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Genetic Improvement of Egg Production and Associated Traits in Egg Type Japanese Quail

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ABSTRACT

Background: Demand for the Japanese quail eggs is increasing due to cheaper cost and alternative to chicken eggs. Development of a separate egg type of Japanese quail strains can fulfill the demand of egg production and nutritional security. With this background, genetic selection was carried out to improve egg production performances of egg type Japanese quail for six generations.

Methods: Nandanam quail-3 was utilized as base population for the improvement of production performance in this study. Initially to strengthen the base population random breeding was carried out in Nandanam quail-3 followed by sire family selection for egg production in females and sib selection in males. The mating plan for producing replacement hatch was shift mating in individual cages. The day-old chick weight, body weight at different age, egg production and reproductive performance were recorded in all six generations.

Result: The analysis of pooled data for fourth and sixth week body weight indicated a genetic gain of 0.60 g and 0.51 g per generation, respectively with an excellent coefficient of determination (0.92% and 0.93%). The per cent hen housed egg production from 6 to 46 weeks of age increased from 202 to 220 eggs during the course of selection. Linear regression analysis revealed that the increase was significant ($P<0.01$), with appreciable magnitude in positive direction ($b=3.77$) with excellent of goodness of fit ($R^2=0.97$). Similarly, the hen day egg production during this period also showed significant ($P<0.01$) upward trend ($b=3.17$) over generations with the trend line showing excellent goodness of fit with observed values ($R^2= 0.96$). The present study concluded that the multi stage selection can improve the body weight and egg production in Japanese quails despite the fact these traits are negatively correlated.

Key words: Egg type Japanese quail, Genetic selection, Production performance.

INTRODUCTION

Japanese quail farming is becoming popular in commercial poultry sector for meat and egg production. Rapid growth rate, early sexual maturity, high rate of egg laying and much lower feed consumption are the advantage of Japanese quail farming. Japanese quails are rapidly gaining in popularity for its commercial exploitation and in near future may acquire an important segment in rapidly growing Indian poultry industry (Mishra and Shukla, 2014). Selection is a powerful means to increase body weight and rate of gain in Japanese quails. Japanese quail is suggested as a pilot animal for genetic studies because of its shorter generation interval and the economy of production resulting from faster growth rate and its smaller body size. Nowadays demand for the Japanese quail eggs is also increasing due to cheaper cost and is alternative to chicken eggs. Developing separate egg type Japanese quail is a need of the hour to propagate layer quail farming which fulfill the demand of egg production and nutritional security. Most of the selection studies in Japanese quail have focused on increasing body weight; on the other hand, only a limited number of studies were aimed at improving egg production (Nestor *et al.,* 1983, Maeda *et al*., 1999 and Minvielle *et al*., 2000). Beside egg production performance, egg quality (both external and internal traits) is also important for human consumption and for hatcheries. Considering the above, a research work was initiated during the year 2014 to develop egg type Japanese quail from Nandanam quail 3 (base population) with genetic selection and its effects on body weight, egg production and reproductive performance were assessed in all six generations.

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MATERIALS AND METHODS

Breeding programme adopted

Genetic improvement for egg production performance of Japanese quail was carried out for six generations at Poultry Research Station (PRS), Tamil Nadu Veterinary and Animal Sciences University, Chennai-51 between 2014 and 2019.

The base population of 600 females was derived from Nandanam quail 3 available in PRS. Individual selection for the improvement of body weight and family selection with shift mating (60 males+240 females) for higher egg production with 1:4 ratio was carried out continuously for six generations to increase the egg number and body weight simultaneously. A total 2000 day-old chicks in three hatches were taken as replacement population in each generation. The population size of 720 females (12 female/ sire families) and 900 males (15 male/ sire family) were selected based on pedigree selection from 60 sires families. Sire family selection for egg production in females and sib selection for body weight in males were adopted as a selection aids at 6 weeks of age. Egg production up to 30 weeks periods were used as selection criteria in family selection for egg production and egg production performance was recorded from six to 46 weeks. The selection pressure was 1 in 4 for females and 1 in 16 for males. Individual selection on fourth week was considered as a selection criteria for improving body weight. To assess the effect of short-term selection on various parameters such as day old chick weight, 4, 6 and 10th week body weight, feed conversion ratio, hen day and hen housed egg production, liveability, fertile and total egg hatchability, time-trend and regression analysis were carried out as per standard statistical methods. (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Body weight performance

