Body weight, feed coefficient and carcass characteristics of two strain quails and their reciprocal crosses

N.VALI[1], EDRISS, M.A.[2] and RAHMANI, H.R.[2]

[1]Department of Animal Sciences, faculty of Agriculture Shahrekord University, Shahrekord, Iran, [2] Department of Animal Sciences, faculty of Agriculture Isfahan University of Technology *(IUT)*, Isfahan, Iran.

ABSTRACT: A study was conducted to compare body weight (BW), feed intake, feed coefficient up to 49 days of age, and carcass characteristics of two quail strains and their reciprocal crosses for genetic groups, namely, Japanese quail (*Coturnix japanese*), Range quail (*Coturnix ypisilophorus*), and their reciprocal in four hatches. Body weights of four groups at 1, 7, 14, 21, 28, 35, 42, 49,56 and 63 days of ages were significantly different (p<0.1), Body weights of female at 49,56 and 63 days of age were significantly higher than males, but there was no significant difference between male and females at the other recorded body weights (P>0.05). There was a significant (P<0.01) effect of hatch for body weights at all ages except 42, 56 and 63. Feed intake of H2 group was also significantly larger than that other groups (P<0.01), while feed coefficient of four groups were not different (P>0.05). At 49 days of age, Carcass percent, breast percent, wing weight and giblet weight of four groups were significantly different (p<0.01), while there was no significant difference for carcass weight (eviscerated), breast weight, carcass rest (thigh, leg and back) among them (p>0.05). Carcass weight, carcass percent, breast weight were significantly affected by sex (p<0.01), while sex was not effective for breast percent difference (p>0.05). The estimated heterosis for the body weight was maximum (18.41%) and minimum (-8.37%) at 14 and 7 days of age, respectively.

Key words: *Coturnix japanese*, *Coturnix ypsilophorus*, feed coefficient, carcass traits, heterosis

Introduction

The Japanese quail (*Coturnix japanese*) is the smallest avian species farmed for meat and egg production and it has also assumed as a world wide importance as a laboratory animal (Baumgartner 1994, Minvielle 1998). In relation to nutrition, it is essential to know clearly and precisely the requirements of the animal species according to their production potential. Adequate food and diet formulation helps not only to reach nutritional requirements but also to increase the levels of feed conversion (Rondelli *etal.*2003). Carcass composition is normally modified by age, sex, handling and diet manipulation, and it is also believed that fat deposition increases with age which is simply related to maturity and happens in the majority of species (Rondelli *etal.*2003).A review of BW data (Darden and Marks,1989) from reciprocal crosses arising from mating Japanese quail lines divergently selected for 4-wk BW reveal rather large reciprocal effects between crosses. Initial BW differences were expected because of the large egg size difference between high and low dams line. However, large BW difference (15 to 24%) remaining at 4wk of age were unexpected (Marks1993$_b$).In the present work, the aims were to study body weights, feed intake, feed coefficient and carcass characteristics of Japanese quail (*Coturnix japanese*) and Range quail (*Coturnix ypsilophorus*) and their reciprocal crosses, and also to estimate heterosis percent for body weight up to 63 days of age.

Materials and methods

A total of 500 quails include 250 Japanese quails (*Coturnix japanese*) and 250 Range quails (*Coturnix ypsilophorus*) were randomly selected from the parents population, (the parents population were contained quails at 105 days of age, which they were recorded for weekly body weight until 63 days of age) and were randomly divided to four groups: 1- Japanese male and female quails (C♂×C♀). 2- Range male and female quails (R♂×R♀). 3- Range male quails and Japanese female quails (R♂×C♀). 4- Japanese male quails and Range female quails (C♂×R♀). These four groups were kept in separate pen at 1 male to 3 female's ratio. After 15 days when these groups were placed in pens, the fertile eggs were collected from each group and coded. Eggs were antisepticised by formaldehyde, and then they were set in incubator (14 days in setter and 2 days in Hatcher). Setter and Hatcher were divided into separate parts per groups according to the egg code. At each hatch 50 quails from each group (a total of 800 quails in 4 hatches) were wing banded and transferred to a litter house with 35°C temperature. The temperature was decreased 3°C on weekly bases and after 4th week, supplemental heating was disconnected. The chicks had access to continuous lighting for the first 48 hours. Thereafter, daily light was reduced to 15 hours (6:00AM until 9:00 PM) and was maintained for the rest of the experiment. Diet which contained 22% crude protein and 2750 kcal/kg metabolizable energy. Food and water were available *ad libitum.* Food intake and body weight individually were recorded weekly for each group. A total of 160 quail (10 males and 10 females) at 49days of age of each group and two hatches were randomly selected and slaughtered in order to study carcass characteristics. They were fasted for 10 to 12 hours before they were slaughtered, bled and plucked. These quails were killed by cutting off the neck vessel. Evisceration was performed by hand. Carcass weight and carcass part weights (breast, wing and giblet) were recorded for each chicken. General Linear Models (GLM) procedures of SAS institute (1998) were employed for analyses of the data and the following models were used for analysis:

