

**GENETIC STUDIES ON GROWTH RATES IN JAPANESE QUAILS
(COTURNIX COTURNIX JAPONICA)**

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ABSTRACT

The data on average daily gains (ADGs) during first, second, third, fourth, fifth to eight, nine to twelve, thirteen to sixteen and seventeen to twenty weeks of age in Black and Brown Japanese quails was analysed by least-squares analysis for studying the effect of strains, generations, sex and hatches. The overall least squares means for ADGs at 1, 2, 3, 4, 5 to 8, 9 to 12, 13 to 16 and 17 to 20 weeks of age were 3.91, 5.78, 6.98, 6.36, 2.73, 0.55, 0.34 and 0.30 g, respectively. The effects of strain, sex and hatch was significant on ADGs at all ages except ADG 9-12, while the influence of generation was evident on ADGs at all ages. The birds of 7th generation exhibited highest average daily gains and sexual dimorphism was in favour of females. Low to high heritability estimates were obtained for ADGs at all ages in Black and Brown Japanese quails by half-sib as well as full sib methods. Moderate to high genetic correlations with positive direction were observed among the majority of the combinations, while low to medium correlations were noticed at phenotypic and environmental level with inconsistency in direction based on half sib analysis. The genetic correlations based on various components of variance (full sib analysis) were mostly moderate to highly positive for majority of the combinations in both Black and Brown Japanese quails, while most of the phenotypic correlations were low to medium and inconsistent in direction.

Key words: average daily gains, correlations, heritability, japanese quails

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INTRODUCTION

Japanese quail (*Coturnix coturnix japonica*) have become popular and gaining commercial importance because of faster growth rate, shorter generation interval and excellent reproductive characteristics and number of quail lines derived from different sources have been genetically improved for growth rate and egg production. Several investigations have been conducted to study the effect of selection on growth parameters of chickens. However, such systematic genetic studies on the Japanese quails are scanty. Hence, the present investigation was undertaken to estimate the phenotypic and genetic variation in growth rates of Black and Brown strains of Japanese quails under selection.

MATERIALS AND METHODS

The data on 3237 Black and 3376 Brown Japanese quails maintained at the Poultry Experimental Station, College of Veterinary Science, Hyderabad were utilized for the present study. The body weights from day old to 4-weeks of age were recorded at weekly intervals and thereafter at four weekly intervals up to 20 weeks of age by using a digital balance with an accuracy of 1g. The average daily gains during the first week (ADG 1) of age was computed as the difference between Weight at first week and Day-old weight divided by 7. Similarly, the ADG during 2nd (ADG 2), 3rd (ADG 3) and 4th (ADG 4) week of age were computed based on the difference in body weights between two successive intervals divided by 7, while Average Daily Gains (ADG 5-8) during 4th to 8th week was computed based

on the difference in body weights between 8th and 4th week body weight divided by 28. Similarly, ADG 9-12, ADG 13-16 and ADG 17-20 were calculated based on the difference in body weights between two successive 4-week age intervals divided by 28. The data on Average Daily gains was subjected to least squares analysis (Harvey, 1979) to resolve the effect of strains, generations, sex and hatches and Duncan's multiple range test (Kramer, 1957) was applied to find out the differences between the means. Data adjusted for hatch and generation effects were utilized for estimation of heritabilities, genetic, phenotypic and environmental correlations (Becker, 1985). Since the progenies of a sire consisted of a mixture of half sibs and full sibs, heritability and correlations were estimated by half sib as well as full-sib methods.

RESULTS AND DISCUSSION

Means

The results of least squares analysis of variance of ADGs revealed significant differences between the two strains and hatches at all ages with an exception during 9 to 12 weeks of age. Generations and sex had a significant ($P < 0.01$) effect on ADGs at all the ages studied, except during first week and 9 to 12 weeks age for the effect of sex.

The overall least squares mean for ADGs during first, second, third and fourth week of age were 3.91, 5.78, 6.98 and 6.36 g, respectively, while daily gains of 2.73, 0.55, 0.34 and 0.30 g were observed during 5 to 8, 9 to 12, 13 to 16 and 17 to 20 weeks of age (Table 1), which were found to be quite higher than those reported by Feroz Mohammed *et al.* (2006).

