Research Journal of
POULTRY
SCIENCES
SINCE 2000
MEDWELL PUBLICATIONS

Carcass Traits as Influenced by Different Body Weight in Four Close-bred Flocks of Japanese Quails (*Coturnix coturnix japonica*)

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Key words: Dressed weight, dressing percentage, giblets and visceral organs

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Page No.: 1-10
Volume: 14, Issue 1, 2021
ISSN: 1993-5285
Research Journal of Poultry Sciences
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Abstract: The present study was conducted to investigate effect of different body weight categories in four close-bred flocks of Japanese quails on their carcass traits. For this purpose, 432 adult (12 weeks-old), quails comprising 108 males and 324 females were used. The body weight categories of male and female quails ranged from 270 to 315 g and 300 to 350 g for heavy, 225 to 270 g and 250 to 300 g for medium and 180 to 225 g and 200 to 250 g for small. The results showed that dressed weight (g) in imported and local flocks of Japanese quails differed significantly ($p<0.05$) in female quails. With respect to body weight categories, a significant difference ($p<0.05$) was recorded for dressed weight and dressing percentage in both the sexes. The imported flock of male Japanese quails differed significantly ($p<0.05$) from all the other local flocks in relative weight of gizzard (filled and empty). The relative heart weight and intestinal weight in local-3 flock of male Japanese quails differed significantly ($p<0.05$) from imported and all other local flocks. The interaction between flocks and body weight was significant ($p<0.05$) for heart, gizzard and intestinal weight only in male quails. The interaction between flocks and body weight was significant ($p<0.05$) for reproductive tract length and number of mature ovarian follicles. From above trial, it was concluded that birds based on its body weight should be reared because it is more economical and desirable by farmers.

INTRODUCTION

Japanese quail farming is one of the most suitable and easily adaptable enterprises possessing low capital investment and rapid turn over all over the world including Pakistan. Japanese quails are raised for their tasty meat and nutritious eggs all over the world[1, 2]. Rearing quails for egg production is rather difficult due to

marketing problems but broiler quail rearing can be adopted looking to market potential for quail meat in cities and big towns. Quails are popular for their good quality meat with high proteins (26%) and less fat (3%) which is also known to increase sexual instinct in humans[3]. It has the great potential to be exploited as an economical and efficient source of production of meat in the country provided its body weight and carcass yield is further improved.

At the moment, these small size birds are mainly consumed as a whole carcass. Growth rate in quail can be further improved to reach an acceptable level of productivity and ensure a satisfying carcass and meat quality according to the specific targets of each production system. The first concern is to produce a carcass of good quality and specifically obtain a maximum meat yield with a limited fatness. Keeping above in view, 4 different close-bred flocks of Japanese quails (1 imported and 3 local) have been maintained at Avian Research and Training Centre, Department of Poultry Production, University of Veterinary and Animal Sciences, Lahore, Pakistan, with the objectives of studying the possibility of improving their growth and productive performance. However, very little information is available on the carcass characteristics of these strains of Japanese quails.

MATERIALS AND METHODS

Location and meteorological data: The present study of 31 weeks duration was conducted to evaluate carcass characteristics of 4 close-bred flocks of Japanese quails with different body weights, at Avian Research and Training Centre, University of Veterinary and Animal Sciences, Lahore, Pakistan.

Bird, s husbandry and diet: Birds were maintained in an independent open-sided laying housed with the east to west dimension measuring 6.10×6.10 m (37.21 m^2), equipped with two rows of 3-tiered laying cages measuring 5.18×1.52 m (47.42 m^2) with sloping wire floor to facilitate egg collection. The ventilation, humidity and house temperature were controlled using ceiling fans, curtains and other helpful manual techniques. Variations in daily temperature (^{o}F) and humidity (%) were noted using a wet and dry bulb hygrometer (Mason's type, Zeal, England) and later an average of the temperature and humidity were derived on weekly basis Fig. 1. The removable dropping trays were fitted under the mesh floor for the removal of faecal material. Feeding of the birds was done through removable individual trough feeders installed outside the cage and watering through the automatic nipple drinker system fitted therein throughout the experimental period. Birds were offered a commercial laying ration at 06:00 AM with quail breeder

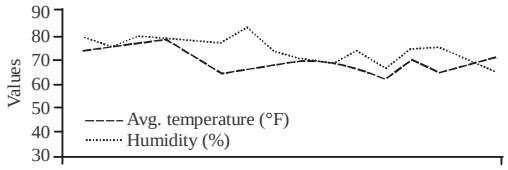

Fig. 1: Variations in temperature (^{o}F) and humidity (%) by a wet and dry bulb hygrometer (Mason's type, Zeal, England) from August, 2018-April, 2019

ration according to NRC[4], (an allowance of 35-40 g/bird/day) containing Metabolizeable energy 2900 kcal/kg, crude protein 20%, calcium 3% and available phosphorus 0.4%.

