Research Article

Comparative Study of Carcass Traits in Four Strains of Japanese Quail (*Coturnix japonica*) at 3 to 6 Weeks of Age

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Abstract | This experiment was designed to evaluate the carcass characteristics of 4 different strains of Japanese quails at 3 to 6 weeks of age. In total, 2160 quail chicks were studied with 108 experimental units of each 20 chicks were applied. Birds had free access to clean and fresh drinking water through automatic nipple drinkers all the times. There was a provision of *ad-libitum* broiler-quail ration feeding as per NRC standard. Data on live weight, dressing percentage, keel length, keel angle, length of shank, giblets and length of intestine were calculated. ANOVA technique was used for data analysis and DMR Test for comparison of means. Significant ($p<0.05$) differences were observed in mean slaughter and liver weight (g) in quail birds. Significant ($p<0.05$) differences were noted in keel length (cm) at week 3, 5 and 6 and keel angle at week-3. A significant ($p<0.05$) effect was observed in mean heart weight at week 3 and 6, gizzard weight at week 4, 5 and 6 and intestinal length (cm) at week 3, 5 and 6; whereas, dressing percentage (%) and shank length (cm) differ non-significantly ($p>0.05$) in this study period. Imported quail strain (M) performed better in almost all the studied parameters than that of other strains of quails.

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Introduction

Nowadays Japanese quails *(Coturnix japonica)* are to be found worldwide including Pakistan locally called "*Betair*". Japanese quail farming is one of the most suitable and easily adaptable enterprises possessing low capital investment and rapid turnover and raised for their tasty meat and nutritious eggs all over the world including Pakistan. 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 (Akram *et al.*, 2008). A number of lines, breeds and varieties have been developed for different production purposes (Jatoi, 2012; Rahman *et al.*, 2016). Japanese quail is well-known for meat and lay matchless and tasty eggs (Mahmoud and El-Tarabany, 2016) and also considered as the excellent

meat producer source amongst all the quails strains present in the worldwide with an average 200 gm live adult weight at 4-weeks of age (Ahmad, 2016; Sabow, 2020). The rearing of quail is highly profitable due to its high reproductive efficiency, early sex maturity, fast growth rate i.e. short rearing period (4 to 5 weeks for meat production) under optimal managemental conditions, less space requirement, more resistance to diseases which minimizes the use of medication and vaccination and delicious meat quality. Moreover, it is highly prolific, very hardy, easy to raise and handle, inexpensive to maintain and an efficient converter of feed into meat (Tikk and Tikk, 1993; Baumgartner, 2004; Minvielle, 2004; Boni *et al*., 2010; Aminzade *et al*., 2012). Rearing quails for egg production is rather difficult due to marketing problems but rearing of broiler quails for meat purpose might be adapted to marketplace in cities and big towns (Kumari *et al*., 2008; Ikhlas *et al*., 2010). Quails are also popular for their good quality meat with high proteins (26%) and less fat (3%) (Daikwo *et al*., 2013; Alagawany *et al*., 2014). In quails, body weight considerably affected age (Boni *et al*., 2010), carcass characteristics (Kumar *et al*., 2011; Sartowska *et al*., 2014) and quality of meat (Genchev *et al*., 2008; Choi *et al*., 2012). Change in carcass traits also influence with advancement of age (Wilkkanowska and Kokoszynski, 2011) and value of meat (Lawrie, 1991; Mohammad, 2016).

These small size birds are mainly consumed as a whole-carcass. The growth rate in quails could be further improved to achieve an adequate level of production and make sure a fulfilling carcass and meat quality as per definite targets of each production system. The main objective is to produce a good quality carcass and specifically obtain maximum meat yield. Inadequate research work has been conducted on different aspects of Japanese quail in developing countries including Pakistan. Therefore, the present experiment was planned with aim to study carcass characteristics in 4 different strains of Japanese quail at 3 to 6 weeks of age.

