The Pharma Innovation Journal 2024; 13(1): 103-107

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
TPI 2024; 13(1): 103-107

www.thepharmajournal.com
Received: 19-10-2023
Accepted: 23-11-2023

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Study of egg production parameters of pure and crossbred Japanese quail strains

Santosh Marandi and Raj Narayan

Abstract
An experiment was conducted to evaluate the egg production and quality traits of offsprings produced by a complete 4 x 4 diallel cross of Japanese quails. The experiment involved 4 strains namely, Cari-uttam (CU), Cari-ujjwal (CJ), Cari-shweta (CS) and Cari-pearl (CP). A total of 16 genetic groups *viz.* four purebreds (CU, CJ, CS and CP), six crossbreds (CUxCJ, CUxCS, CUxCP, CJxCS, CJxCP, CSxCP) and six reciprocals (CJxCU, CSxCU, CPxCU, CSxCJ, CPxCJ and CPxCS) were obtained from this cross. 40 Female laying birds from each group were transferred to individual laying cages at 5thwee k of age for further quantitative traits recording. Age at first egg was significantly lower in cross-breds (36.88±0.21) when compared with pure breds (37.53±0.33). Among four pure bred groups, CS had the highest egg production at 8th, 10th and 12th week but later at 15th, 20th, 25th and 30th week of age CJ had the highest egg production whereas CU had the highest average egg production of 6.48±0.11 at 12th week. Amongst the different crossbreds the egg production was highest in CUxCP, CSxCJ, CUxCJ, CUxCJ, CJxCU, CJxCU and CJxCS for 8th, 10th, 12th, 15th, 20th, 25th and 30th week of age respectively.

Keywords: Japanese quail, egg weight, egg production, Cari Uttam, Cari Ujjwal, Cari Shweta, Cari pearl

1. Introduction

The utilization of alternative or non-chicken poultry production systems presents an opportunity to diversify the resource base within the expanding poultry sector. Simultaneously, it offers alternatives for both poultry producers and consumers. Recent trends in production and consumption indicate a growing proportion of non-chicken poultry species contributing to the overall poultry meat and egg production. The Japanese quail, recognized as the smallest avian species suitable for egg and meat production (Baumgarterner, 1994) [2], is gaining popularity among Indian consumers. These birds have become subjects of various selection experiments due to their compact body size, rapid generational turnover, and high reproductive capabilities. The cost-effectiveness associated with their small body size (80-300g), along with a short generation interval (3-4 generations per year), disease resistance, and prolific egg production, positions them as excellent candidates for laboratory research (Vali, 2008) [8]. Consequently, they have been extensively utilized in numerous research studies (Kayang *et al*., 2004) [4].

Genetic enhancement in poultry is achieved through selection, crossbreeding, or a combination of both methodologies. The fundamental approach involves harnessing additive genetic effects at numerous independent loci during selection processes, while crossbreeding systems focus on exploiting favorable dominant effects (Cunningham, 1987) [3]. This distinctive selection program has led to the development of specialized sire and dam lines, contributing to significant improvements in broiler and layer progeny performance. Integrating these specialized lines into commercial layer quail ventures has the potential to induce heterosis in various economically important traits, thereby reducing production costs. It's worth noting that such specialized sire and dam lines are currently absent in commercial quail production systems.

The second crucial aspect in layer breeding involves crossbreeding. Within this system, the identification and testing of superior cross combinations play a pivotal role. The evaluation of line performance in cross combinations can be assessed through general and specific combining ability. Despite various methods available for estimating combining ability among crosses, the diallel experiment has proven to be particularly useful (Nath, 1999, and Mohammed *et al*., 2005) [7, 5]. While there is an abundance of literature on production experiments in chickens, only a limited number of reports exist on Japanese quail, especially concerning lines developed at CARI, namely Cari Uttam, Cari Ujjwal, Cari Sweta, and Cari Pearl.

Hence, the present study was conducted to estimate and compare the egg production and egg quality traits of four Japanese quail strains to find out suitable sire and dam quail line for commercial enterprise.