The overall least squares mean ADG of 3.91 g recorded during first week of age, reached a maximum of 6.98 g during third week of age and declined gradually to the lowest of 0.30 g, during 17 to 20 weeks of age. The ADGs of Black Japanese quails were significantly higher than those of Brown Japanese quails at all the ages, except during 9 to 12 weeks of age. Both Black and Brown Japanese quails recorded highest ADGs of 7.33 and 6.64 g during third week of age, respectively. Significant effect of strain on ADGs noticed in the present study indicated that the two strains of Japanese quails in the present study were genetically distinct and cannot be treated as a single group which also corroborated with the findings of Feroz Mohammed *et al.* (2006) and Singh *et al.* (2010).

The chicks of 7th generation recorded significantly ($P < 0.01$) higher ADGs during first four weeks of age, whereas the chicks of 5th and 6th generations recorded higher ADGs during 5 to 12 weeks of age.

Sex of the chick had a significant effect on ADGs at all the ages studied, except during first week and 9 to 12 weeks of age. The ADGs of females were found to be higher by 0.16, 0.24, 0.20, 1.35, 0.08, 0.06 and 0.05 g over the males during second, third, fourth and fifth to eighth, ninth to twelfth, 13 to 16 and 17 to 20 weeks of age. The mean ADGs of 3.89 and 3.92 g recorded in males and females during first week of age improved gradually and attained a maximum of 6.86 and 7.10 g during third week, and declined gradually to 2.06 and 3.41 g during 5 to 8 weeks of age. This indicated that rearing either male or female Japanese quails beyond 8 weeks of age by the commercial

farmers may not be profitable, as also pointed out by Metodiev *et al.* (1997).

The significant differences among the hatches for ADGs, noticed in the present study could be attributable to the variation in the environmental conditions over different hatches. The highest ADGs were recorded during 3rd week of age in the majority of hatches, while the lowest ADGs were noticed during 17 to 20 weeks of age.

Genetic parameters

Heritability

Heritability estimates for ADGs in both Black and Brown Japanese quails based on half sib and full sib analysis are detailed in Table 2. Heritability estimates based on half sib analysis ranged from 0.11 to 0.81 in Black males and 0.15 to 0.95 in Black females, where a slow to medium estimates were noticed in Brown males (0.02 to 0.27) and females (0.05 to 0.41).

Heritability estimates based on full sib analysis varied from 0.03 to 0.20, 0.04 to 0.31 and 0.07 to 0.22 based on sire, dam and sire + dam component of variance in Black males and corresponding estimates in Black female ranged from 0.01 to 0.21, 0.09 to 0.98 and 0.12 to 0.50.

Heritability estimates based on sire, dam and sire + dam component of variance ranged from 0.02 to 0.63, 0.22 to 0.28 and 0.01 to 0.61 in Brown males and the corresponding estimates in females varied from 0.03 to 0.23, 0.02 to 0.64 and 0.03 to 0.32. The heritability estimates recorded for ADGs in the present investigation is comparable to most of the estimates reported in literature (Praharaj *et*

al., 1990; Aggrey and Cheng, 1994 and Feroz Mohammed *et al.*, 2006).

Majority of the estimates from dam component were higher than those from the sire component indicating the possibility of existence of maternal and non additive genetic effects. Heritability estimates based on sire + dam component of variance ranged from low to medium indicating the existence of moderate genetic variance, which could facilitate the improvement through selection coupled with optimum management conditions.

Correlations

The genetic, phenotypic and environmental correlations among the ADGs at various ages in Black and Brown Japanese quails based on half sib and full sib analysis are shown in Table 3.

The genetic correlations among the ADGs at various ages based on half sib analysis varied from -0.57 to 0.96 in Black males, -0.13 to 0.67 in Black females, 0.04 to 0.46 in Brown males and -0.37 to 0.69 in Brown females, while the phenotypic and environmental correlations in both the strains were found to be low to moderate in magnitude and mostly negative in direction.