Materials and Methods

The present experiment was planned to examine the carcass traits in 4 different strains of Japanese quails at 3 to 6 weeks of age maintained at Avian Research and Training Centre (ARTC), University of Veterinary and Animal Sciences (UVAS), Lahore. These 4 quail strains were used in this experiment by allocating names as M (Major), K (Kaleem), S (Saadat) and Z (Zahid). In total, 2160 quail chicks were studied with 108 experimental units of each 20 chicks were applied. The brooding temperature during first week was maintained at 95°F and reduced by 5°F each week till 70°F having humidity level of 60% (North and Bell, 1991). Birds had free access to clean and fresh drinking water through automatic nipple drinkers all the times. There was a provision of *ad-libitum* broiler-quail ration feeding as per NRC Standard (1994). Experimental quails were tagged during the study period for their proper identification. From week 3 to onward, 216 quail (randomly picked one bird from each replicate) and were withdrawals feed up to 5-6 hours before slaughter, to ensure their intestines must be free from undigested feed to reduce the chances of any contamination. Quails were slaughtered by humanitarianly to make sure for complete blood loss. Quail were weighed separately then studied parameters were also weighed individually to studied the carcass traits live weight (g), dressing percentage, keel length (cm), keel angle, shank length (cm), edible giblets (g) and intestine length (cm).

Statistical analysis

Collected data in terms of carcass traits were analyzed using Analysis of variance (ANOVA) techniques (Steel *et al*., 1997) using SAS, 9.1, (2002-03) portable software, assuming following mathematical model:

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

Where;
Y, each observation; μ, population mean; Si, effect of the treatment; εij, random error.

The means were compared using Duncan's Multiple Range (DMR) test (Duncan, 1955).

Results and Discussion

The live weight (g) of the quail birds differed significantly ($P < 0.05$) in M (Major) strain (Table 1). The results of present study are close to earlier findings of Rehman (2006); Jatoi (2012); Hassan and Fadhi (2019) who reported that, slaughter weight (g) at the age of 4-week differed significantly among local and imported quail stocks. Similarly, Alamuoye and Ojo (2015) also noted higher average live weight (g) ($P<0.05$) at different ages in Japanese quail. Furthermore; Sabow (2020) observed highest

slaughter weight (g) and carcass yields in brown type of quails than other quails. Walita *et al.* (2017) also noted higher mean slaughter weight (g) in quails at the age of 5, 8 and 11 weeks. According to Wilkkanowska and Kokoszynski (2011) quail carcass yield traits increased in older ages. Alves *et al.* (2014) also reported higher liver weight in quails at 42 weeks of age than 35 weeks. El-Full, (2000) further indicated that carcass characteristics differ significantly by age in Japanese quail. The proper age which could be used to slaughter the young quail and to predict economic traits was 6 weeks, because birds had higher dressing and protein percentages than at older ages. Body weight or slaughter age was preferable because such measures did not require slaughtering of the quail. Similarly, Walita *et al.* (2017) reported that quail slaughtered around 5-6 weeks of age could be obtained higher carcass yields. Dressing percentage and shank length (cm) differed non-significantly in this study (Table 1). Results of this experiment are also in confirmation with previous results of Rehman (2006) and Jatoi (2012) who reported that dressing percentage and shank length (cm) among imported and local Japanese quails stocks show non-significant effect at week-4. Similarly, Anna and Dariusz (2011) also reported that Pharaoh quail slaughtered at 33 days did not show any significant difference in carcass yield. In terms of dressing proportion (%) in Japanese quails (6 to 33 weeks); earlier researchers Wilson *et al.* (1961); Bacon and Nestor (1983); El-Fiky (1991); Kosba *et al.* (1992); Anna and Dariusz (2011) noted as 69.4%, 59.3 to 67.3%, 69.6 to 68.1% and 66.1 to 63.7% respectively. In this study; keel length (cm) differed significantly at 3, 5 and 6 weeks except week-4; indicated difference in keel length (cm) among studied quails (Table 1) are close to prior results of Rehman (2006) and Jatoi (2012) who reported that keel length (cm) differed significantly among imported and local Japanese quails stocks at week-3 while non-significant effect on week-4. Keel angle also differ significantly ($P < 0.05$) at week-3; except week 4, 5 and 6 in this study. The results indicated difference in keel angle among studied quails (Table 1) are in array with Rehman (2006) and Jatoi (2012) who noted higher keel angle in Japanese quails at week-3 while, non-significant effect on week-4.