The day-old chick weight of all six generations ranged from 9.2 to 9.28 g (Table 1). Although the time trend analysis revealed a positive change of 0.011 g per generation, which was insignificant (P>0.05) and less reliable (R^2=0.52). The 4th and 6th week mean body weight of the first generation was 163.46 g and 178.82 g respectively, which increased to 166.16 g and 181.35 g respectively in 6th generation. Similarly, the 10th week female body weight in 1st generation increased from 241.12 g to 243.35 g at 6th generation. The linear regression analysis of fourth week body weight in males over generations revealed significant (P<0.01) increment of 0.59 g per generation. A very high R^2 value (0. 83%) indicates excellent goodness of fit and reliability of linear regression model over observed values. Similarly, the fourth week body weight in females also had a positive change (b= 0.89g) per generation with high degree of goodness of fit (R^2= 0.93). The analysis of pooled data for fourth week body weight indicated a genetic gain of 0.60 g per generation, with an excellent coefficient of determination (0.92%). Similarly, the linear regression analysis of sixth week body weight in males and females over generations revealed significant (P<0.01) increment of 0.26 g and 0.76 g per generation, respectively. Although the goodness of fit of linear regression was poor (R^2= 0.47%) males, a high value of 0.87% was recorded in females indicating excellent goodness of fit and reliability. The analysis of pooled data for sixth week body weight indicated a genetic gain of 0.51 g per generation, with an exceptionally good coefficient of determination (0.93 %). The 4th and 6th week body weights recorded in this study was higher than those reported by Mohammed *et al*. (2006), Hyankova *et al*. (2008), Sakunthaladevi *et al*. (2010), Khaldari *et al*. (2010), Hossain *et al*. (2015) and Subhashini *et al*. (2018a) in Japanese quail. In our study, it was evident that the mean body weight increased in the course of selection. However, a higher phenotypic response of 13.23 g and genetic repose of 9.69 g has been reported by Churchil *et al*. (2019a) in Japanese quails.

Table 1: Effect of selection on body weight performance of egg type Japanese quail in different generation (Mean±SE).

Parameters	(G1)	(G2)	(G3)	(G4)	(G5)	(G6)
Hatch weight (g)	9.20±0.01 (2010)	9.24±0.02 (2022)	9.28±0.05 (2018)	9.27±0.02 (1996)	9.26±0.01 (2031)	9.27±0.03 (2005)
Fourth week body weight						
Male (g)	154.81±0.84 (948)	155.13±1.10 (982)	154.64±1.03 (959)	156.16±0.97 (948)	157.07±1.111 (964)	57.52±1.05 (941)
Female (g)	170.11±0.72 (964)	171.87±0.83 (941)	173.02±0.91 (973)	173.22±0.62 (977)	174.50±0.68 (987)	174.78±0.55 (964)
Pooled (g)	163.46±0.71 (1912)	163.50±0.90 (1923)	163.83±0.87 (1932)	164.69±0.79 (1925)	165.78±0.79 (1951)	166.15±0.52 (1905)
Sixth week body weight						
Male (g)	170.78±0.72 (910)	171.26±0.83 (958)	171.92±0.21 (918)	172.86±0.62 (913)	171.84±0.45 (933)	172.09±0.67 (904)
Female (g)	186.87±0.97 (947)	187.14±0.21 (917)	188.98±0.84 (954)	188.19±0.59 (948)	190.13±0.43 (965)	190.62±0.31 (922)
Pooled (g)	178.82±0.74 (1857)	179.20±0.52 (1875)	180.45±0.52 (1872)	180.52±0.50 (1861)	180.98±0.41 (1898)	181.35±0.49 (1826)
10th week female body weight	241.12±1.01	242.41±0.99	241.54±1.03	240.58±1.28	242.61±1.32	243.35±1.44

Liveability (%)

The mean liveability ranged from 92.1 to 93.53% and that of 7 to 46 weeks, from 94.25 to 95.50% (Table 2). The linear regression analysis of liveability during 0 to 6 weeks of age revealed an increment of 0.34% ($P<0.05$) per generation with high degree of goodness of fit of regression equation with the observed values. On the other hand, the livability from 7 to 46 weeks of age over generations revealed insignificant ($P>0.05$) change of only 0.11%. The per cent liveability observed in our study is comparable with Subhashini *et al*. (2018) and Ahmad *et al*. (2018) who recorded 92.50% and 87.81% respectively during 0-4 weeks of age in selected line of quails. Improvement in fitness traits in each generation observed in our study might be due to application of intense selection resulted in better exploitation of superior genes, which leads to increased liveability as reported by Hussain *et al*. (2013).