$$Y_{ijkl}=\mu+GR_i+HA_j+SE_k+ e_{ijkl}$$

$$Y_{ijkl}=\mu+GR_i+HA_j +WE_k+e_{ijkl}$$

where:

Y_{ijkl} is the individual observation for trait Y.

μ is the overall mean for trait Y_{ijkl}.

GR_i is the effect of the i^{th} group.

HA_j is the effect of j^{th} hatch.

SE_k is the effect of the k^{th} sex.

WE_k is the effect of the k^{th} week.

e_{ijkl} is random error.

Results and discussion

Least squares means and standard error by group, sex, hatch and overall means of body weight and the symbols of significance for the main effects are shown in Table 1and 2. Body weight of four groups at 1, 7, 14, 21, 28, 35, 42, 49, 56 and 63 days of ages were significantly different ($p<0.01$). At all ages except 1 day of age, Japanese quail, were the heaviest in four groups, but body weight at 7, 21, 35, 42, 49 and 63 days of age between Japanese quail and H1 were not different ($p>0.05$). Body weight between H1 and H2 at 14, 42 days of ages were not significantly different ($p>0.05$), however body weights of H1 at 1, 7, 21, 28, 35, 49, 56 and 63 days of ages were significantly ($p<0.01$) heavier than H2 (Table 1and 2). Results obtained for body weight in Japanese quail at 42 day of age were agreed or higher than the previous studies, which were unselected, but it was lower than selected groups (Bacon *etal.* 1986; Marks, 1993a; Mignon-Grasteau and Minvielle, 2003). Body weights at 49, 56, and 63 days of age were significantly different ($p<0.01$) between sexes, and females showed higher weight of body than males which is in agreement with earlier studies (Bumgartner 1994, Minvielle *etal.*2000).

The least squares means by groups, hatch and week of feed intake, weight gain, and feed coefficient with the symbols of significance for the main effects are shown in Table 3. Mean feed intake was greatest in H2 among groups, but feed coefficient (grams of feed: grams of weight gain) was not different among the groups. Feed intake (grams per bird per day) were significantly different among weeks ($p<0.01$).Mean feed intake for 1 to 7 weeks of ages were 2.63, 6.55, 9.80, 11.60, 15.25, 18.19, 19.14 grams; respectively. Marks (1993a) reported the pattern of increasing feed intake with increasing body weight is evident in both the P and C lines, and his results support earlier observation regarding increases in feed intake associated with selection responses for increased body weight Marks (1981). He added the cause of this close relationship, it is difficult to separate true differences in feed intake between selected (fast-growing) and unselected (slow-growing) genotypes. Minvielle *et al.*1995 reported daily feed intake vary between generation, with a peak at generation 7, but line EE with the highest intake of 33.7gr ingested consistently 4 to 5 g more per day than line DD. Marks (1980) reported the difference of feed intake noted between line of high and low body weight are more accentuated in the first days of life, even before differences in body weight were established, indicating that there is a high genetic correlation between feed intake and genetic variation of growth rate.

Feed coefficient was significantly different among weeks ($p<0.01$). Lowest and highest of feed coefficient for 1th and 7nd weeks were 1.96±0.19 and 6.20±0.18, respectively. These values are generally lower than values in report of Marks (1993a). Mortality percent were not significantly ($p>0.05$) among groups and also between hatch. Mortality percent were not significantly between 1 and 2 of weeks, also among 3, 4, 5, 6 and 7 weeks ($p>0.05$).