Table 1: *Carcass traits in four strains of Japanese quail at 3-6 weeks of age.*

Parameters	Strains Weeks	M♠	K♣	S♥	Z♦
		(Mean ± *SE)			
Live weight (g)	wk-3	104.22±1.788^{a}	100.56±1.254^{ab}	99.19±1.611^{b}	91.26±1.172^{c}
	wk-4	143.22±2.608^{a}	140.04±1.581^{a}	134.00±2.273^{b}	130.63±1.373^{b}
	wk-5	173.44±2.903^{a}	170.52±2.443^{ab}	165.04±3.299^{b}	155.33±1.609^{c}
	wk-6	193.74±3.796^{a}	190.89±4.144^{a}	176.56±4.246^{b}	170.78±2.998^{b}
Dressing percentage	wk-3	54.67±0.531^{a}	54.43±0.589^{a}	54.14±0.661^{a}	54.50±0.421^{a}
	wk-4	58.01±0.617^{a}	59.21±0.401^{a}	59.94±0.452^{a}	59.60±0.512^{a}
	wk-5	59.68±0.296^{a}	59.51±0.389a	58.27±0.533a	60.22±0.664a
	wk-6	54.63±0.483^{a}	56.59±0.454^{a}	56.61±0.485^{a}	56.18±0.424^{a}
Keel length (cm)	wk-3	1.86 ±0.052^{b}	2.11 ±0.065^{a}	2.09 ±0.083^{a}	2.11 ±0.065^{a}
	wk-4	2.36 ±0.087^{a}	2.54 ±0.052^{a}	2.50 ±0.077^{a}	2.54 ±0.052^{a}
	wk-5	3.06 ±0.101^{b}	3.58 ±0.063^{a}	3.44 ±0.064^{a}	3.58 ±0.063^{a}
	wk-6	3.69 ±0.067^{a}	3.37 ±0.043^{b}	3.48 ±0.065^{b}	3.37 ±0.043^{b}
Keel angle (Λ)	wk-3	14.48±0.645^{b}	18.00±1.208^{a}	15.44±0.958^{ab}	16.63±0.902^{ab}
	wk-4	27.78±1.673^{a}	25.33±1.835^{a}	29.78±1.275^{a}	27.11±1.901^{a}
	wk-5	19.19±0.768^{a}	17.70±0.866^{a}	16.78±0.872^{a}	18.78±1.073^{a}
	wk-6	17.19±0.739^{a}	17.11±0.682^{a}	18.59±0.788^{a}	19.11±0.829^{a}
Shank length (cm)	wk-3	2.90±0.031^{a}	2.85±0.041^{a}	2.82±0.033^{a}	2.79±0.043^{a}
	wk-4	3.11±0.031^{a}	3.15±0.032^{a}	3.19±0.037^{a}	3.13±0.033^{a}
	wk-5	3.20±0.030^{a}	3.25±0.026^{a}	3.21±0.025^{a}	3.22±0.032^{a}
	wk-6	3.31±0.022^{a}	3.30±0.026^{a}	3.29±0.036^{a}	3.25±0.026^{a}

*Different alphabets on means show significant difference at $P < 0.05$. ♠M: Major; ♣K: Kaleem; ♥S: Saadat; ♦Z: Zahid; *SE: Standard error.*

Table 2: *Weight of giblets (liver, heart and gizzard) and intestinal length (g, cm/100g BW) (cm) in four strains of Japanese quail at 3-6 weeks of age.*

Parameters	Strains Weeks	M♠	K♣	S♥	Z♦
		(Mean ± *SE; g, cm/100g BW)			
Liver weight (g)	wk-3	2.39±0.101^{c}	2.72±0.052^{b}	2.55±0.073^{bc}	3.08±0.084^{a}
	wk-4	3.36±0.112^{ab}	3.34±0.114^{ab}	3.11±0.038^{b}	3.40±0.100^{a}
	wk-5	3.50±0.062^{a}	3.49±0.080^{a}	3.54±0.102^{a}	3.06±0.128^{b}
	wk-6	4.44±0.070^{a}	3.96±0.087^{b}	4.33±0.040^{a}	4.33±0.091^{a}
Heart weight (g)	wk-3	0.85 ±0.021^{a}	0.86±0.018^{a}	0.84 ±0.021^{a}	0.78±0.024^{b}
	wk-4	1.09 ±0.048^{a}	0.96±0.053^{a}	1.02 ±0.036^{a}	1.01±0.037^{a}
	wk-5	1.46 ±0.024^{a}	1.46 ±0.033^{a}	1.36±0.045^{a}	1.46 ±0.088^{a}
	wk-6	1.96 ±0.029^{a}	1.77 ±0.032^{b}	1.99 ±0.015^{a}	1.71 ±0.035^{b}
Empty gizzard weight (g)	wk-3	3.05 ±0.037^{a}	3.12 ±0.084^{a}	3.11 ±0.071^{a}	3.14 ±0.074^{a}
	wk-4	4.26 ±0.123^{a}	4.00±0.110^{ab}	3.83 ±0.109^{b}	3.84 ±0.086^{b}
	wk-5	4.12 ±0.09^{a}	4.00±0.132^{ab}	3.86±0.076^{ab}	3.74 ±0.108^{b}
	wk-6	4.89 ±0.062^{a}	4.22 ±0.153^{c}	4.76±0.036^{ab}	4.53 ±0.104^{b}
Intestinal length (cm)	wk-3	39.97±0.168^{a}	39.36±0.360^{a}	36.63±0.789^{b}	36.53±0.409^{b}
	wk-4	40.48±0.858^{a}	38.96±0.639^{a}	38.84±0.318^{a}	40.56±0.878^{a}
	wk-5	37.68±0.620^{ab}	38.90±0.361^{a}	38.77±0.362^{a}	36.46±0.633^{b}
	wk-6	42.60±0.382^{a}	42.20±0.435^{a}	42.06±0.181^{a}	42.51±0.545^{a}