Feed consumption

The mean feed consumption and FCR (Table 3) during 0 to 6 weeks of age was 452.02 g and 2.51 respectively. The feed consumption from 0 to 6 weeks of age showed positive change of very low magnitude (b= 2.68 g; R^2= 0.53; $P>0.05$) over generations to reach 459.01 g in sixth generation from 116.50g at first generation. Similarly, low magnitude insignificant positive change was also observed with feed consumption from 7 to 46 weeks of age (b= 0.063 kg g; R^2= 0.15; $P>0.05$) from first (9.80 kg) to sixth (10.50 kg) generation. Similar reports was observed by Ahmad *et al*. (2018) who recorded 430.25 gm of feed intake with 2.40 FCR during 0 to 4 weeks of age in selected line of Japanese quail and reported that pedigree birds had significantly better FCR compared with mass-selected and random-bred control birds. Further, Subhashini *et al*. (2018a) observed a cumulative feed efficiency of 2.36 during 4th week in Japanese quail. In addition, Hussain *et al*. (2013) observed that a selected line had better feed efficiency than the control group.

Egg production (%)

The age at sexual maturity in egg type Japanese quail was reduced from 42 in first generation to 40 days in sixth generation (Table 4). The change was significant ($P<0.05$) in negative direction (b= -0.40 day; R^2= 0.70) over generations. Hossain *et al*. (2015) observed an average sexual maturity of 40 days in layer Japanese quail in Bangladesh. Studies reported a wide range of age at sexual maturity (42 to 56 days) in Japanese quail which is in harmony with the present investigation (Devi *et al*., 2010; Monica *et al*., 2020). The decreasing age at sexual maturity as a correlated response for improvement in egg production in poultry is an established phenomenon as these traits are negatively correlated (Narayanankutty *et al*., 2008, Churchil *et al*., 2019b).

The per cent hen housed egg production from 6 to 46 weeks of age increased from 202 to 220 eggs during the course of selection. Linear regression analysis revealed that the increase was significant ($P<0.01$), with appreciable magnitude in positive direction (b=3.77) with excellent of goodness of fir (R^2=0.97). Similarly, the hen day egg production during this period also showed significant ($P<0.01$) upward trend (b=3.17) over generations with the trend line showing excellent goodness of fit with observed values (R^2 = 0.96). With this degree of improvement he hen day egg production reached to 225 eggs in sixth generation from 206 eggs in the first generation. Similar to our finding,

Table 2: Effect of selection on liveability (%) of egg type Japanese quail in different generation (Mean ± SE).

Parameters	(G1)	(G2)	(G3)	(G4)	(G5)	(G6)
Liveability % (0-6 weeks)	92.10±0.15	92.23±0.19	92.26±0.20	93.40±0.24	93.45±0.18	93.53±0.17
Liveability % (7-46 weeks)	94.25±0.20	95.10±0.18	95.50±0.19	94.50±0.13	94.60±0.17	95.50±0.18

Table 3: Effect of selection on feed consumption and feed efficiency of egg type Japanese quail in different generation (Mean±SE).

Parameters	(G1)	(G2)	(G3)	(G4)	(G5)	(G6)
Feed consumption (gm) (0-6 weeks)	446.50±2.29	452.35±2.20	441.48±1.95	454.30±2.01	458.50±2.13	459.01±1.90
FCR (0-6 weeks)	2.52	2.51	2.45	2.52	2.53	2.53
Feed consumption (kg) (7-46 weeks)	9.8^{a}±3.48	10.64^{ab}±4.59	10.36^{ab}±4.10	10.08^{a}±3.59	10.30^{ab}±5.28	10.50^{ab}±4.89
Feed efficiency per dozen of egg	0.568	0.599	0.571	0.547	0.549	0.564

Table 4: Effect of selection on egg production performance of egg type Japanese quail in different generation (Mean±SE).