Table 4 lists lest squares means for carcass traits by groups, sex and hatch with their standard error and symbols of significance for the main effects. Carcass characteristics were significantly affected by groups source of variation ($p<0.01$). Carcass weight (evisceration) was not different among groups and values for this trait were 114.48±1.60, 112.63±2.52, 111.79±1.74 and 110.69±2.06 for H1, Ra, Co and H2 respectively (Table 4). All of carcass traits of females were significantly ($p<0.01$) higher than male except breast percent and carcass percent these are in agreement with previous studies (Caron and Minvielle 1990 and Minvielle *et al.* 2000).There was no different in the breast percent and giblet (liver+heart+gizzard) between hatches, while for other traits (total carcass, carcass weight, carcass percent, breast weight and wing weight) were significantly different ($p<0.01$).

Estimations of heterosis for the body weights at 1 to 63 days of ages are shown in Table 5. Positive heterosis was for body weight at 1, 14, 21, 28, 49, 56 and 63 days of ages, while other of ages was negative heterosis. Heterosis percent were for body weight at 14 days of age the highest (18.41%) and the lowest for 7 days (-8.37%). There are very few reports on heterosis particularly strain crossing. Minvielle *etal.* 1995 reported heterosis for early egg production and feed in take in Japanese quail with two lines, and explained heterosis for daily feed in take was positive but largely not significant. Piao *etal.*(2004) reported large heterosis was found for the age at first egg, the number of eggs and the total egg weight up days of age. However, the average egg weight of SR (crossing) was lighter than that of RR (random bred population), showing no heterosis.

References

BACON, W.L., NESTOR, K.E. AND LONG, D.W. (1986) Divergent selection for body weight and yolk precursor in Coturnix coturnix Japanica. 6. Correlated response in plasma calcium and eggshell traits. *Poult. Sci.* **65**:355-359.

BAUMGARTNER, J. (1994) Japanese quail production, breeding and genetics. *World's Poultry Science Journal, vol.* **50**:227-235.

CARON, N. AND MINVIELLE, F. (1990) Mass selections for 45-day body weight in Japanese quail: selection response carcass composition, cooking properties, and sensory characteristics. *Pout. Sci.,* **69**:1037-1045.

DARDEN, R. AND MARKS, H.L. (1989) Divergent selection for growth in Japanese quail under split and complete nutritional environments. 3. Influences of selection for growth on heterotic effects for body weight feed and water intake patterns, abdominal fat, and carcass lipid characteristics. *Poult. Sci.* **68**:37-45.

PIAO J.S.O., KOBAYASHI, S., WADA, Y. AND MAEDA, Y. (2004) Purebred and carcass bred performances from a Japanese quail with very small body size. *Anim. Res.* **53**:145-153

MARKS, H.L. (1980) Feed efficiency of selected and non selected Japanese quail lines. *Poult. Sci.* **59**; 173-176.
Marks, H.l. (1981) Selection environment influences on feed and water intake of Japanese quail following long-term selection for 4-week body weight. *Poult. Sci.* **60**:2572-2580.

MARKS, H.L. (1993_a) Carcass composition, feed intake, and feed efficiency following long-term selection four week body weight in Japanese quail. *Poult. Sci.* **72**:1005-1011.

MARKS, H.L. (1993_b) Divergent selection for growth in Japanese quail under split and complete nutritional environments.6.Differential body weights inreiprocal crosses. *Poult. Sci.* **72**: 1847-1854.

MINGNON-GRASTEAU, S. AND MINVIELLE, F. (2003) Relation between tonic immobility and production estimated by factorial correspondence analysis in Japanese quail. *Poult. Sci.* **82**: 1839-1844.

MINVIELLE, F., MONVOISIN, J. L., FRENOT, A. AND COSTA, J. (1995) heterosis for early egg production and feed intake in Japanese quail. *Arch Geflugelk,* **59**:89-93.

MINVIELLE, F. (1998) Genetic and breeding of Japanese quail for production around the world. *Proceedings 6th Asian Pacific poultry congress* Nagoya, Japan June 4-7th.