2. Materials and Methods

In the present study, a complete 4x4 diallel cross of four Japanese quail strains namely Cari Uttam (CU), Cari Ujjwal (CJ), Cari Shweta (CS) and Cari Peal (CP), was carried out at Japanese quail unit, Division of Avian Genetics and Breeding, Central Avian Research Institute, Izatnagar which gave four pure bred, 6 cross bred and 6 reciprocal cross bred combinations. A total of 480 sires (comprising 120 sires from each strain) and equal number of dams (120 from each strain) were used in the study. From each genetic group 30 sires and 30 dams were randomly allotted for a particular group from a strain. The mating was carried out in individual pedigree laying cages, and all birds were provided uniform environment throughout.

Eggs were collected twice a day, marked as per the genotype, cleaned and stored for 10 days in the egg cooler before setting them in an automatic incubator. The eggs were set in the automatic incubator in two different hatches at 10 day interval. The eggs were transferred in the pedigree boxes and then transferred to the hatching trays on 14th day of incubation. The chicks were taken out from the hatchers on the 17th day of incubation. At hatch, chicks were wing-banded and weighed immediately to nearest 0.1 g. The chicks were not vaccinated against any disease. Chicks of same genetic group were brooded and reared together in battery brooders upto 5th weeks of age. Standard management practices were followed throughout the experimental period and it was kept uniform for all genetic groups. Sexing were done at 3rd week of age. Uniform numbers of chick were maintained in each genetic group. The feeding and watering was provided *ad-libitum.* 40 Female laying birds from each group were transferred to individual laying cages at 5th week of age for further quantitative traits recording.

2.1 Quantitative traits recorded

The Following production quality parameters were recorded:

a) Age at first egg production.
b) Part time egg production were recorded upto 30th week of age which were partitioned in different components of production upto 8th, 10th, 12th,15th, 20th, 25th and 30th week of age respectively.

The analysis of data was performed using non-linear regression model procedure by statistical software SPSS (20).

3. Result and discussion

3.1 Age at first egg (age of sexual maturity)

Table 1 depicts the Mean±S.E. for various egg qualities of different genetic groups (crosses). The comparison between pure and crossbreds as well as sirewiese and damwise analysis is presented in table 2. Age at first egg was significantly lower in cross-breds (36.88±0.21) when compared with pure breds (37.53±0.33). Among the pure breds, CU reflected the lowest age (37.15±0.65) at first egg, followed by CJ (37.35±0.59) and CP (37.35±0.66). CS (38.25±0.74) had the highest age at first egg within the group. Among the group compiled according to sire used, CU's off-springs were having lowest age (35.34±0.32) at first egg, whereas CP's off-springs had the highest age (38.80±0.40). When grouped according to the dam used, CP (35.24±0.30) had the lowest age at first egg whereas CU had the significantly higher age (38.35±0.34). Among the cross breds, CUxCP was analyzed to have lowest age (33.80±0.60^{a}) at first egg, while CPxCS (41.35±0.60) had significantly higher age at their first egg production.

All the genetic groups were significantly different for age at first egg. Various crossbreds (CUxCS, CUxCP, CJxCP and CSxCP) recorded significantly lower age at first egg than other crosses and purebreds. Most of the crosses had significantly lower age at first egg than purebreds. The average age at first egg obtained in this study appears to be within the normal range and was found to be lower than results reported by Narayan *et al*. (1998) [6].

3.2 Egg production

Table 3 depicts the Mean±S.E. for egg production of different genetic groups (crosses) at 8th, 10th, 12th, 15th, 20th, 25th and 30th week. Comparison between pure and crossbreds as well as sirewise and damwise comparison is given in table 4.