Bird, s population and experimental design: A total of 432 adult (12 weeks old) quails, comprising, 108 males and 324 females were used. The birds were randomly picked up from the available stock and then divided into 108 experimental units (replicates comprising one male and three females of each). These experimental units were randomly assigned to 12 treatment groups having 4 close-bred flocks (imported, local 1, local 2 and local 3)×3 body weights with randomized complete block design in factorial arrangements having 9 replicates in each treatment. The body weight categories of heavy male and female quails ranged from 270 to 315 g and from 300 to 350 g, respectively, medium from 225 to 270 g in male and 250 to 300 g in female and small ranged from 180 to 225 g in male and from 200 to 250 g in females. The maximum and minimum temperature of the quail house was recorded daily. Natural day light was provided to the birds at the start of the experiment and then light hours were increased by half an hour weekly till 16 h light per day. Fresh and clean drinking water was provided at all the times through automatic nipple drinkers. The experimental birds were tagged for their proper identification. At the age of 31 weeks, two breeder quails (one male and female each) from each replicate were picked up at random and were kept off feed for 5-6 h prior to slaughter, to keep their intestines free from undigested feed. The birds were slaughtered humanely to ensure complete bleeding and were individually weighed on sophisticated electronic digital balance prior to slaughter.

Data collection: Throughout experimental, quail, s carcass characteristics (Dressing percentage, live weight (g), dressed weight (g), relative weight (g/100g BW) of giblets, liver, heart, gizzard (filled and empty) and relative weight (g/100g BW) of giblets (The weight of the giblet i.e., liver, heart and gizzard (filled and empty) during evisceration of the birds after slaughtering of each breeder quail was recorded separately) and relative weight, length and number of visceral organs including intestinal weight

(g), intestinal length (cm), reproductive tract weight (g), reproductive tract length (cm), mature ovarian follicle numbers and testes weight (g) were measured.

Statistical analysis: The data thus collected were analyzed using ANOVA techniques (Steel *et al.*[5] with Randomized Complete Block Design (RCBD) under factorial arrangement for further interpretation using General Linear Model (GLM) procedures (SAS 9.1)[6] portable software, assuming following mathematical model:

$$Y_{ij} = \mu + S_i + W_j + \varepsilon_{ij}$$

Where:

Y = Each observation
μ = Population mean
S_i = Number of flocks treated as blocks (i = 4)
W_j = Weight categories treated as treatments (j = 3)
ε_{ij} = Random error associated with i flocks and j weight categories

The comparison of means was made using Duncan's Multiple Range (DMR) test[7].

RESULTS AND DISCUSSION

The results in respect of slaughter characteristics in male and female breeder quail parents of 4 close-bred flocks (Imported, Local-1, Local-2 and Local-3) have been presented as under:

Carcass characteristics: The mean final live body weight (g), dressed weight (g) and dressing percentage of the quails are shown in Table 1 and 2.

Dressed (carcass) weight (g): The dressed weight of imported and local flocks of Japanese quails showed significant difference ($p<0.05$) in female quails, while, male exhibited non-significant difference when slaughtered at 31 week of age (Table 1). The maximum dressed weight (176.44±15.07) was recorded in birds from imported flock and minimum (143.77±7.65) in local-2. With respect to body weight categories, a significant difference ($p<0.05$) was found in both the sexes. The maximum dressed weight (148.00±3.60) was observed in male with heavy weight category, whereas, minimum (128.16±4.49) in small weight category. In female, maximum dressed weight (178.58±3.60) was observed also with heavy weight category, whereas, minimum (141.83±3.53) in small weight category. The interaction between flocks and body weight also showed significant difference in both the sexes. The maximum dressed weight (155.00±5.77) was recorded in male quails of imported flock with heavy weight category while, minimum (131.67±4.37) in local-2 flock with medium weight category. In female, maximum dressed weight (255.00±13.22) was noted in imported flock with heavy weight category while, minimum (132.00±6.80) in local-2 flock with small weight category (Table 1). In the present study, dressed weight differed significantly ($p<0.05$) in female quails only whereas, male quails showed non-significant differences. With respect to body weight categories, significant difference ($p<0.05$) was observed in dressed weight of both the sexes. The interaction between flocks and body weight also showed significant difference in both sexes.

Dressing percentage: The dressing percentage in imported and local flocks of male Japanese quails varied non-significantly while, female birds of imported flock showed significant difference ($p<0.05$) from all local flocks (Table 2). The maximum dressing percentage (57.27±2.30) was recorded in birds from imported flocks and minimum (48.03±1.51) in local-2 flock. With respect to body weight categories, non- significant difference was found in dressing percentage in both the sexes. The interaction between flocks and body weight was observed to be non-significant in male quails, whereas, it was significant ($p<0.05$) in females. The maximum dressing percentage (64.15±0.17) was recorded in imported flock with heavy weight category and minimum (47.52±0.64) in local-2 flock with medium weight category (Table 2). In the present study, dressing percentage in imported and local flocks of male quails varied non-significantly from each other whereas, it varied significantly ($p<0.05$) in imported and all the local female flocks.

