Nutritional compositions of Japanese quail (\textit{Coturnix coturnix japonica}) breed lines raised on a basal poultry ration under farm conditions in Ruwa, Zimbabwe

Augustine Jeke, Crispen Phiri, Kudakwashe Chitiindingu and Philip Taru

\textit{Cogent Food & Agriculture} (2018), 4: 1473009
FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Nutritional compositions of Japanese quail (Coturnix coturnix japonica) breed lines raised on a basal poultry ration under farm conditions in Ruwa, Zimbabwe

Augustine Jeke¹*, Crispen Phiri¹, Kudakwashe Chitiindingu² and Philip Taru¹

Abstract: Proximate composition experiments were conducted to determine nutritional compositions of eggs from three Japanese quail breeds (Jumbo Pharaoh, A&M giant and Manchurian golden) raised under farm conditions in Zimbabwe. Crude protein (analysis of variance (ANOVA), F₂, 33 = 4.13, p = 0.02) and crude fat (ANOVA F₂, 33 = 7.14, p = 0.00) were significantly different among the three breeds. Total ash (one-way ANOVA, F₂, 33 = 3.20, p = 0.05) was marginally significantly different whilst crude fibre (ANOVA F₂, 33 = 1.05, p = 0.36) did not vary significantly among the quail breeds. Tukey’s post hoc tests revealed significant variation (p < 0.05) in mean crude protein content between Jumbo Pharaoh and Manchurian golden breeds. The Jumbo Pharaoh breed had highest crude protein content (13.07 ± 0.18 g 100 g⁻¹) among the three breeds. Post hoc comparison test showed significant difference (p < 0.05) in mean crude fat content between the Jumbo Pharaoh and A&M giant breeds and also that of Jumbo Pharaoh and Golden Manchurian breeds. Jumbo Pharaoh had the highest crude fat content (11.90 ± 0.03 g 100g⁻¹) among the breeds. We concluded that Japanese quail eggs contain favourable proportions of essential nutrients, particularly proteins for the human diet, and their consumption can contribute positively towards improved nutrition and food security in the country. Eggs from the Jumbo Pharaoh breed...
contain the most ideal proportions of nutrients among the investigated breeds. We recommend further studies to characterize specific nutrient profiles in Japanese quail eggs and comparison of their nutrient constituents with other commonly consumed poultry species in Zimbabwe. The determination of bioactive compounds in the quail eggs is also recommended.

**Subjects:** Food Chemistry; Food Analysis; Meat & Poultry

**Keywords:** breed; Japanese quail; diet; essential nutrient

**1. Introduction**

There has been increased concern over dietary protein sources particularly in addressing malnutrition and undernourishment in the world. Meanwhile, consumers have also shown much interest in nutrient compositions of food they consume (Swanepoel, Leslie, Rijst, & Hoffman, 2016). Food and Agriculture Organization the United Nations have been emphasized the identification of alternative food resources as a key intervention to improve food security in the growing world population, which is projected to be 9 billion by 2050 (Rosen, Meade, Fuglie, & Rada, 2016; Shapouri et al., 2011). The incorporation of game birds such as pheasant (*Phasianus colchicus*), chukar (*Alectoris chukar*), guinea fowl (*Numida meleagris*), geese (*Alopochen aegyptiaca*) and quail (*Coturnix coturnix*) in food security programmes have been recommended, particularly for developing countries (Geldenhuys, Hoffman, & Muller, 2013). The existence of a diversity of fowl species producing meat and eggs may provide a wide array of nutrient constituents (Chepkemoi et al., 2016; Geldenhuys et al., 2013). Identification and promotion of alternative poultry egg sources may also boost egg supply and contribute to an enhanced nutrient provision in human diets (Geldenhuys et al., 2013). Further, the variation in egg quality and taste among poultry species may also provide consumers with a wider selection pool for choice eggs.

In some parts of Africa including Zimbabwe, the consumption of Japanese quail eggs is still regarded a novel practice, which is also surrounded by myth and controversies (Bakoji et al., 2013; Mushava, 2016). In Zimbabwe, Japanese quail farming is practised commercially mainly in farms and urban areas. The consumption of eggs from Japanese quail (*C. coturnix japonica*, Linneaus 1758) is popular among European and Asian countries with the highest consumption in France, Italy, the United Kingdom and Japan (A. Genchev, 2012; Tunsaringkarn, Tungjaroenchai, & Siriwong, 2013). Japanese quail became popular as an agricultural bird for egg production in Asia during the fourteenth century (Chang et al., 2009). Currently, Japanese quail (*Coturnix c. japonica*) are farmed for meat and eggs in many parts of the world (Chang et al., 2005; Perennou, 2009).