Parameters	(G1)	(G2)	(G3)	(G4)	(G5)	(G6)
Age at sexual maturity (days)	42	41	42	41	40	40
HDEP (6-46 wks) %	73.80	76.10	77.41	78.10	80.00	80.64
HHEP (6-46 wks) %	72.13±1.26(720)	74.19±1.58(720)	74.68±1.29(708)	77.01±1.51(710)	78.41±1.31(718)	78.55±1.49(705)
HDEP (6-46 weeks) (No's)	206	213	216	218	224	225
HHEP (6-46 weeks) (No's)	202	207	209	215	219	220
Average egg wt (g)	12.20 ±0.09	12.26 ±0.03	12.18±0.08	12.10±0.08	12.12±0.08	12.14±0.09

Table 5: Effect of selection on reproductive performance of egg type Japanese quail in different generation (Mean±SE).

Parameters	(G1)	(G2)	(G3)	(G4)	(G5)	(G6)
Fertility (%)	79.78±1.29	78.76±1.85	79.17±1.45	79.59±1.56	79.92±1.44	80.17±1.53
Hatchability (%)	64.18±1.41	64.32±1.45	64.51±1.69	64.50±1.24	64.35±1.78	64.49±1.77

Table 6: Egg quality parameters of egg type Japanese quail (Mean±SE).

Parameters	Value (n=30)
Egg weight (g)	12.12±0.08
Shape index	78.59±0.14
Specific gravity	1.071±0.019
Albumen index	0.104±0.002
Yolk index	0.425±0.012
Haugh unit score	82.58±0.13
Yolk colour	5.31±0.09
Shell thickness (mm)	0.207±0.002
Shell percentage	8.46±0.13

Hossain *et al*. (2015) observed that the hen day egg production of 89 % during 45-49 weeks and 88 % during 50-52 weeks of age in Japanese quail. Durmus *et al*. (2017) found that, the egg production of the layer lines Japanese quail ranged from 44.60 to 57.01 eggs for a 2-month period and from 245.4 to 332.7 eggs for 13 months. Further, Narinc *et al*. (2013) found that the mean value of egg production in a control Japanese quail line was 216 eggs for 52 weeks. In another study, Krishna Daida and Sahitya Rani (2017) found that broiler Japanese quail variety attain the age at sexual maturity between 55.79 to 56.53 days and the hen day egg production was 31.23, 69.91 and 54.81 % in 16th, 32nd and 46th week respectively.

Egg weight

Although the change was not significant (P>0.05), the mean egg weight showed a declining trend over generations during selection (b= - 0.02) to reach 12.14 g in sixth generation from 12.20g in the first generation. The reduction in egg weight in short term selection has been reported earlier (Nestor and Noble, 1995). The reduction in egg weight in poultry selected for egg number has been reported already as these traits are negatively correlated (Churchil *et al*., 2019b).

Reproductive performance

The parameters like fertility and hatchability of eggs (Table 5) were not much affected due to selection. The fertility of eggs in the first generation was 79.78%, which is almost same across the generations with minimum and maximum values as 78.76 and 80.17% respectively. Similarly, hatchability also showed no marked changes due to selection with values varying from 64.18 to 64.51% across the generations. The regression analysis also revealed insignificant (P>0.05) change of fertility (b = 0.17; R^2 = 0.34) and hatchability (b = 0.04; R^2 = 0.43) values across generations. Similar to this study Asasi and Jaafar, (2000) found an average fertility of 75% and hatchability of 65% up to 52 weeks of egg production.

Egg quality parameters

The egg quality parameters such as egg weight, shape index, specific gravity, albumen index, yolk index, Haugh unit score, yolk colour, shell thickness and shell percentage values presented in Table 6 were comparable with that of previous studies (Kumari *et al*. (2016); Subhashini *et al*. (2018 b); Monika *et al*. (2020) in different strains of Japanese quails.

CONCLUSION

It can be concluded that the multi stage selection can improve the body weight and egg production in Japanese quails despite the fact these traits are negatively correlated. This type of selection programmes can be adopted for exploiting body weight and egg number simultaneously to develop dual purpose Japanese quails.

Conflict of interest: None.

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