An overall average egg production at 8th, 10th, 12th, 15th, 20th, 25th and 30th weeks of age was 4.98±0.08, 5.92±0.05, 6.31±0.03, 6.09±0.04, 5.66±0.04, 5.22±0.05 and 4.68±0.06 respectively. For most of the egg production from 8th to 30th week difference between various genetic groups were mostly significant. Among four pure bred groups the average egg production was found to be 4.74±0.15, 5.98±0.10, 6.45±0.05, 6.22±0.06, 5.85±0.08, 5.57±0.10 and 4.91±0.11 at 8th, 10th, 12th, 15th, 20th, 25th and 30th weeks of age respectively; 4.58±0.36, 5.80±0.28, 6.48±0.11, 6.05±0.13, 5.68±0.18, 5.40±0.21 and 4.45±0.19 respectively in case of CU; 4.98±0.29, 6.08±0.18, 6.43±0.10, 6.55±0.11, 6.25±0.16, 6.20±0.14, and 5.75±0.19 respectively in case of CJ; 5.83±0.19, 6.35±0.15, 6.58±0.09, 6.33±0.13, 5.93±0.16, 5.75±0.17 and 5.33±0.18 respectively in case of CS and 3.58±0.23, 5.70±0.18, 6.33±0.12, 5.95±0.13, 5.55±0.15, 4.93±0.20 and 4.13±0.21 respectively in case of CP. CS had the highest egg production at 8th, 10th and 12th week but later at 15th, 20th, 25th and 30th week of age CJ had the highest egg production. The 12th week overall egg production among the pure bred was highest; 6.45±0.05 followed by 6.22±0.06 at 15th week, 5.98±0.10 at 10th week, 5.85±0.08 at 20th week, 5.57±0.10 at 25th week, 4.91±0.11 at 30th week and the least 4.74±0.15 at 10th week of age.

CU had the highest average egg production of 6.48±0.11 at 12th week, followed by 15th week, 10th week, 20th week, 25th week, 8th week and 30th week. CJ had the highest egg production of 6.55±0.11 for 15th week of age, followed by 12th week, 20th week, 10th week, 30th week and 8th week. CS had the highest egg production of 6.58±0.09 at 12th week of age, which was followed by 10th week, 15th week, 20th week, 8th week, 25th week and 30th week. Similarly in case of CP, egg production was found to be highest at 12th week of age, followed by 15th week, 10th week, 20th week, 25th week, 30th week and least in 8th week.

Amongst the different crossbred groups the egg production was highest in CUxCP, CSxCJ, CUxCJ, CUxCJ, CJxCU, CJxCU and CJxCS for 8th, 10th, 12th, 15th, 20th, 25th and 30th week of age respectively. Except 8th week of age, crossbreds had lower egg production than the pure breds at all age intervals recorded, while egg production was found similar at 20th week of age. Upon pooling data as per type of sire used the mean egg production was highest for groups sired by CS males for 8th, 10th and 12th week, whereas mean egg production were highest for groups sired by CJ males for 15th, 20th, 25th and 30th week. Similarly dam-wise pooling of data revealed highest mean body weight in groups CU for 8th and 20th week, while for 10th and 15th week CJ group showed maximum production. Similarly, for 12th week, CP dams showed highest egg production and CS females recorded highest egg production for 25th and 30th week.

The production trait is a priority in poultry layer industry and is influenced by number of genetic and non-genetic factors. Significant differences in specified weekly egg production and production differences were realized between different genotypes, mating systems as well as sire and dam groups. This speaks of a strong genetic component influencing the egg production in quails. In general, total egg production in purebreds was found to be higher than crossbreds, except CU during the period under study. Pureline CU showed early higher egg production but failed to produce more number of egg in the periods followed. Although Narayan *et al*. (1998) [6] reported similar egg production pattern in egg type quail and estimated that 12th week egg production was highest among the birds under studies, but no literature was found on the lines under study. Agarwal *et al*. (1994) [1] also reported significant genetic group differences for egg production in quail lines.

Table 1: Mean ± S.E. of Age at sexual maturity in the pure and crossbreds of J. quail

Group	Number of birds (N)	Age at first egg (age of sexual maturity)
Pure		
CU x CU	20	37.15±0.65^{def}
CJ x CJ	20	37.35±0.59^{def}
CS x CS	20	38.25±0.74^{ef}
CP x CP	20	37.35±0.66^{def}
Cross		
CU x CJ	20	36.55±0.55^{cde}
CU x CS	20	33.85±0.38^{a}
CU x CP	20	33.80±0.60^{a}
CJ x CU	20	38.55±0.77^{f}
CJ x CS	20	37.10±0.41^{def}
CJ x CP	20	35.00±0.23^{abc}
CS x CU	20	37.25±0.32^{def}
CS x CJ	20	37.85±0.51^{def}
CS x CP	20	34.80±0.51^{ab}
CP x CU	20	40.45±0.67^{g}
CP x CJ	20	36.05±0.67^{bcd}
CP x CS	20	41.35±0.60^{g}
Total	320	37.04±0.18

Effects bearing different superscripts across the column differ significantly

Table 2: Mean ± S.E. of ASM in between pure and cross breds, mating system, sire wise and dam wise in different groups