Relative weight (g/100g BW) of giblets: The results in respect of mean relative weights (g/100g BW) of liver, heart and gizzard (with and without contents) of both the sexes of breeder quails are presented in Table 3-6.

Liver: Imported and all the local male and female breeder flocks of Japanese quails showed non-significant differences in mean relative weight of liver during this study (Table 3). The body weight categories size had non-significant effect on the mean relative weight of liver in both the sexes of quails. The interaction between flocks and body weight categories was non-significant (Table 3). In the present study, both the sexes of imported and all the local flocks of Japanese quails differed non-significantly in mean relative weight of liver.

Heart: Local-3 flock of male Japanese quails was found to differ significantly ($p<0.05$) in the mean relative weight of heart than other local and imported flocks (Table 4). The maximum relative mean weight of heart (0.96 ±0.08) was recorded in birds from Local-3 flock and minimum (0.73±0.07) in local-1. In female birds, the relative mean heart weight of imported and all local flocks showed

Table 1: Dressed weight (g) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		---------- (Mean ± SE**; g) ----------				
Heavy	Male	155.00±5.77^{a}	154.33±5.36^{a}	132.67±7.26^{ab}	150.00±2.51^{a}	148.00±3.60^{E}
	Female	255.00±13.22^{a}	160.67±18.49^{b}	161.33±20.21^{b}	167.33±5.89^{b}	178.58±10.46^{E}
Medium	Male	136.00±11.37^{ab}	131.67±4.37^{ab}	148.33±14.65^{a}	142.67±7.31^{ab}	139.66±4.75^{EF}
	Female	167.67±22.55^{b}	143.67±6.98^{b}	138.00±3.00^{b}	138.67±9.69^{b}	147.00±6.58^{F}
Small	Male	127.67±3.28^{ab}	127.33±2.33^{ab}	140.00±9.86^{ab}	117.67±14.3^{b}	128.16±4.49^{F}
	Female	136.67±5.84^{b}	148.00±4.72^{b}	132.00±6.80^{b}	150.67±7.21^{b}	141.83±3.53^{F}
Mean	Male	139..55±5.55	137.77±4.68	140.33±5.96	136.77±6.78	
	Female	176.44±15.07^{A}	150.77±6.39^{B}	143.77±7.65^{B}	152.22±5.68^{B}	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error

Table 2: Dressing percentage (%) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		---------- (Mean±SE**; %) ----------				
Heavy	Male	55.19±0.71	53.41±0.79	49.97±3.20	52.53±2.84	52.77±1.09
	Female	64.15±0.17^{a}	51.64±1.10^{b}	48.08±4.68^{b}	50.31±3.05^{b}	53.55±2.24
Medium	Male	52.85±2.29	48.49±3.74	53.02±4.09	54.46±0.84	52.21±1.45
	Female	55.04±4.18^{b}	52.45±1.00^{b}	47.52±0.64^{b}	49.34±1.93^{b}	51.09±1.33
Small	Male	52.85±1.27	48.41±2.86	53.420.74	50.38±1.41	51.26±0.96
	Female	52.62±3.04^{b}	52.70±1.84^{b}	48.51±2.23^{b}	53.51±3.68^{b}	51.83±1.32
Mean	Male	53.63±0.87	50.10±1.60	52.14±1.61	52.45±1.11	
	Female	57.27±2.30^{A}	52.26±0.70^{B}	48.03±1.51^{B}	51.05±1.61^{B}	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error

Table 3: Relative weight (g/100 g BW) of liver in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		----------(Mean ± SE**; cm/100g BW***) ----------				
Heavy	Male	1.66±0.24	1.45±0.07	1.93±0.64	1.93±0.15	1.74±0.16
	Female	2.38±0.56	2.42±0.23	3.26±1.01	2.90±0.07	2.74±0.27
Medium	Male	1.78±0.30	1.86±0.48	1.84±0.25	1.93±0.24	1.85±0.14
	Female	2.29±0.45	2.65±0.04	3.04±0.55	3.17±0.36	2.79±0.20
Small	Male	1.96±0.17	1.60±0.19	1.29±0.28	1.64±0.23	1.62±0.11
	Female	2.66±0.16	2.67±0.39	2.37±0.14	2.15±0.70	2.46±0.18
Mean	Male	1.80±0.12	1.63±0.16	1.69±0.23	1.84±0.11	
	Female	2.45±0.22	2.58±0.13	2.89±0.36	2.74±0.27	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; ***BW = Body Weight