MINVIELLE, F., GANDEMER, G., MAEDA, Y., LEBORGOYEN, G. AND BOULAY, M. (2000) Carcass characteristics of a heavy Japanese quail line under introgressios with the roux gene. *British Poult. Sci.* **41**:41-45.

PIO, J., OKAMOTO, S., KOBAYASHI, S., WADA, Y. AND MEADA, Y. (2004) purebred and crossbred performance from a Japanese quail line with very small body size. *Anim. Res.* **53**:145-153.

RONDELLI, S., MARTINEZ, O. AND GARCIA, PT. (2003) Sex effect on productive parameters, carcass and body fat composition of two commercial broilers lines. *Brazilian Journal of Poult. Sci.* **3**:169-173.

SAS INSTITUTE (1998) Statistical analysis system. User guide. Sas Institute Inc. Cary, NC.1998.

Table 1: Least squares means and standard error for body weights (BW: grams) in quails.

Source		BW1	BW7	BW14	BW21	BW28
Total mean		7.88±0.04	21.63±0.24	49.15±0.46	76.67±0.73	110.31±1.01
Group	Co	7.84±0.06^{b}	22.92±0.28^{a}	51.25±0.61^{a}	79.37±0.99^{a}	115.54±1.29^{a}
	Ra	8.23±0.07^{a}	21.73±0.33^{b}	48.01±0.72^{b}	74.61±1.17^{bc}	109.06±1.52^{b}
	H1	8.23±0.15^{a}	22.32±0.08^{ab}	44.89±1.75^{b}	78.36±2.83^{ab}	106.24±3.68^{b}
	H2	7.14±0.14^{c}	18.20±0.77^{c}	45.55±1.68^{b}	70.82±2.72^{c}	97.53±3.54^{c}
Sex	female	7.82±0.07^{a}	21.01±0.38^{a}	47.26±0.63^{a}	75.65±1.53^{a}	107.72±1.75^{a}
	male	7.92±0.07^{a}	21.58±0.37^{a}	47.60±0.82^{a}	75.93±1.33^{a}	106.47±1.73^{a}
Hatch	1	8.21±0.06^{a}	17.74±0.33^{c}	48.51±0.72^{ab}	81.13±1.17^{a}	116.63±1.52^{a}
	2	7.91±0.07^{b}	22.77±0.54^{a}	46.54±1.19^{bc}	74.65±1.93^{b}	100.59±2.51^{b}
	3	7.69±0.11^{b}	21.32±0.60^{b}	44.62±1.30^{c}	74.17±2.11^{b}	113.04±2.75^{a}
	4	7.70±0.09^{b}	23.34±0.48^{a}	50.04±1.04^{a}	73.21±1.69^{b}	98.12±2.21^{b}

Co: Japanese quail (*Coturnix Japanese*), Ra: Range quail (*Coturnix ypsilophorus*),
H1: hybrid 1(R♂×C♀) and H2: hybrid 2 (C♂×R♀).
Letters $^{(a, b, c)}$ Means within each subclass column with superscript are significantly different (P>0.01).

Table 2: Least squares means and standard error for body weights (BW: grams) in quails.

Source		BW35	BW42	BW49	BW56	BW63
Total mean		139.32±1.12	170.33±2.22	189.45±1.23	20.8.02±1.86	215.35±2.93
Group	Co	145.86±1.49[a]	177.50±3.19[a]	193.89±1.59$_{a}$	211.22±2.38[a]	221.92±3.80[a]
	Ra	138.79±1.75[b]	167.21±3.76[b]	189.34±1.85[b]	207.43±2.53[a]	205.97±4.71[b]
	H1	137.43±4.24[ab]	171.94±9.07[ab]	191.70±4.47[ab]	207.87±4.62[a]	221.92±5.60[a]
	H2	125.65±4.08[c]	158.01±8.73[b]	176.63±4.30[c]	196.13±4.35[b]	205.64±5.35[b]
Sex	female	138.38±2.02[a]	170.77±4.33[a]	196.06±2.13[a]	219.36±2.34[a]	233.62±3.85[a]
	male	135.48±1.99[a]	166.55±4.27[a]	179.72±2.11[b]	191.96±2.39[b]	194.11±4.01[b]
Hatch	1	134.37±1.75[b]	165.99±3.75[a]	187.53±1.85[b]	204.51±1.98[a]	211.92±2.12[a]
	2	137.59±2.89[ab]	173.25±6.18[a]	198.02±3.04[a]	206.81±2.99[a]	215.81±6.32[a]
	3	143.25±3.17[a]	170.11±6.78[a]	188.56±3.40[b]	NA	NA
	4	132.50±2.54[b]	165.30±5.44[a]	177.46±2.68[c]	NA	NA