*Different alphabets on means show significant difference at P < 0.05. ♠M: Major; ♣K: Kaleem; ♥S: Saadat; ♦Z: Zahid; *SE: Standard error.*

In study; liver weight (g) showed significantly differences in four strains of quail birds in all the slaughter ages. Higher liver weight (3.08±0.084) was noted in Z strain whereas, significant effect were also noted at week 3 and 6 in K and S strain respectively, while, a non-significant difference were observed in M strain at 4 and 5 weeks. Empty gizzard weight was significantly differed at 4, 5 and 6 weeks (Table 2). These results indicated differences in liver, heart and gizzard weight among different strains of Japanese quails are in agreement with Kumari *et al.* (2008) who noted higher slaughter characteristics (liver, heart and gizzard) among different strains of Japanese quails. Likewise; Walita *et al.* (2017) observed that slaughter weight in terms of giblets significantly differ (P<0.05) in quails at 5 to 6 weeks of age. Moreover; Dhaliwal *et al.* (2004) observed that enhancement of giblet proportion (%) rationally linked by means of body weight at 4 weeks in Japanese quails. The findings of this study are also fully confirmation with Rehman (2006) and Jatoi (2012) who reported that giblets weight differed significantly at week-4 in quails. Similarly, these results indicated significant variations in giblets weight in studied quails which are in accordance with results of Oguz *et al.* (1996) who observed same difference in different quail lines. El-Full (2000) also reported significant (P ≤ 0.01) differences were attributed to slaughter age in terms of heart, gizzard, liver, edible and inedible percentages. Length of intestine (cm) considerably differed at weeks 3, 5 and 6, except weeks 4 in this study. This indicated differences in length of intestine among studied quails (Table 2) are confirmation with observations of Rehman (2006) and Jatoi (2012) who noted significant difference in length of intestine amongst imported and local quail stocks at week 3; probably due to higher carcass weight of imported strain than those of other local strains of quails Sandip (2010). Likewise; Walita *et al.* (2017) reported significant differences in quail birds at 5 to 6 weeks in terms of intestinal length (cm).

Conclusions and Recommendations

Considerable variations in almost all the studied parameters in different strains of quails were noted throughout the experimental period indicate that possibility of further improvement in carcass traits. Imported quail strain (M) performed better in almost all the studied parameters than that of other strains of quails.

Novelty Statement

The rearing of quail is highly profitable due to its high reproductive efficiency, early sex maturity and fast growth rate especially for meat purpose. There-

fore; this amazing small bird has been declared by researchers as the "model avian species for future research".

Author's Contribution

Erum Bughio was major author who designed and accomplishes this experiment. Ahmed Sultan Jatoi helped in write-up of this manuscript. Athar Mahmud, Muhammad Hayat Jaspal and Jibran Hussain assisted in data analysis, however; data and samples were collected by Shahid Mehmood, Reema Bughio and Hafiz Muhammad Ishaq.

Conflict of interest

The authors have declared no conflict of interest.

References

Ahmad, S., 2016. Quail farming: An industry overview. Pak. Poult. MAG., 6(22): 17-18.

Akram, M., Z.U. Rehman, A. Mahmood, K. Javed, A.W. Sahota and M.H. Jaspal. 2008. Comparative productive performance of Japanese quail from different local and imported flocks. Proc. XXIII World Poult. Cong. 30th June- 4th July, 2008 held at Brisbane, Australia. pp. 355.