Table 4: Relative weight (g/100g BW) of heart in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		----------(Mean ± SE**; cm/100g BW***) ----------				
Heavy	Male	0.84±0.08^{ab}	0.73±0.04^{b}	0.74±0.09^{b}	1.17±0.11^{a}	0.87±0.06
	Female	0.84±0.03	0.81±0.06	1.02±0.22	0.75±0.04	0.85±0.06
Medium	Male	0.98±0.06^{ab}	0.70±0.17^{b}	0.90±0.14^{ab}	0.71±0.08^{b}	0.82±0.06
	Female	0.89±0.05	0.76±0.01	0.92±0.07	1.12±0.14	0.92±0.05
Small	Male	0.94±0.12^{ab}	0.76±0.18^{b}	0.63±0.09^{b}	0.99±0.12^{ab}	0.83±0.07
	Female	0.80±0.05	0.89±0.08	1.01±0.17	0.94±0.14	0.91±0.05
Mean	Male	0.92±0.05^{AB}	0.73±0.07^{B}	0.76±0.06^{AB}	0.96±0.08^{A}	
	Female	0.84±0.02	0.82±0.03	0.98±0.08	0.93±0.08	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; *** BW = Body Weight

non-significant difference. With respect to body weight categories, there was non-significant difference in their relative mean weight of heart in both the sexes. However, the interaction between flocks and body weight in male quails showed significant difference (p<0.05). The maximum relative mean weight of heart (1.17±0.11) was observed in local-3 flock with heavy weight category and minimum (0.63±0.09) in local-2 flock with small weight category. However, female birds showed non-significant difference in their mean liver weight (Table 4). In the present study, relative heart weight in local-3 male flock of Japanese quails differed significantly (p<0.05) from all other flocks while female quails had non-significant difference in this respect in all the local and imported flocks. With respect to body size categories, a non-significant difference was found in the mean relative weight of heart in both the sexes. However, interaction between flocks and body size had significant (p<0.05) effect only in male quails.

Table 5: Relative weight (g/100 g BW) of gizzard (filled) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		----------(Mean ± SE**; cm/100g BW***) ----------				
Heavy	Male	2.03±0.02^{ab}	2.03±0.11^{ab}	1.96±0.28^{ab}	2.12±0.32^{ab}	2.04±0.09
	Female	2.04±0.17	1.92±0.18	2.82±0.42	2.87±0.39	2.41±0.18
Medium	Male	2.47±0.43^{ab}	1.65±0.27^{b}	2.58±0.22^{a}	2.59±0.19^{a}	2.32±0.17
	Female	1.96±0.28	2.18±0.16	2.52±0.21	2.90±0.07	2.39±0.13
Small	Male	2.33±0.30^{ab}	1.66±0.18^{b}	2.12±0.13^{ab}	1.95±0.15^{ab}	2.02±0.11
	Female	2.94±0.66	2.41±0.21	2.30±0.13	2.31±0.28	2.49±0.18
Mean	Male	2.28±0.16^{A}	1.78±0.11^{B}	2.22±0.14^{A}	2.22±0.15^{A}	
	Female	2.31±0.26	2.17±0.11	2.55±0.16	2.69±0.17	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; *** BW = Body Weight

Table 6: Relative weight (g/100 g BW) of gizzard (empty) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		----------(Mean ± SE**; cm/100g BW***) ----------				
Heavy	Male	1.54±0.18^{ab}	1.50±0.10^{ab}	1.63±0.24^{ab}	1.75±0.23^{ab}	1.61±0.09
	Female	1.49±0.11^{b}	1.68±0.13^{ab}	2.04±0.20^{ab}	1.59±0.22^{b}	1.70±0.09
Medium	Male	1.82±0.43^{ab}	1.16±0.24^{b}	2.11±0.13^{a}	1.58±0.18^{ab}	1.67±0.15
	Female	1.48±0.19^{b}	1.61±0.08^{b}	1.68±0.08^{ab}	2.31±0.11^{ab}	1.77±0.10
Small	Male	1.65±0.09^{ab}	1.41±0.19^{ab}	1.66±0.09^{ab}	1.44±0.15^{ab}	1.54±0.06
	Female	2.52±0.78^{a}	1.84±0.15^{ab}	1.87±0.13^{ab}	1.87±0.11^{ab}	2.02±0.19
Mean	Male	1.67±0.14^{AB}	1.38±0.10^{B}	1.80±0.11^{A}	1.59±0.10^{AB}	
	Female	1.83±0.29	1.71±0.07	1.86±0.09	1.92±0.13	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; *** BW = Body Weight