Group	Number of birds	Age at first egg (age of sexual maturity)
Mating system		
Pure-breds	80	37.53±0.33^{b}
Cross-breds	240	36.88±0.21^{a}
Sire groups		
CU	80	35.34±0.32^{a}
CJ	80	37.00±0.30^{b}
CS	80	37.04±0.31^{b}
CP	80	38.80±0.40^{c}
Dam groups		
CU	80	38.35±0.34^{c}
CJ	80	36.95±0.30^{b}
CS	80	37.64±0.41^{b}
CP	80	35.24±0.30^{a}
Overall		
Total	320	37.04±0.18

Effects bearing different superscripts across the column differ significantly

Table 3: Mean ± S.E. of weekly egg production upto 30th week of age

Group	Number of birds	8th week	10th week	12th week	15th week	20th week	25th week	30th week
Pure								
CU x CU	40	4.58±0.36^{cd}	5.80±0.28^{bc}	6.48±0.11^{d}	6.05±0.13^{bcd}	5.68±0.18^{cd}	5.40±0.21^{bc}	4.45±0.19^{cdef}
CJ x CJ	40	4.98±0.29^{cdef}	6.08±0.18^{bc}	6.43±0.10^{cd}	6.55±0.11^{f}	6.25±0.16^{e}	6.20±0.14^{d}	5.75±0.19^{i}
CS x CS	40	5.83±0.19^{f}	6.35±0.15^{c}	6.58±0.09^{d}	6.33±0.13^{cdef}	5.93±0.16^{cde}	5.75±0.17^{cd}	5.33±0.18^{hi}
CP x CP	40	3.58±0.23^{ab}	5.70±0.18b^{c}	6.33±0.12^{cd}	5.95±0.13^{bc}	5.55±0.15^{cd}	4.93±0.20^{b}	4.13±0.21^{cd}
Cross								
CU x CJ	40	5.45±0.30^{def}	6.00±0.23^{bc}	6.55±0.08^{d}	6.50±0.09^{ef}	6.08±0.16^{de}	5.45±0.17^{bc}	5.13±0.18^{ghi}
CU x CS	40	5.40±0.29^{def}	5.95±0.27^{bc}	6.50±0.09^{d}	6.30±0.11^{cdef}	5.88±0.14^{cde}	5.40±0.20^{bc}	5.15±0.17^{ghi}
CU x CP	40	5.63±0.23^{ef}	6.03±0.20^{bc}	6.43±0.09^{cd}	6.30±0.13^{cdef}	5.83±0.16^{cde}	5.20±0.21^{bc}	4.98±0.19^{fgh}
CJ x CU	40	5.33±0.29^{def}	5.90±0.23^{bc}	6.45±0.10^{d}	6.43±0.13^{def}	6.25±0.15^{e}	5.55±0.18^{bc}	5.18±0.21^{ghi}
CJ x CS	40	5.48±0.31^{def}	6.13±0.22^{bc}	6.38±0.13^{cd}	5.95±0.14^{bc}	5.75±0.16^{cde}	5.48±0.19^{bc}	5.28±0.25^{ghi}
CJ x CP	40	5.58±0.24^{ef}	6.15±0.15^{bc}	6.25±0.13^{cd}	6.00±0.14^{bcd}	5.63±0.16^{cd}	5.40±0.20^{bc}	5.00±0.19^{fgh}
CS x CU	40	5.83±0.21^{f}	6.13±0.19^{bc}	6.40±0.11^{cd}	5.95±0.14^{bc}	5.53±0.16^{cd}	5.15±0.21^{bc}	4.90±0.20^{efgh}
CS x CJ	40	5.60±0.28^{ef}	6.20±0.13^{c}	6.30±0.13^{cd}	5.95±0.15^{bc}	5.63±0.17^{cd}	5.18±0.20^{bc}	4.63±0.22^{defg}
CS x CP	40	4.70±0.38^{cde}	6.10±0.14^{bc}	6.50±0.09^{d}	6.05±0.14^{bcd}	5.63±0.18^{cd}	4.98±0.20^{b}	4.33±0.22^{cde}
CP x CU	40	4.63±0.35^{cd}	5.48±0.25^{ab}	6.05±0.15^{bc}	6.10±0.16^{bcde}	5.40±0.18^{bc}	4.30±0.22^{a}	3.43±0.20^{ab}
CP x CJ	40	4.25±0.26^{bc}	5.78±0.21^{bc}	5.90±0.14^{b}	5.68±0.14^{ab}	4.63±0.19^{a}	3.98±0.21^{a}	3.28±0.20^{a}
CP x CS	40	2.93±0.25^{a}	4.90±0.28^{a}	5.45±0.18^{a}	5.38±0.15^{a}	5.03±0.18^{ab}	5.13±0.21^{bc}	3.95±0.22^{bc}
Total	640	4.98±0.08	5.92±0.05	6.31±0.03	6.09±0.04	5.66±0.04	5.22±0.05	4.68±0.06

