of quail in different generations

Traits	Generations				P value
	GI	G0	G1	G2	
External quality					
Egg weight (g)	8.38^{a}±0.102	9.28^{b}±0.089	9.89^{b}±0.034	9.75^{b}±0.047	0.027
Egg shell weight (g)	1.08±0.014	1.11±0.021	1.09±0.016	1.13±0.020	0.076
Egg shell thickness (mm)	0.21±0.004	0.22±0.006	0.22±0.003	0.22±0.004	0.091
Shape index	79.3^{a}±0.473	83.5^{b}±0.650	86.4^{b}±0.342	85.7^{b}±0.160	0.0006
Internal quality					
Yolk index	45.3±0.19	47.2±1.21	48.49±1.73	48.2±1.55	0.066
Yolk height (mm)	8.82^{a}±0.126	10.51^{b}±0.119	11.66^{c}±0.165	11.05^{c}±0.179	0.0002
Yolk width (mm)	22.28±0.009	22.19±0.008	22.77±0.007	22.38±0.004	0.054
Albumin height (mm)	4.07^{a}±0.077	5.32^{b}±0.054	6.16^{c}±0.055	5.72^{b}±0.061	0.010
Yolk weight (g)	3.54^{b}±0.067	3.01^{a}±0.067	3.78^{c}±0.062	3.53^{b}±0.058	0.032
Albumin weight (g)	3.79^{a}±0.069	6.64^{b}±0.043	8.57^{d}±0.038	7.88^{c}±0.041	0.0001
Egg shell membrane thickness (mm)	0.12^{a}±0.004	0.21^{b}±0.002	0.23^{b}±0.005	0.22^{b}±0.01	0.0008
Haugh Unit	89.57^{a}±0.439	95.05^{b}±0.546	97.76^{b}±0.67	96.65^{b}±0.761	0.0041

Legends: GI= Initial population; G0= Foundation stock; G1=Generation one; and G2= Generation two.
Means with different superscripts between column are differed significantly at P<0.05

Table-7: Correlations between live weight with egg production, egg weight and egg quality traits of quail in different generations

Traits	Generations				P value
	GI	G0	G1	G2	
Live weight (g)					
Egg production (No)	0.48^{a}	0.85^{b}	0.95^{c}	0.94^{c}	0.012
Egg weight (g)	0.05	0.06	0.06	0.06	0.065
Egg shape index	0.53	0.54	0.55	0.54	0.211
Egg yolk index	0.30	0.30	0.31	0.30	0.764
Haugh Unit	0.59^{a}	0.61^{b}	0.62^{b}	0.61^{b}	0.043

Notes: GI= Initial population; G0= Foundation stock; G1=Generation one; and G2= Generation two

Means with different superscripts between column are differed significantly at P<0.05 and 5 weeks of age) in the first generation. While for the 2nd generation, the significant positive correlations reported between egg weight and other egg quality traits and this finding are agreed with the report of Ojedapo [31] and Chimezie *et al.* [27], who reported positive correlations between egg weight and some other egg quality traits.

Conclusion

From this research it reveals that the female were heavier than the male and attained earlier sexual maturity. The results of this study showed that with a steady state population subjected to selection in successive generations the performance and survival traits of Japanese quail can be improved and the selection has the positive effects on the improvement of traits.

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