Japanese quail breeds which are mostly farmed in Zimbabwe include the Jumbo Pharaoh, A & M Giant, Manchurian golden and Goliath breeds (Mushava, 2016). The breeds are pure lines which were selectively obtained to produce birds of desirable size and egg yield. The Jumbo Pharaoh breed has a wild-type plumage and regarded as a dual purpose bird which grows a large body for good meat production, as well as having a high egg yield (Douglas, 2013). The Texas A&M breed was first developed at the Texas A&M University and was selectively bred to produce white meat (light coloured meat) and have white feathers. The Manchurian golden has a golden speckled colour, with males lighter than the females. The breed was developed predominantly for egg production (Douglas, 2013). The Goliath breed attains a large body size and it was specifically developed for meat production.

Japanese quail eggs which are mostly farmed in Zimbabwe include the Jumbo Pharaoh, A & M Giant, Manchurian golden and Goliath breeds (Mushava, 2016). The breeds are pure lines which were selectively obtained to produce birds of desirable size and egg yield. The Jumbo Pharaoh breed has a wild-type plumage and regarded as a dual purpose bird which grows a large body for good meat production, as well as having a high egg yield (Douglas, 2013). The Texas A&M breed was first developed at the Texas A&M University and was selectively bred to produce white meat (light coloured meat) and have white feathers. The Manchurian golden has a golden speckled colour, with males lighter than the females. The breed was developed predominantly for egg production (Douglas, 2013). The Goliath breed attains a large body size and it was specifically developed for meat production.

Japanese quail eggs weigh an average 11–13 g (Chepkemoi et al., 2016). Regardless of their small size, the eggs are reportedly packed with nutrients which may be 3–4 times greater than the nutrient value of chicken eggs (Abduljaleel, Shuhaimi-Othman, & Babji, 2011; Tunsaringkarn et al., 2013). Also Japanese quail eggs are believed to have therapeutic effects due to the presence of bioactive compounds such as lysozymes, ovomucoid and cystatin in the eggs (Douglas, 2013; Kovacs-Nolan et al., 2005). In this regard, the consumption of quail eggs may become a practical...
alternative to traditionally consumed chicken eggs. The quality and composition of farmed Japanese quail eggs may be affected by factors such as stocking density, feed compositions, layer’s age, storage time, trait and environment among others (Douglas, 2013). Kumari, Gupta, Prakash, and Reddy (2008) found quality parameters of Japanese quail eggs to have high heritability.

Japanese quail farming is regarded as a low cost investment due to their relatively low floor area requirement (Douglas, 2013). Further, the birds also exhibit low feed requirement, consuming an average of 20–30 g per day of feed as compared to 120–130 g per day for chicken (Bakoji et al., 2013). Japanese quail are hardy birds and show greater resistance to diseases such as ulcerative enteritis, fowl pox and new castle, thus minimizing costs on antibiotics (Chang et al., 2005). Thus, quail farming can be a profitable and sound farming practice and has great potential to replace chicken farming if incorporated in the mainstream poultry farming business.

While consumers have shown a keen interest in egg nutrient compositions, extensive global and national investigations on egg compositions have largely focused on chicken eggs creating a paucity of information about other poultry egg nutritional compositions. The study was motivated by the existence of a gap in knowledge about quail egg consumption in Zimbabwe. The introduction of Japanese quail farming in the country was characterized by hype and an influx of people venturing into the practice in the various settlements in the country. However, speculation about the authenticity of purported nutritional benefits as well as pessimistic media framing about the quail farming business has affected the adoption and assimilation of the practice across important sectors of the country. We assessed nutritional compositions of various Japanese quail (Coturnix.c. japonica) breeds (Jumbo Pharaoh, A&M giant and Manchurian golden) farmed in Zimbabwe, making particular reference to the population farmed in Ruwa, Mashonaland East Zimbabwe. This is a crucial step in authentication of the purported nutritional value of Japanese quail eggs which has been widely disputed locally.