Effects bearing different superscripts across the column differ significantly

Table 4: Mean ± S.E. of weekly egg production between pure and crossbreds mating system, sire wise and dam wise groups

Group	Number of birds	8th week	10th week	12th week	15th week	20th week	25th week	30th week
Mating system								
Pure-breds	160	4.74±0.15^{a}	5.98±0.10	6.45±0.05^{b}	6.22±0.06^{b}	5.85±0.08^{b}	5.57±0.10^{b}	4.91±0.11^{b}
Cross-breds	480	5.06±0.09^{b}	5.89±0.06	6.26±0.04^{a}	6.05±0.04^{a}	5.60±0.05^{a}	5.10±0.06^{a}	4.60±0.07^{a}
Sire groups								
CU	160	5.26±0.15^{b}	5.94±0.12^{b}	6.49±0.05^{b}	6.29±0.06^{c}	5.86±0.08^{c}	5.36±0.10^{b}	4.93±0.09^{b}
CJ	160	5.34±0.14^{b}	6.06±0.10^{b}	6.38±0.06^{b}	6.23±0.07^{bc}	5.97±0.08^{bc}	5.66±0.09^{c}	5.30±0.11^{c}
CS	160	5.49±0.14^{b}	6.19±0.08^{b}	6.44±0.05^{b}	6.07±0.07^{b}	5.68±0.08^{b}	5.26±0.10^{b}	4.79±0.11^{b}
CP	160	3.84±0.15^{a}	5.46±0.12^{a}	5.93±0.08^{a}	5.78±0.08^{a}	5.15±0.09^{a}	4.58±0.11^{a}	3.69±0.11^{a}
Dam groups								
CU	160	5.09±0.16	5.83±0.12	6.34±0.06	6.13±0.07	5.71±0.09	5.10±0.11^{a}	4.49±0.11^{a}
CJ	160	5.07±0.15	6.01±0.10	6.29±0.06	6.17±0.07	5.64±0.10	5.20±0.11^{ab}	4.69±0.12^{ab}
CS	160	4.91±0.16	5.83±0.13	6.23±0.07	5.99±0.07	5.64±0.09	5.44±0.10^{b}	4.93±0.11^{b}
CP	160	4.87±0.15	5.99±0.09	6.38±0.06	6.08±0.07	5.66±0.08	5.13±0.10^{a}	4.61±0.10^{ab}
Overall								
Total	640	4.98±0.08	5.92±0.05	6.31±0.03	6.09±0.04	5.66±0.04	5.22±0.05	4.68±0.06

Effects bearing different superscripts across the column differ significantly

4. Conclusion

Analysis of variance revealed significant differences among the genetic groups for various layer quail traits (age at sexual maturity, egg production at 8th, 10th, 12th, 15th, 20th, 25th and 30th week of age). On perusal of table 4 it was evident that CUxCP showed lowest age at sexual maturity (age at first egg) and was closely followed by CUxCS. Table 4 revealed that CSxCS and CSxCU had the highest egg production at 8th week of age, while CSxCS had the highest egg production at 10th and 12th week of age. At 15th week of age CJxCJ revealed highest egg production whereas at 20th week of age CJxCJ and CJxCU recored highest egg production. For 25th and 30th week CJxCJ revealed highest production of egg.

On perusal of table 4 it was evident that CUxCP showed highest cumulative egg production from 6th to 20th week whereas CJxCJ showed highest cumulative egg production at 25th and 30th week, and therefore it may be concluded that line CU as male and CP as female line appears to be the most elite cross among the crossbreds studied for the first 20 weeks of age whereas CJ purebreds are most elite group for 25th to 30th week.

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