Alagawany, M., M.E.A. El-Hack, V. Laudadio and V. Tufarelli. 2014. Effect of low-protein diets with crystalline amino acid supplementation on egg production, blood parameters and nitrogen balance in laying Japanese quails. Avian Biol., 7: 235–243. https://doi.org/10.3184/175815514X14152945166603

Alamuoye, O.F. and J.O. Ojo. 2015. Comparison of Carcass characteristics of sexed Japanese Quails (*Corturnix corturnix japonica*). Sch. J. Agric. Vet. Sci., 2(5): 342-344.

Alves, A.L.R., C.A. Bori, A.V. Pires, S.R.F. Pinheiro, R.G. Oliveira, K.M. Oliveira, F.M. Goncalves and F.R. Oliveira. 2014. Carcass evaluation and meat quality of slaughtered meat quails at different ages. Rev. Bras. Saúde Prod. Anim. Salvador., 15(1): 131-140. https://doi.org/10.1590/S1519-99402014000100020

Aminzade, B., B., Karami and E. Loti. 2012. Meat quality characteristics in Japanese quails fed with *Mentha piperita* plant. Anim. Biol. Anim. Husb., 4: 20–23.

Anna, W. and K. Dariusz. 2011. Comparison of slaughter value in pharaoh quail of different ages. J. Cent. Eur. Agric., 12(1): 145-154. https://doi.org/10.5513/JCEA01/12.1.891

Bacon, W.L. and K.E. Nestor. 1983. Divergent selection for body weight and yolk precursor in *Coturnix coturnix Japonica*. 4-Correlated responses in carcass composition and carcass yield of progeny during growth. Poult. Sci., 62: 537-544. https://doi.org/10.3382/ps.0620537

Baumgartner, J., 1994. Japanese quail production, breeding and genetics. Worlds Poult. Sci., 50: 227-235.

Boni, I., H. Nurul, and I. Noryati. 2010. Comparison of meat quality characteristics between young and spent quails. Int. Food Res. J., 17: 661–666.

Choi, Y.I., H.J. Ahn, B. K. Lee, S.T. Oh, B.K. An, and C.W. Kang. 2012. Nutritional and hormonal induction of fatty liver syndrome and effects of dietary lipotropic factors in egg-type male chicks. Asian Austral. J. Anim. Sci., 25: 1145–1152. https://doi.org/10.5713/ajas.2011.11418

Daikwo, S.I., O.M. Momoh, and N.I. Dim. 2013. Heritability Estimates of, Genetic and phenotypic correlations among some selected carcass traits of Japanese quail (Coturnix coturnix japonica) raised in sub–humid Climate. J. Boil. Agric. Healthc., 3(5).

Dhaliwal, S.K., M.L. Chaudhary, G.S. Brahand and J.S. Sandhu. 2004. Growth and carcass characteristics of selected and control lines of Japanese quails (*Coturnix coturnix japonica*). Ind. J. Poult. Sci., 39(2): 112-119.

Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics. 11: 1-42. https://doi.org/10.2307/3001478

El-Fiky, F.A., 1991. Genetic studies on some economic traits in Japanese quail. Ph.D. Diss., Fac. Agric. Al-Azhar Univ., Cairo, Egypt.

El-Full, E.A., 2000. Effects of slaughter age and sex on carcass composition of Japanese quail. Egypt. Poult. Sci. J., 20(3): 649-661.

Genchev, A., G. Mihaylova, S. Ribarski, A. Pavlov and M. Kabakchiev. 2008. Meat quality and composition in Japanese quails. Trakia J. Sci., 6: 72–82.

Hassan, K.H. and M.A. Fadhil. 2019. Genetic selection for body weight in Japanese quail (*coturnix coturnix japonica*) under different nutritional environments. Adv. Anim. Vet. Sci., 7(7): 526-529. https://doi.org/10.17582/journal.aavs/2019/7.7.526.529

Ikhlas, B., N. Huda and N. Ismail. 2010. Comparison of meat quality characteristics of

young and spent quail. Asian J. Food Agric. Ind., 5: 498–504.

Jatoi, A.S., 2012. Productive performance of four close-bred flocks of Japanese quails with different body weights and its effect on subsequent progeny growth. Ph.D. Diss., Dep. Poult. Prod., Fac. Anim. Prod. Technol. Univ. Vet. Anim. Sci., Lahore, Pakistan.

Kosba, M.A., M.F. Hassan, F.N.K. Soliman, M.A. Aziz and M. Bahie El-Deen. 1992. Selection for dressing percentage in Japanese quail. Egypt. Poult. Sci., 12: 333-346.