2. Methods and data analysis
Japanese quail eggs were collected from an established poultry farm in Ruwa, namely Victor Chickens, located in Mashonaland East province in Zimbabwe. A total of 108 (36 eggs per breed) freshly laid eggs were collected from three Japanese quail breed lines, that is, Jumbo Pharaoh, A&M giant and the Manchurian golden breeds in June and July 2017. The birds from which the eggs were collected were in good health. The birds were fed on an optimum layers’ ration containing 20% protein, 3.2% calcium and 0.6% phosphorus. Eggs from each quail breed were randomly handpicked and assigned into 12 composite samples of 3 eggs each for nutrient analysis. The eggs were washed, carefully opened and homogenized using the hand stirring method for nutrient content determination. Proximate composition experiments were performed to determine the content of crude protein, crude fat, ash and crude fibre in the Japanese quail whole eggs following the Association of Official Analytical Chemists methods (Association of Official Analytical Chemists [AOAC], 2000). The crude protein content was determined using the Kjeldahl method by means of the automated UDK 159 Velp Scientifica Kjeldahl system (Velp Scientifica, Europe, Italy) performing the digestion, distillation and titration processes. The protein factor 6.25 was used to estimate the crude protein content from sample percentage nitrogen. The crude fat content was determined by the Soxhlet extraction method using diethyl ether as the solvent. Total ash content in the Japanese quail eggs was determined through ashing in a 9 l scientific laboratory muffle furnace (BM Scientific, model 909, USA) at 500°C for 24 h. Crude fibre was determined by the digestion and ignition method involving acid digestion using sulphuric acid (H₂SO₄) and ignition of the digested sample in a 9 l scientific laboratory muffle furnace (BM Scientific, model 909, USA) at 550°C for 6 h (Dida Bulbula & Urga, 2018). Statistical analysis was done in Statistical Package for Social Sciences (SPSS) for windows version 20 (IBM, Chicago, USA). Data were tested for normality and homogeneity of variance using Kolmogorov–Smirnov and Levene’s test for homogeneity of the variance respectively. Data were found to conform to normality assumptions. A one-way analysis of variance (ANOVA) was computed to determine
variation in nutrient composition among the different Japanese quail breeds with the Japanese quail breeds being a categorical predictor and nutrient content variables as depended variables at, (p < 0.05) significance level. For variables with significant variation, (p < 0.05), Tukey’s HSD post hoc tests were used to determine the difference in nutrient content across the three Japanese quail breeds.

3. Results

Results showed that there is a significant variation at (p < 0.05) in crude protein content (one-way ANOVA, $F_{2, 33} = 4.13, p = 0.02$) among the three Japanese quail breeds Table (1). Tukey’s HSD post hoc comparison tests showed significant variation (p < 0.05) in protein content between Jumbo Pharaoh and Manchurian gold breeds. The eggs from the Jumbo Pharaoh breed had the highest percentage crude protein content $(13.07 \pm 0.18 \text{ g } 100 \text{ g}^{-1})$ among the three breeds (Figure 1). We

| Nutrient       | Jumbo Pharaoh | A&M giant | Manchurian gold | $F_{2, 33}$ | P-value |
|----------------|---------------|-----------|-----------------|-------------|---------|
| Ash (%)        | 1.03 ± 0.06   | 0.96 ± 0.05 | 0.81 ± 0.07    | 3.20        | 0.05    |
| Crude fat (%)  | 11.90 ± 0.03  | 11.33 ± 0.15 | 11.45 ± 0.10   | 7.14        | 0.00    |
| Crude fibre (%)| 0.56 ± 0.02   | 0.60 ± 0.02 | 0.57 ± 0.02    | 1.05        | 0.36    |
| Crude protein  | 13.70 ± 0.18  | 13.07 ± 0.15 | 13.01 ± 0.75   | 4.22        | 0.02    |

Notes: Significant levels are from one-way ANOVA tests. Different letter superscripts within rows for each variable denote significant differences (Tukey’s HSD, p < 0.05). Significant figures are indicated in bold.

Figure 1. Mean nutrient content variation among Japanese quail breeds (error bars at 95% confidence interval).
also observed a statistically significant difference in crude fat content (one-way ANOVA, $F_{2, 33} = 7.14, p = 0.00$) among the Japanese quail breeds. Tukey's HSD post hoc tests showed significant differences ($p < 0.05$) in crude fat content between Jumbo Pharaoh and A&M giant breeds as well as that of Jumbo Pharaoh and Manchuria golden breeds. Eggs from the Jumbo Pharaoh breed had the highest percentage crude fat content ($11.09 \pm 0.03$ g 100 g$^{-1}$) among the three quail breeds (Figure 1). We observed a marginally significant (one-way ANOVA, $F_{2, 33} = 3.20$, $p = 0.05$) variation in ash content among the quail breeds. Tukey's HSD post hoc tests also revealed a marginally significant variation ($p = 0.05$) in ash content between Jumbo Pharaoh and Manchurian golden breeds. The crude fibre content of the three Japanese quail breeds did not show any significant variation (one-way ANOVA, $F_{2, 33} = 1.048$, $p = 0.362$) (Table 1).