Medium to high genetic estimates were observed based on sire (-0.97 to 0.22), dam (-0.25 to 0.76) and sire + dam (-0.47 to 0.95) components of variance in Black males and low to high estimates were noticed in Black females (0.02 to 0.81, -0.76 to 0.44 and -0.23 to 0.56). Medium to high (-0.52 to 0.18) association was observed at phenotypic level in Black strain. The environmental correlations based on sire,

dam and sire + dam components of variance varied from -0.16 to 0.15, -0.21 to 0.16 and -0.18 to 0.17 in Black males, whereas, the corresponding correlations in Black females ranged from -0.18 to 0.06, -0.10 to 0.19 and -0.13 to 0.13.

In Brown Japanese quails, the genetic correlations based on sire, dam and sire + dam components ranged from -0.95 to 0.23, -0.51 to 0.49 and -0.12 to 0.61, respectively. The environmental correlations based on sire (-0.25 to 0.12), dam (-0.37 to 0.12), sire and dam (-0.33 to 0.09) components of variance were low to moderate in magnitude with both the directions, whereas phenotypic correlations ranged from -0.26 to 0.09. The genetic correlation coefficients among the ADGs at few ages in Black and Brown Japanese quails were either outside the biological limits or were not estimable.

These results corroborated the findings of Praharaj *et al.* (1990), Aggrey and Cheng (1994) and Feroz Mohammed *et al.* (2006), who found medium to high positive genetic and phenotypic associations and negative environmental correlations with moderate estimates among the ADGs at various ages.

Medium to high positive genetic correlations obtained in the present study for most of the combinations in both Black and Brown Japanese quails indicated that ADGs at different ages were influenced by pleiotropic genes and linkage and selection for high ADGs at early age would automatically improve the ADGs at later ages as a correlated response to selection.

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Table 1. Least squares means (g) of Average Daily Gains (ADG) in Japanese quails