Gizzard weight-empty and filled: The imported flock of male Japanese quails varied significantly (p<0.05) in mean relative weight of filled gizzard from all local flocks (Table 5). The maximum relative mean weight of filled gizzard (2.28±0.16) was recorded in birds from imported flock and minimum (1.78±0.11) in local-1. However, female birds in different flocks exhibited non-significant difference. With respect to body weight categories, there was non-significant difference in their relative mean weight of gizzard in both the sexes. The interaction between flocks and body weight in male birds showed significant difference (p<0.05). The maximum relative mean weight of filled gizzard (2.59±0.19) was observed in local-3 flock with medium weight category and minimum (1.65±0.27) in local-1 flock in the same weight, whereas, female birds showed non-significant difference (Table 5). The relative mean gizzard weight (empty) in local-2 male flock significantly (p<0.05) varied from imported and other local flocks (Table 6). The maximum mean gizzard weight (1.80±0.11) was recorded in local-2 flock and minimum (1.38±0.10) in local-1. However, female birds showed non-significant difference in the relative mean weight of empty gizzard. With respect to body weight categories, there was non-significant difference in their relative mean gizzard weight in both the sexes. The interaction between flocks and body weight category also showed significant difference (p<0.05) in both the sexes. The maximum (2.11±0.13) mean gizzard weight (empty) in male birds was observed in local-2 flock with medium weight category and minimum (1.16±0.24) in local-2 flock with small weight category, whereas, in female birds the maximum (2.52±0.78) mean gizzard weight was recorded in imported flock with small weight category and minimum (1.48±0.19) in imported flock with medium size category (Table 6). In the present study, the imported flock of male Japanese quails differed significantly (p<0.05) in relative weight of gizzard (filled and empty) from all other local flocks, whereas, female birds did not differ significantly. However, with respect to body weight categories, a non-significant difference in the weight of gizzard (filled and empty) in both the male and female quails was observed. The interaction between flocks and body weight was found to be significant (p<0.05) only in male birds and this interaction was also significant for empty gizzard weight in both the sexes. The mean gizzard weight in imported male flock remained higher than in the local flocks.

Relative weight, length and number (g, cm, #/100g BW) of visceral organs: The results in respect of mean relative weight of intestine, intestinal length, reproductive tract weight and length, number of mature follicles and testes weight in breeder quails recorded at the end of the experiment are presented in Table 7-12, respectively.

Intestinal weight (g) and length (cm): The male quails of local-3 flock significantly (p<0.05) differed from imported and other local flocks in mean relative intestinal weight (Table 7). The maximum intestinal weight (3.37±0.21) was recorded in local-3 flock and minimum (2.47±0.36) in local-2. However, the mean intestinal weight of imported and all the local female flocks differed

Table 7: Relative intestinal weight (g/100 g BW) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		----------(Mean ± SE**; cm/100g BW***) ----------				
Heavy	Male	2.80±0.07^{ab}	2.64±0.16^{ab}	1.77±0.70^{b}	3.35±0.30^{a}	2.64±0.24
	Female	4.54±0.27	3.76±1.05	4.04±0.14	5.01±0.55	4.34±0.30
Medium	Male	2.93±0.47^{ab}	2.59±0.11^{ab}	2.80±0.32^{ab}	3.58±0.33^{a}	2.97±0.18
	Female	3.50±0.18	3.75±0.34	3.65±0.68	4.75±0.46	3.91±0.24
Small	Male	2.84±0.13^{ab}	2.58±0.18^{ab}	2.85±0.78^{ab}	3.19±0.54^{a}	2.87±0.21
	Female	5.29±1.00	4.17±0.43	3.63±0.62	3.75±0.89	4.21±0.38
Mean	Male	2.86±0.14^{AB}	2.60±0.07^{B}	2.47±0.36^{B}	3.37±0.21^{A}	
	Female	4.44±0.39	3.89±0.35	3.77±0.27	4.50±0.38	

Different alphabets on means in a row show significant differences at p<0.0; *CBF = Close-Bred Flocks; **SE = Standard Error; *** BW = Body Weight

Table 8: Relative intestinal length (cm/100 g BW) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Sex	Imported	Local-1	Local-2	Local-3	Mean
		----------(Mean ± SE**; cm/100g BW***) ----------				
Heavy	Male	20.62±3.04	20.12±3.17	21.91±2.58	21.44±4.08	21.02±1.40
	Female	19.66±2.15^{cd}	24.31±2.72^{abc}	17.43±0.53^{d}	20.58±1.12^{abc}	20.49±1.08^{F}
Medium	Male	22.91±1.79	18.53±2.28	18.74±2.07	21.78±0.98	20.49±0.97
	Female	20.31±1.40^{bcd}	24.23±1.48^{abc}	23.26±1.77^{abc}	25.85±0.42^{a}	23.41±0.84^{E}
Small	Male	18.26±1.35	21.91±2.94	22.08±0.84	21.56±1.92	20.95±0.94
	Female	25.34±1.84^{ab}	23.64±1.04^{abc}	22.37±1.36^{abcd}	21.90±0.74^{abcd}	23.31±0.68^{E}
Mean	Male	20.63±1.28	20.18±1.49	20.91±1.12	21.60±1.33	
	Female	21.77±1.28^{AB}	24.06±0.95^{A}	21.02±1.12^{B}	22.78±0.89^{AB}	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; *** BW = Body Weight