4. Discussion

The observed trait-based variation in nutrient content of eggs from Japanese quail birds conform to a related study by G. Genchev, Ribarski, Afanasjev, and Blohin (2006) who observed the statistically significant difference in egg and meat quality parameters between the English white and the Jumbo Pharaoh breeds. Similarly, May, Schmidt, and Stadelman (1957) and Kumari et al. (2008) also reported trait-based variation in poultry egg compositions due to differences in initial albumen quality. Our results were consistent with findings by A. Genchev (2012) who reported higher protein content in the Jumbo Pharaoh breed than the Manchurian golden breed. In addition, a lower crude fat content in the Jumbo line as compared to the Manchurian golden breed was also reported by A. Genchev (2012). The differences in the nutrient composition of eggs among the Japanese quail breeds fed on the same diet, under similar farm conditions may be attributed to various factors with high heritability. For instance, variation in feed conversion ratio among the different Japanese quail breeds implies a difference in selection for feed conversion, which Varkoohi et al. (2011) reported being trait influenced. The higher nutrient content in eggs from the Jumbo Pharaoh breed may imply the breed’s selection for nutrient rich eggs. Results from this study affirm earlier findings on Japanese quail genetics where high heritability was observed in various egg quality parameters including nutrient compositions (Minvielle & Oguz, 2002). These results suggest that the Jumbo Pharaoh breed may be a better line of Japanese quail for egg productivity due to the higher nutrient content of their eggs as compared to other breed lines used in this study.

Mean nutrient content of eggs from the various Japanese quail breeds from our results were in the same range with other studies on nutrient content of eggs from farmed Japanese quail, for example, A. Genchev (2012) reported 13.91–14.08% crude protein, 10.15–11.15% crude fat and 0.89–0.98% ash content in Japanese quail eggs of the Jumbo Pharaoh and Manchurian golden breeds. Our results also showed similar nutrient compositions to findings by Tokuşoğlu (2006) who reported 13.12% crude protein, 1.16% ash content and 11.10% crude fat content in farmed Japanese quail eggs. In addition, nutrient content in the eggs from farmed Japanese quail breeds in Zimbabwe did not differ much from the international references from the US Department of Agriculture on poultry egg nutrient compositions stating 12.56% crude protein, 9.51% crude fat, 0.00% crude fibre (USDA, 2016). The conforming of egg nutrient compositions with international references makes eggs from farmed Japanese quail breeds in Zimbabwe acceptable as a dietary nutrient source. However, our figures showed slightly higher nutrient content in the farmed Japanese quail eggs in Zimbabwe than observed by Tunsaringkarn et al. (2013) who reported 12.7 g 100 g$^{-1}$ crude protein, 9.89 g 100 g$^{-1}$ crude fat and 1.06 g 100 g$^{-1}$ ash content in farmed Japanese quail eggs from Ayutthaya province, Thailand. We attribute this difference to management practices such as the difference in stocking densities, environmental conditions and varying feed compositions.

Chang et al. (2005) suggested that environmental conditions may influence productivity in organisms, especially where populations are moved over a longer geographical space. Nonetheless, the nutrient content of Japanese quail birds studied in Zimbabwe did not suggest a loss of productive traits and vigour in the birds as being feared by the public. Resilience and adaptation characteristics of Japanese quail may have ensured the maintenance of productive traits under changing environmental conditions as
postulated by Douglas (2013). The Japanese quail is described by Sanchez-Donoso et al. (2012) as a hardy bird, with a robust character enabling the birds to cope with environmental changes and still retaining their productive traits. In this regard, Japanese quail has been successfully introduced in many countries under a range of climatic conditions. Douglas (2013) also highlighted that Japanese quails have high adaptation abilities to a range of environments and are able to acclimate to various climates without losing their productivity. Therefore, the adoption and success of Japanese quail farming in the country may supplement egg production and help to alleviate food shortages and reduce malnutrition in the country.

5. Conclusion
Japanese quail eggs contain favourable proportions of nutrients particularly crude protein making them a delicacy for human consumption. We concluded that eggs from the Jumbo Pharaoh breed have more favourable proportions of nutrients making the breed more ideal for egg production. The incorporation of Japanese quail egg consumption in human diet may provide a boost towards food security and improved nutrition in the country. Japanese quail farming also has great potential to supplement the country's egg supply and expand agricultural business opportunities, helping in poverty alleviation. We recommend further studies to characterize the specific nutrient profiles of Japanese quail eggs in terms of amino acid and fatty acid profiles, as well as ash mineral content since these, give specific benefits which may be derived from quail eggs. The assessment of phytochemical compounds in Japanese quail eggs to ascertain the purported medicinal value of the eggs is also recommended.