	n	ADG 1		ADG 2		ADG 3		ADG 4		n	ADG 5-8		ADG 9-12		ADG 13-16		ADG 17-20	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Overall	6613	3.91	0.01	5.78	0.02	6.98	0.02	6.36	0.02	826	2.73	0.04	0.55	0.03	0.34	0.02	0.30	0.01
Strains:																		
Black	3237	4.16 ^b	0.02	6.10 ^b	0.03	7.33 ^b	0.03	6.54 ^b	0.03	414	2.83 ^b	0.05	0.57	0.03	0.37 ^b	0.02	0.32 ^b	0.02
Brown	3376	3.66 ^a	0.02	5.46 ^a	0.03	6.64 ^a	0.03	6.19 ^a	0.03	412	2.64 ^a	0.05	0.54	0.03	0.31 ^a	0.02	0.28 ^a	0.02
Generations:																		
5	1753	3.14 ^a	0.02	5.62 ^b	0.03	6.41 ^a	0.03	6.14 ^b	0.03	268	3.08 ^c	0.07	0.75 ^b	0.04	0.29 ^a	0.02	0.23 ^a	0.02
6	1811	4.28 ^c	0.02	5.39 ^a	0.04	7.05 ^b	0.04	5.94 ^a	0.04	283	2.35 ^a	0.07	0.48 ^a	0.04	0.38 ^b	0.02	0.38 ^b	0.02
7	2068	4.43 ^d	0.02	6.04 ^c	0.03	7.46 ^c	0.04	6.98 ^d	0.04	275	2.77 ^b	0.06	0.43 ^a	0.03	0.35 ^b	0.02	0.28 ^a	0.02
8	981	3.78 ^b	0.03	6.07 ^c	0.05	7.01 ^b	0.05	6.39 ^c	0.06	-	-	-	-	-	-	-	-	-
Sexes:																		
Male	3224	3.89	0.02	5.70 ^a	0.03	6.86 ^a	0.03	6.26 ^a	0.03	209	2.06 ^a	0.07	0.51	0.04	0.31 ^a	0.02	0.27 ^a	0.02
Female	3389	3.92	0.02	5.86 ^b	0.03	7.10 ^b	0.03	6.46 ^b	0.03	617	3.41 ^b	0.04	0.59	0.03	0.37 ^b	0.02	0.32 ^b	0.01
Hatches:																		
1	1199	3.56 ^b	0.03	5.41 ^b	0.04	7.18 ^{dc}	0.05	7.28 ^g	0.05	152	2.73 ^{bc}	0.08	0.49	0.04	0.32 ^{ab}	0.03	0.26 ^{ab}	0.02
2	834	3.99 ^d	0.03	6.45 ^d	0.05	7.23 ^c	0.06	6.91 ^c	0.06	113	2.36 ^a	0.09	0.51	0.05	0.39 ^b	0.03	0.34 ^b	0.03
3	975	3.70 ^c	0.03	5.92 ^c	0.04	7.31 ^c	0.05	7.10 ^f	0.05	140	2.40 ^a	0.08	0.57	0.05	0.42 ^b	0.03	0.32 ^{ab}	0.03
4	775	4.27 ^e	0.03	5.09 ^a	0.05	7.04 ^{cd}	0.06	7.45 ^h	0.06	115	2.52 ^{ab}	0.09	0.53	0.05	0.29 ^a	0.03	0.27 ^{ab}	0.03
5	785	4.57 ^f	0.03	5.12 ^a	0.05	8.20 ^f	0.06	5.93 ^c	0.06	103	2.66 ^{bc}	0.10	0.51	0.06	0.38 ^{ab}	0.03	0.37 ^b	0.03
6	823	3.60 ^b	0.03	6.81 ^c	0.05	6.98 ^c	0.06	5.53 ^b	0.06	89	2.83 ^c	0.10	0.47	0.06	0.32 ^{ab}	0.03	0.36 ^b	0.03
7	618	4.06 ^d	0.04	5.19 ^a	0.06	6.17 ^b	0.07	6.35 ^d	0.07	50	3.09 ^d	0.13	0.52	0.08	0.34 ^{ab}	0.05	0.30 ^{ab}	0.04
8	315	4.11 ^d	0.05	5.26 ^{ab}	0.08	8.39 ^f	0.10	3.62 ^a	0.10	27	3.01 ^c	0.19	0.67	0.11	0.31 ^{ab}	0.06	0.23 ^{ab}	0.06
9	289	3.29 ^a	0.06	6.77 ^c	0.09	4.34 ^a	0.10	7.11 ^{fg}	0.11	37	2.97 ^c	0.16	0.71	0.09	0.30 ^{ab}	0.06	0.22 ^a	0.05

Means followed by the same superscripts (s) in each effect do not differ significantly (P<0.05).

Table 2. Estimates of heritabilities of Average Daily Gains (ADG) of Japanese quails