Table 9: Relative reproductive tract weight (g/100 g BW) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Imported	Local-1	Local-2	Local-3	Mean
	---------- (Mean ± SE**; cm/100g BW***) ----------				
Heavy	3.08±0.59	3.57±0.79	3.41±0.38	3.48±0.87	3.38±0.29
Medium	4.02±0.93	3.14±0.71	3.03±0.15	2.50±0.79	3.17±0.34
Small	5.01±1.43	3.04±0.73	3.37±0.90	3.26±0.51	3.67±0.47
Mean	4.03±0.59	3.25±0.38	3.27±0.29	3.08±0.39	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; ***BW = Body Weight

Table 10: Relative reproductive tract length (cm/100 g BW) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Imported	Local-1	Local-2	Local-3	Mean
	---------- (Mean ± SE**; cm/100g BW***) ----------				
Heavy	9.06±0.28^{d}	12.30±0.94^{bc}	9.71±0.53^{cd}	8.89±0.59^{d}	9.99±0.49^{F}
Medium	10.29±0.73^{bcd}	13.21±1.34^{ab}	10.89±0.48^{bcd}	9.34±1.58^{cd}	10.93±0.64^{EF}
Small	15.70±0.83^{a}	11.04±0.51^{bcd}	9.02±1.38^{d}	10.90±1.04^{bcd}	11.67±0.85^{E}
Mean	11.68±1.07^{A}	12.18±0.58^{A}	9.88±0.52^{B}	9.71±0.65^{B}	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; ***BW = Body Weight

Table 11: Relative mature ovarian follicles numbers (#/100 g BW) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Imported	Local-1	Local-2	Local-3	Mean
	---------- (Mean ± SE**; cm/100g BW***) ----------				
Heavy	0.94±0.06^{ab}	1.28±0.11^{ab}	1.51±0.22^{ab}	0.88±0.49^{b}	1.15±0.14
Medium	1.29±0.12^{ab}	1.23±0.19^{ab}	1.37±0.01^{ab}	1.09±0.38^{ab}	1.25±0.10
Small	1.65±0.05^{a}	1.30±0.10^{ab}	1.25±0.18^{ab}	1.29±0.09^{ab}	1.37±0.07
Mean	1.30±0.11	1.27±0.07	1.37±0.09	1.09±0.19	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; ***BW = Body Weight

Table 12: Relative testes weight (g/100 g BW) in 4 close-bred flocks of Japanese quails with different body weight categories at 31 week

*CBF/Category	Imported	Local-1	Local-2	Local-3	Mean
	---------- (Mean ± SE**; cm/100g BW***) ----------				
Heavy	2.89±0.45	2.45±0.28	1.82±0.79	2.45±0.68	2.40±0.27
Medium	3.67±0.83	2.78±0.38	2.66±0.69	3.01±0.19	3.03±0.27
Small	3.53±0.90	2.69±0.26	2.64±0.58	3.67±0.89	3.13±0.33
Mean	3.36±0.39	2.64±0.16	2.38±0.37	3.05±0.37	

Different alphabets on means in a row show significant differences at p<0.05; *CBF = Close-Bred Flocks; **SE = Standard Error; *** BW = Body Weight

non-significantly. With respect to body weight categories, a non-significant difference was found in their mean intestinal weight in both the sexes. The interaction between flocks and body weight also had significant difference ($p<0.05$) in male birds. The maximum mean body weight was recorded in local-3 flock with medium weight category (3.58±0.33) and minimum (1.77±0.70) in local-2 flock with heavy weight. Female birds showed non-significant difference in their mean intestinal weight (Table 7). The mean relative intestinal length in male quails of imported and all local flocks, varied non-significantly however, female quails showed significant difference ($p<0.05$) (Table 8). The maximum mean intestinal length (24.06±0.95) was recorded in local-1 and minimum (21.02±1.12) in local-2 flock. With respect to body weight categories, male quails had non-significant variation in their mean intestinal length. The interaction between flocks and body weight was also found to be non-significant. Female quails had significant difference ($p<0.05$) in their mean intestinal length. The maximum mean intestinal length (23.41±0.84) was recorded in quails of heavy weight category and minimum in small body weight category (20.49±1.08). The interaction between flocks and body weight in female quails also showed significant difference ($p<0.05$). The maximum mean intestinal length (25.85±0.42) was found in local-3 flock with medium weight category and minimum (17.43±0.53) in local-2 flock with small category (Table 8).

The results of the present study showed that local-3 flock of male Japanese quails significantly ($p<0.05$) differed from imported and other local flocks in intestinal weight (g) whereas, non-significant differences were noted in female flock. With respect to body weight categories, a non-significant difference in the mean intestinal weight in both the sexes and in the mean intestinal length in male quails was observed. The interaction between flocks and body weight was found to be significant ($p<0.05$) in male quails only. The mean intestinal length (cm) in imported and all the local flocks of male Japanese quails showed non-significant difference, whereas, in female quails it showed significant difference ($p<0.05$).