Co: Japanese quail (*Coturnix Japanese*), Ra: Range quail (*Coturnix ypsilophorus*),
H1: hybrid1 (R♂×C♀) and H2: hybrid 2 (C♂×R♀). NA: not available
Letters [(a, b, c)] Means within each subclass column with superscript are significantly different (P>0.01).

Table3. Least-squares mean of feed intake, individual gain, feed coefficient and mortality in quails.

Source		Individual feed intake (gr/day/bird)	Individual gain (gr/day/bird)	Feed coefficient	Mortality (%)
Group:	Co	$11.74{\pm}0.05^{b}$	$3.53{\pm}0.10^{a}$	$3.38{\pm}0.10^{a}$	$2.95{\pm}0.67^{a}$
	Ra	$11.75{\pm}0.05^{b}$	$3.47{\pm}0.10^{a}$	$3.37{\pm}0.10^{a}$	$3.26{\pm}0.67^{a}$
	H1	$11.80{\pm}0.10^{b}$	$3.31{\pm}0.20^{a}$	$3.60{\pm}0.21^{a}$	$3.64{\pm}1.33^{a}$
	H2	$12.23{\pm}0.10^{a}$	$3.66{\pm}0.20^{a}$	$3.55{\pm}0.21^{a}$	$2.81{\pm}1.33^{a}$
Hatch:	female	$11.83{\pm}0.05^{a}$	$3.47{\pm}0.10^{a}$	$3.53{\pm}0.10^{a}$	$2.48{\pm}0.67^{a}$
	male	$11.93{\pm}0.05^{a}$	$3.52{\pm}0.10^{a}$	$3.42{\pm}0.11^{a}$	$3.84{\pm}0.68^{a}$
Week:	1	$2.63{\pm}0.09^{g}$	$1.44{\pm}0.18^{d}$	$1.96{\pm}0.19^{e}$	$6.03{\pm}2.04^{a}$
	2	$6.55{\pm}0.08^{f}$	$3.50{\pm}0.17^{c}$	$2.02{\pm}0.18^{e}$	$5.14{\pm}1.16^{a}$
	3	$9.80{\pm}0.08^{e}$	$3.76{\pm}0.17^{bc}$	$2.72{\pm}0.18^{d}$	$3.46{\pm}1.08^{b}$
	4	$11.60{\pm}0.08^{d}$	$4.47{\pm}0.17^{a}$	$2.70{\pm}0.18^{d}$	$2.82{\pm}1.01^{b}$
	5	$15.25{\pm}0.08^{c}$	$4.06{\pm}0.17^{ab}$	$4.07{\pm}0.18^{c}$	$1.90{\pm}0.98^{b}$
	6	$18.19{\pm}0.08^{b}$	$4.06{\pm}0.17^{ab}$	$4.67{\pm}0.18^{b}$	$1.47{\pm}0.97^{b}$
	7	$19.14{\pm}0.08^{a}$	$3.16{\pm}0.17^{c}$	$6.20{\pm}0.18^{a}$	$1.34{\pm}0.97^{b}$

Co: Japanese quail (*Coturnix Japanese*), Ra: Range quail (*Coturnix ypsilophorus*),H1: hybrid 1(R♂×C♀) and H2: hybrid 2 (C♂×R♀).
Letters $^{(a- g)}$ Means within each subclass column with superscript are significantly different (P>0.01).