	Half-sib		Full-sib						Half-sib		Full-sib					
	h^2	SE	h^2_s	SE	h^2_D	SE	h^2_{s+D}	SE	h^2	SE	h^2_s	SE	h^2_D	SE	h^2_{s+D}	SE
	Black males								Black females							
ADG 1	0.22	0.04	0.20	0.09	0.04	0.11	0.12	0.05	0.22	0.04	0.12	0.10	0.20	0.12	0.16	0.05
ADG 2	0.22	0.04	0.09	0.10	0.25	0.14	0.17	0.06	0.35	0.04	0.21	0.11	0.26	0.13	0.24	0.06
ADG 3	0.11	0.03	0.07	0.08	0.07	0.12	0.07	0.05	0.21	0.04	0.09	0.10	0.23	0.12	0.16	0.05
ADG 4	0.19	0.04	0.03	0.10	0.31	0.15	0.17	0.06	0.20	0.04	0.15	0.09	0.09	0.11	0.12	0.05
ADG 5-8	0.81	0.27	\$	-	\$	-	0.22	0.31	0.68	0.14	0.01	0.42	0.98	0.70	0.50	0.26
ADG 9-12	0.48	0.25	0.87	0.52	\$	-	0.08	0.28	0.15	0.11	\$	-	0.23	0.59	0.11	0.21
ADG 13-16	0.37	0.24	0.85	0.42	\$	-	\$	-	0.95	0.16	\$	-	\$	-	\$	-
ADG 17-20	\$	-	0.36	0.43	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-
	Brown males								Brown females							
	h^2	SE	h^2_s	SE	h^2_D	SE	h^2_{s+D}	SE	h^2	SE	h^2_s	SE	h^2_D	SE	h^2_{s+D}	SE
ADG 1	0.19	0.04	0.08	0.09	0.23	0.13	0.15	0.05	0.41	0.05	0.19	0.12	0.45	0.15	0.32	0.06
ADG 2	0.17	0.04	0.02	0.09	0.28	0.14	0.15	0.05	0.11	0.03	0.04	0.08	0.14	0.11	0.09	0.04
ADG 3	0.10	0.03	0.01	-	0.22	0.13	0.11	0.05	0.06	0.03	0.06	0.04	0.24	0.13	0.09	0.05
ADG 4	0.02	0.03	0.02	0.07	0.01	0.06	0.01	0.04	0.05	0.03	0.03	0.07	0.02	0.10	0.03	0.04
ADG 5-8	\$	-	\$	-	\$	-	0.37	0.42	\$	-	\$	-	\$	-	0.06	0.28
ADG 9-12	0.27	0.29	0.63	0.67	0.54	-	0.05	0.42	0.07	0.12	\$	-	0.49	0.68	0.12	0.22
ADG 13-16	0.11	0.28	\$	-	0.27	0.22	0.10	0.45	0.08	0.12	\$	-	0.64	0.71	0.15	0.22
ADG 17-20	\$	-	\$	-	\$	-	0.61	0.68	\$	-	0.23	0.25	\$	-	\$	-

\$ - beyond the biological limits

Table 3. Estimates of genetic (r_G), phenotypic (r_P) and environmental (r_E) correlations among Average Daily Gains (ADG) of Black and Brown Japanese quails