Reproductive tract weight (g), reproductive length (cm) and mature ovarian number (#): The mean relative weight of reproductive tract in imported quail flock was found to vary non-significantly from that of all local flocks (Table 9). Body weight categories had non-significant effect on the mean weight of reproductive tract. The interaction of flocks and body weight was also observed to be non-significant (Table 9).

The mean relative length of reproductive tract in local-1 flock of Japanese quails varied significantly ($p<0.05$) from imported and other local flocks (Table 10). The maximum length of mean reproductive tract (12.18±0.58) was recorded in birds from local-1 flock and minimum (9.71±0.65) in local-3. With respect to body weight categories, significant difference ($p<0.05$) was noted in reproductive tract length (Table 3). The maximum length of mean reproductive tract (11.67±0.85) was recorded in small weight category quails and minimum (9.99±0.49) in heavy weight birds. The interaction between flocks and body weight also had significant effect ($p<0.05$) on reproductive tract length. The maximum mean reproductive tract length (15.70±0.83) was observed in imported flock with heavy weight category and minimum (8.89±0.59) in local-3 flock with heavy category (Table 10).

The mean relative number of mature ovarian follicles in imported flock of Japanese quails differed non-significantly from that of all other local flocks (Table 11). Body weight categories also had non-significant effect on the mean number of mature ovarian follicles. However, interaction between flocks and body weight was found to be significant ($p<0.05$) in this respect. The maximum mean number of mature ovarian follicles (1.65±0.05) was observed in imported flock with small weight category and minimum (0.94±0.06) in the same flock with heavy category (Table 11).

In the present study, the mean reproductive tract weight (g) and mature ovarian follicles number in imported flock of Japanese quails showed non-significant difference from all the local flocks.

Testes weight (g): The mean relative weight of testes in imported flock of Japanese quails differed non-significant from all local flocks (Table 12). Body size categories had non-significant effect on weight of testes in quails. The interaction between flocks and body weight was also found to be non-significant (Table 12). The mean testes weight (g) in imported and all the local flocks of Japanese quails varied non-significantly during this study. With respect to body size categories, a non-significant difference was observed in their mean weight of testes.

Similar findings have been reported indicating a significant difference in carcass weight component between the sexes at 4-weeks of age ($p<0.01$) with females quails having higher figures than males[8]. A marginally higher carcass weight in females and a similar parts and carcass yield ratio of empty carcass (without head, neck and feet over live body weight) in both the sexes of quails in pure line K with 68 percent carcass yield has been reported[2]. The findings of this study indicate that dressed weight in imported flock was higher than that of local flocks. Similarly, heavy weight male quails had maximum dressed weight followed by that of medium and small quails. These results are in line with those of Bacon and Nestor[9] who reported that carcass weight was influenced by live body weight in Japanese

quails. Vali *et al.*[10] observed significantly higher carcass weight in male than females in all the lines with significant ($p<0.1$) strain variation.

These findings are in quite agreement with those of Khaldari *et al.*[8] who observed a significant difference in body weight and carcass weights in quails but not for carcass percentage components between the sexes ($p<0.01$), females had higher figures than males at 4 week of age. Similar findings indicating significant variations in dressing percentage among cross-bred chickens have been reported by Mondal *et al.*[11]. The findings of this study with respect to body weight categories showed a non- significant difference in dressing percentage between both the sexes. The interaction between flocks and body size was found to be non-significant in male quails only. The dressing yield can be influenced by breed, body size, slaughtering age, sex, feed quality and the processing techniques[12]. During the present study, the heavy weight male quails had maximum dressing percentage followed by medium and small weight, whereas small and medium female quails had higher dressing percentage. These results are in line with those of Iqbal *et al.*[13] who indicated significantly ($p<0.01$) higher dressing percentage in indigenous male than female chicken. Growth and different carcass traits have been reported to be positively correlated[14]. Dressing percentage in Japanese quail has been reported as 69.4% (Wilson *et al.*[15] 59.3-67.3% (El-Fiky [16] and 69.6-68.1% (Kosba *et al.* [17] at 6 weeks of age.

Similar findings indicating non-significant differences in liver weight have been reported among three chicken breeds, Black Nicobari, Brown Nicobari and Barred birds[18]. Liver weights were found to be influenced by lines in both the sexes of Japanese quails[19]. With respect to body size categories, a non-significant difference in relative weight of liver was observed in both the sexes during this study. The interaction between flocks and body size was also non-significant. Similar findings indicating heavier liver weight in male than female native geese have been indicated[20]. The results of this study further showed that medium weight category birds had maximum liver weight followed by that of heavy and small quails in both the sexes. Similar findings indicating that liver weight in Japanese quails was influenced by their live body weight have been reported by Vali *et al.*[10]. Przywarova *et al.* [21] observed higher ($p<0.01$) liver weight in female Japanese quails. The liver weight was associated with increase in giblet percentage in Japanese quails[22].