Table 4: Least squares means and standard error for carcass traits in quails

Source		TC(gr)	CW(gr)	CP (%)	BRW(gr)	BP (%)	WW(gr)	GHL(gr)
Total mean		161.82±1.71	109.54±2.98	61.81±0.36	44.50±0.55	40.63±0.19	10.93±0.14	13.87±0.19
group	Co	169.11 ± 2.47^{a}	111.79 ± 1.74^{a}	60.13 ± 0.46^{b}	45.25 ± 0.82^{a}	40.46 ± 0.35^{ab}	10.99 ± 0.19^{b}	14.63 ± 0.31^{a}
	Ra	167.14 ± 3.58^{a}	112.63 ± 2.52^{a}	60.37 ± 0.67^{b}	46.68 ± 1.20^{a}	41.48 ± 0.51^{a}	10.62 ± 0.27^{b}	13.91 ± 0.45^{ab}
	H1	164.08 ± 2.27^{ab}	114.48 ± 1.60^{a}	64.00 ± 0.42^{a}	46.31 ± 0.76^{a}	40.47 ± 0.32^{ab}	11.84 ± 0.17^{a}	13.47 ± 0.28^{b}
	H2	158.00 ± 2.92^{b}	110.69 ± 2.06^{a}	64.26 ± 0.54^{a}	44.43 ± 0.98^{a}	40.15 ± 0.42^{b}	11.19 ± 0.22^{b}	12.99 ± 0.37^{b}
Sex	Female	169.59 ± 2.07^{a}	114.80 ± 1.46^{a}	61.40 ± 0.38^{b}	46.76 ± 0.69^{a}	40.77 ± 0.29^{a}	11.41 ± 0.16^{a}	14.42 ± 0.26^{a}
	male	159.57 ± 1.98^{b}	110.00 ± 1.40^{b}	62.98 ± 0.37^{a}	44.57 ± 0.66^{b}	40.52 ± 0.28^{a}	10.92 ± 0.15^{b}	13.08 ± 0.25^{b}
Hatch	1	156.59 ± 1.74^{b}	103.76 ± 1.22^{b}	60.45 ± 0.32^{b}	42.47 ± 0.58^{b}	40.90 ± 0.25^{a}	10.23 ± 0.13^{b}	14.04 ± 0.22^{a}
	2	172.58 ± 2.32^{a}	121.04 ± 1.63^{a}	63.93 ± 0.43^{a}	48.87 ± 0.77^{a}	40.38 ± 0.33^{a}	12.10 ± 0.18^{a}	13.46 ± 0.29^{a}

Co: Japanese quail (*Coturnix Japanese*), Ra: Range quail (*Coturnix ypsilophorus*), H1: hybrid 1(R♂×C♀) and H2: hybrid 2 (C♂×R♀).

Letters (a, b) Means within each subclass column with superscript are significantly different (P>0.01).

TC: total carcass (carcass with head and feet), CW: carcass weight (evisceration), CP: carcass percent (body weight/ carcass weight)

BRW: breast weight, BP: breast percent (breast weight/carcass weight), WW: wing weight,

GHL: gizzard, heart and liver weight (giblet).

Table5: Estimations of average heterosis percent.

Age (days)	Body weight (gr)				Heterosis%
	Ra	Co	H1	H2	
1	7.21	7.45	8.05	7.51	6.14
7	16.23	17.92	16.64	14.65	-8.37
14	34.52	38.44	39.76	46.63	18.41
21	62.50	69.02	70.59	76.23	11.63
28	95.01	104.79	105.55	107.15	6.46
35	123.98	132.57	127.37	123.27	-2.30
42	153.11	161.81	158.70	155.41	-0.26
49	168.29	179.47	180.46	176.49	2.64
56	185.35	186.02	209.47	194.39	8.75
63	193.69	194.24	223.93	202.84	10.01

Co: Japanese quail (*Coturnix Japanese*), Ra: Range quail (*Coturnix ypsilophorus*), H1: hybrid 1(R♂×C♀) and H2: hybrid 2 (C♂×R♀).

$$\text{Heterosis\%} = \left(\left(\frac{\left(\left(\overline{H}1 + \overline{H}2\right) - \left(\overline{R}A + \overline{C}O\right)\right)/2}{\left(\overline{R}A + \overline{C}O\right)/2} \right) \Big/ 2 \right) \times 100$$