	Half-sib						Full-sib																																
	Black males												Black females						Brown males						Brown females														
	$r_{G(S)}$	SE	r_P	SE	$r_{E(D)}$	SE	$r_{G(S)}$	SE	$r_{G(D)}$	SE	$r_{G(S+D)}$	SE	r_P	SE	$r_{E(S)}$	SE	$r_{E(D)}$	SE	$r_{E(S+D)}$	SE	$r_{G(S)}$	SE	$r_{G(D)}$	SE	$r_{G(S+D)}$	SE	r_P	SE	$r_{E(S)}$	SE	$r_{E(D)}$	SE	$r_{E(S+D)}$	SE					
ADG1×ADG2	0.33	0.11	-0.09	0.03	-0.21	0.22	0.19	\$	-	0.48	0.14	-0.09	0.11	-0.16	0.16	-0.21	0.14	-0.18	0.22																				
ADG1×ADG3	0.68	0.09	0.10	0.03	0.08	\$	-	\$	-	0.20	0.12	0.10	0.14	0.02	0.11	0.16	0.11	0.09	0.16																				
ADG1×ADG4	-0.57	0.09	-0.17	0.03	-0.06	\$	-	-0.25	0.12	-0.47	0.21	-0.17	0.21	-0.09	0.11	-0.15	0.17	-0.12	0.17																				
ADG2×ADG3	0.96	0.01	-0.02	0.03	-0.20	\$	-	0.76	0.21	0.95	0.15	-0.01	0.15	-0.14	0.18	-0.14	0.16	-0.14	0.18																				
ADG2×ADG4	0.12	0.13	0.14	0.03	0.14	-0.97	0.34	0.69	0.20	0.41	0.13	0.14	0.17	0.15	0.19	0.01	0.10	0.09	0.11																				
ADG3×ADG4	\$	-	-0.15	0.03	\$	\$	-	\$	-	\$	-	-0.52	0.24	\$	-	\$	-	0.17	0.21																				
	Black females												Brown males						Brown females																				
ADG1×ADG2	0.28	0.09	-0.01	0.03	-0.12	0.30	0.12	0.28	0.14	0.29	0.14	-0.01	0.14	-0.07	0.14	-0.09	0.11	-0.08	0.12																				
ADG1×ADG3	0.59	0.08	0.15	0.03	0.03	0.81	0.43	0.44	0.16	0.56	0.25	0.16	0.21	0.08	0.15	0.08	0.12	0.08	0.14																				
ADG1×ADG4	-0.13	0.12	-0.08	0.03	-0.07	0.02	0.17	-0.50	0.17	-0.23	0.13	-0.08	0.13	-0.08	0.15	-0.04	0.10	-0.06	0.13																				
ADG2×ADG3	0.66	0.06	0.01	0.03	-0.24	\$	-	-0.76	0.18	0.20	0.15	0.01	0.11	-0.18	0.16	0.11	0.14	-0.04	0.12																				
ADG2×ADG4	0.67	0.06	0.18	0.03	0.01	\$	-	-0.20	0.10	0.47	0.19	0.18	0.25	0.06	0.11	0.19	0.16	0.13	0.18																				
ADG3×ADG4	0.34	0.11	-0.09	0.03	-0.20	0.71	0.24	-0.20	0.10	0.19	0.21	-0.09	0.17	-0.17	0.10	-0.10	0.11	-0.13	0.18																				
	Brown males												Brown females																										
ADG1×ADG2	0.46	0.11	-0.04	0.03	-0.15	\$	-	-0.05	0.14	0.24	0.11	-0.04	0.15	-0.12	0.11	-0.07	0.11	-0.09	0.12																				
ADG1×ADG3	0.04	0.17	0.08	0.03	0.08	\$	-	-0.15	0.20	-0.06	0.14	0.08	0.16	0.08	0.12	0.12	0.14	0.09	0.13																				
ADG1×ADG4	0.15	0.39	-0.15	0.03	-0.18	-0.95	0.02	\$	\$	-	-0.15	0.12	-0.16	0.13	-0.24	0.12	-0.20	0.14	0.14																				
ADG2×ADG3	0.35	0.16	-0.14	0.03	-0.21	\$	-	-0.32	0.15	0.01	0.15	-0.14	0.16	-0.19	0.14	-0.12	0.16	-0.16	0.20																				
ADG2×ADG4	0.08	0.41	-0.04	0.03	-0.04	\$	-	\$	\$	-	-0.03	0.10	-0.03	0.10	-0.11	0.17	-0.07	0.12	0.12																				
ADG3×ADG4	\$	-	-0.26	0.03	-0.33	\$	\$	\$	\$	-	-0.26	0.16	-0.30	0.19	-0.37	0.21	-0.33	0.16	0.16																				
	Brown females																																						
ADG1×ADG2	0.62	0.08	0.02	0.03	-0.15	\$	-	0.28	0.16	0.52	0.16	0.03	0.11	-0.08	0.11	-0.07	0.12	-0.08	0.12																				
ADG1×ADG3	-0.41	0.14	0.05	0.03	0.16	\$	-	0.13	0.17	-0.11	0.18	0.05	0.12	0.12	0.15	0.06	0.12	0.09	0.16																				
ADG1×ADG4	-0.37	0.16	-0.11	0.03	-0.08	-0.88	0.12	0.44	0.21	-0.12	0.20	-0.11	0.14	-0.08	0.12	-0.16	0.14	-0.12	0.17																				
ADG2×ADG3	0.69	0.13	-0.15	0.03	-0.23	\$	-	0.49	0.20	0.61	0.16	-0.15	0.16	-0.20	0.15	-0.26	0.18	-0.23	0.16																				
ADG2×ADG4	0.47	0.22	0.09	0.03	0.06	0.23	0.04	-0.51	0.19	0.16	0.20	0.09	0.17	0.06	0.11	0.11	0.16	0.08	0.11																				
ADG3×ADG4	\$	-	-0.21	0.03	-0.29	\$	\$	\$	-	\$	-	-0.21	0.18	-0.25	0.16	-0.37	0.19	-0.31	0.18																				

\$ - beyond the biological limits