These findings indicating variation in heart weight between different close-bred flocks of quails are in close agreement with those of Kumari *et al.*[23] who reported significant difference in heart weight between black and brown strains of Japanese quails. Breed differences in heart weight of chickens have also been indicated[11].

Table 13: Composition of the ration offered to the experimental birds

Ingredient	Inclusion rate (g/100 g)
Corn	62.30
Guar Meal	3.00
Raw rice Bran	4.00
Soybean Meal 44%	1.31
Rape Seed Meal	2.00
DL-Methionine	0.23
L-threonine	0.08
Calcium Carbonate	8.29
Salt	0.11
Corn Glutten	1.00
Canola Meal	8.00
Cotton Seed Meal	4.00
Lysine Sulphate	0.36
Premix	0.30
L-Tryptophan	0.01
Fish Meal 47%	1.00
Feather Meal 54%	4.00
Quantum 600FTU	0.01
Total	100.00
Crude protein (%)	16.5
Metabolisable energy	2902 Kcal/Kg

Selection in Japanese quails for body weight at 4 weeks was associated with increase in giblets percentage[22]. Statistically significant ($p<0.001$) difference in heart weight in geese of different origins have been pointed out[24]. Age related differences in heart weight of chickens with higher heart weight at 10 weeks than at 6 weeks of age have also been indicated[25] (Table 13).

These results indicating difference in gizzard weight among different close-bred flocks are in conformity with those of Kumari *et al.*[23] who reported that black strain of Japanese quails was superior to brown quails for all the slaughter characters including gizzard weight. Selection at 4 weeks body weight in Japanese quails has been associated with increase in giblet percentage[22]. TurgutKirmizibaYrak[20] observed that male native geese had significantly better gizzard weight than the females. The gizzard weight was found to have significant ($p<0.01$) association with body weight in Japanese quails (Bacon and Nestor 1983) and geese[24]. In a similar study, Rehman[25] observed significant difference ($p<0.05$) in intestinal weight and length among imported and local stocks of Japanese quails. Bhatti *et al.*[26] reported breed differences in length of intestine with higher figure in Nick chick layers than other breeds of chickens which was attributed to higher production in Nick chick. Jaturasitha[27] reported higher intestinal percentage in male than female chickens. Iqbal[13] reported that Aseel chickens had higher ($p<0.05$) intestinal weight in male than female at 12 weeks of age, however, differences were non-significant between sexes at 15 weeks of age.

These findings are quite in agreement with those of Rehman[25] who reported non-significant effect of close-bred flocks on reproductive tract weight, length and ovarian follicular numbers in imported and local stocks of Japanese quails. Levent *et al.*[19] observed that sex organ

weights and yields in both the sexes were similar between different quail lines. Non-significant ($p>0.05$) differences were observed in ovary weight among four varieties of Aseel at 12 and 15 weeks of age[13]. With respect to body weight categories, a non-significant difference was found in reproductive tract weight and mature ovarian follicle numbers, whereas, a significant difference ($p<0.05$) in reproductive tract length was observed in this study.

The evidence derived from the available literature suggests that a negative relationship between body weight and different reproductive traits in Japanese quails exists similar to chickens and turkeys[28]. A positive correlation between ovarian follicles and body weight during the growth period in Japanese quails has been indicated Anthony *et al.*[29], however, age at sexual maturity and follicle number was reported to be negatively correlated in two lines of quails[30]. A higher ovary weight was observed following the onset of sexual maturity than 1 or 2 weeks before at the age of 35 and 28 days, respectively[31].

These findings are in line with those of Rehman[25] who reported non-significant difference in testes weight of imported and local stocks of Japanese quails. Levent *et al.*[19] observed similar weights of sex organs and yields in both the sexes between different quail lines. Similarly, non-significant ($p>0.05$) differences were observed in testes weight among the four varieties of Aseel at 12 and 15 weeks of age[13].

CONCLUSION

Dressed yield, reproductive tract weight and length and mature ovarian follicle numbers were higher in imported flock. Significant variation was recorded in relative weight of giblets, testes and intestines and intestinal length among different close-bred flocks. Dressed weight and dressing percentage were higher in heavy female parents than in medium and small quails. Reproductive tract weight and length, mature ovarian follicle number and gizzard weight were better in the small weight parents in comparison to heavy and medium weight parents.

ACKNOWLEDGMENTS

The author would like to acknowledge Faculty Member of Poultry Production Department, University of Veterinary and Animal Science, Shaheed Benazir Bhutto University of Veterinary and Animal Sciences, Sakrand-Pakistan for providing support necessary for this study. This manuscript is part of the Ahmad Sultan Jatoi Ph.D thesis.

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