Kumar, M.S., R.K. Sudhakar, K. Kondal and N. Krishnaiah. 2011. Studies on the effect of age and sex on carcass characteristics of various strains of Japanese quail. Ind. J. Poult. Sci., 46: 25-30.

Kumari, B.P., B.R. Gupta, A. Reddy, P. Rajasekhar, M.G. Prakash, Reddy and K. Sudhakar. 2008. Genetic and non-genetic factors affecting the carcass characteristics of Japanese quails (*Coturnix coturnix japonica*). Ind. J. Anim. Res., 42(4): 248-252.

Lawrie, R.A., 1991. Meat science. 5th ed. Pergamon Press, Oxford, UK.

Mahmoud, S. and El-Tarabany. 2016. Effect of thermal stress on fertility and egg quality of Japanese quail. J. Therm. Biol., 61: 38-43. https://doi.org/10.1016/j.jtherbio.2016.08.004

Minvielle, F., 2004. The future of Japanese quail for research and production. Worlds Poult. Sci. J., 60: 500-507. https://doi.org/10.1079/WPS200433

Mohammad, H.K., 2016. Influence of season, sex and age on hematological characteristics, body weight and rectal temperature in black local quail. Bas. J. Vet. Res., 1: 340–348. https://doi.org/10.33762/bvetr.2016.124277

North, M.O. and D.D. Bell. 1991. Commercial Chicken Production Manual. Published by Avi Book Co. 4th ed. New York. USA.

NRC, 1994. Nutrients requirements of poultry. 9th revised ed. National Academy Press. Washington, D.C., USA.

Oguz, I., O. Altan, F. Kirkpinar and P. Settar. 1996. Body weights, carcass characteristics, organ weights, abdominal fat and lipid content of liver and carcass in two lines of Japanese quail (*Coturnix coturnix japonica*), unselected and selected for four-week body weight. Br. Poult. Sci., 37(3): 579-588. https://doi.org/10.1080/00071669608417888

Rahman, A.N.M.A., M.N. Hoque, A.K. Talukder and Z.C. Das. 2016. A survey of Japanese quail (*Coturnix coturnix japonica*) farming in selected areas of Bangladesh. Vet. World. 9(9): 940-947. https://doi.org/10.14202/vetworld.2016.940-947

Rehman, Z., 2006. Comparative productive performance of Japanese quail from different local and imported stocks. M. Phil. Diss., Dep. Poult. Prod., Fac. Anim. Prod. Technol. Univ. Vet. Anim. Sci., Lahore, Pakistan.

Sabow, A.B., 2020. Carcass characteristics, physicochemical attributes, and fatty acid and amino acid compositions of meat obtained from different Japanese quail strains. Trop. Anim. Health Prod., 52: 131–140. https://doi.org/10.1007/s11250-019-01991-2

Sandip, B., 2010. Carcass studies of Japanese quails (*Coturnix coturnix japonica*) reared in hot and humid climate of eastern India. World Appl. Sci. J., 8(2): 174-176.

Sartowska, K.E., A. Korwin-Kossakowska, E. Polawska, P. Lipinska and G. Sender. 2014. Sex-related differences in the nutritional value of Japanese quail meat. Int. J. Food Sci. Technol., 49: 2635–2642. https://doi.org/10.1111/ijfs.12596

SAS, 2002-03. SAS/STATE User's guide: Statistics. Version 9.1., SAS Institute Inc, Cary, North Carolina, USA.

Steel, R.G.D., J.H. Torrie and D.A. Dickie. 1997. Principles and procedures of statistics. A biometric approach. 3rd ed. McGraw-Hill Book Publishing Company, Toronto, Canada.

Tikk, V. and H. Tikk. 1993. Quail industry of Estonia. World`s Poult. Sci., 49: 65-69. https://doi.org/10.1079/WPS19930007

Walita, K.Z., J. Tanganyika and S.R. Mussah. 2017. Effect of sex, type of feed and age at slaughter on carcass yield characteristics of Japanese quails. Int. J. Avian Wildl. Biol., 2(2): 50-53. https://doi.org/10.15406/ijawb.2017.02.00015

Wilkkanowska, A. and D. Kokoszynski. 2011. Comparison of slaughter value in pharaoh quail of different ages. J. Cent. Eur. Agric., 12(1): 145–154. https://doi.org/10.5513/JCEA01/12.1.891

Wilson, W.O., U.K. Abbott and H. Abplanalp. 1961. Evaluation of Coturnix (Japanese quail) as pilot animal for poultry. Poult. Sci., 40: 651-657. https://doi.org/10.3382/ps.0400651