Acknowledgements
Special thanks go to various laboratory technicians at Chinhoyi University of Technology whom we worked with during the conducting of experiments, including Mr. A. Chanyandura, Dr. T Mwedzi, Ms. R. Makanda, Ms. M Dandadzi, Ms R. Machabangu, Mr. A. Masheka and Mrs. S. Chemura.

Funding
The undertaking of this study was funded by the Chinhoyi University of Technology research grant PG008.

Competing interests
The authors declare no competing interests.

Author details
Augustine Jeke
E-mail: augustinejeke@yahoo.co.uk
ORCID ID: http://orcid.org/0000-0001-9561-0546
Crispen Phiri
E-mail: crispenphiri@gmail.com
Kudakwashe Chitindingu
E-mail: kchitindingu@gmail.com
Philip Taru
E-mail: philip.taru@yahoo.ie

1 School of wildlife, Ecology and Conservation, Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe.

2 School of Agricultural Sciences and Technology, Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe.

Citation information
Cite this article as: Nutritional compositions of Japanese quail (Coturnix coturnix japonica) breed lines raised on a basal poultry ration under farm conditions in Ruwa, Zimbabwe, Augustine Jeke, Crispen Phiri, Kudakwashe Chitindingu and Philip Taru, Cogent Food & Agriculture (2018), 4: 1473009.

Cover image
Source: Author.

References
Abduljaleel, S. A., Shuhaimi-Othman, M., & Bobji, A. (2011). Variation in trace elements levels among chicken, quail, guinea fowl and pigeon eggshell and egg content. Research Journal of Environmental Toxicology, 5(5), 301–308. doi:10.3923/rjet.2011.301.308

Association of Official Analytical Chemists. (2000). Official methods of analysis (Vol. II, 17th ed.). Washington, DC. Association of Official Analytical Chemists.

Bokoji, I., Aliyu, M., Haruna, U., Jibril, S., Sani, R., & Danwanka, H. (2013). Economic analysis of quails bird (Cortunix coturnix) production in Bauchi local government area, Bauchi state, Nigeria. Research Journal of Agriculture and Environmental Management, 2(12), 420–425.

Chang, G., Chang, H., Liu, X., Xu, W., Wang, H., Zhao, W., & Olowofeso, O. (2005). Developmental research on the origin and phylogeny of quails. World’s Poultry Science Journal, 61(1), 105–112. doi:10.1079/WPS200346

Chang, G., Liu, X., Chang, H., Chen, G., Zhao, W., Ji, D., … Hu, G. (2009). Behavior differentiation between wild Japanese quail, domestic quail, and their first filial generation. Poultry Science, 88(6), 1137–1142.

Chepkemoi, M., Sila, D., Oiyer, P., Malaki, P., Ndiema, E., Agwanda, B., … Ommehe, S. (2016). Nutritional diversity of meat and eggs of five poultry species in Kenya. Paper presented at the Scientific conference proceedings. November 2015. Jomo Kenyatta University of Agriculture and Technology.

Dida Bulbula, D., & Urgo, K. (2018). Study on the effect of traditional processing methods on nutritional composition and antinutritional factors in chickpea (Cicer arietinum). Cogent Food & Agriculture, 4(1), 1622370. doi:10.1080/23311932.2017.1422370

Douglas, T. A. (2013). Coturnix revolution: The success in keeping the versatile coturnix: Everything you need to know about the Japanese quail. Create Space Independent Publishing Platform, USA.

Geldenhuys, G., Hoffman, L. C., & Muller, N. (2013). Gamelbirds: A sustainable food source in Southern Africa? Food Security, 5(2), 235–249. doi:10.1007/s12571-013-0245-0

Genchev, A. (2012). Quality and composition of Japanese quail eggs (Coturnix japonica). Trakia Journal of Sciences, 10(2), 91–101.

Genchev, G., Ribarski, S., Afnasiev, D., & Blohin, I. (2006). Fattening capacities and meat quality of Japanese
quails of Faraon and White English breeds. Journal of Central European Agriculture, 6(4), 495-500.

Kovacs-Nolan, J., Phillips, M., & Mine, Y. (2009). Advances in the value of eggs and egg components for human health. Journal of Agricultural and Food Chemistry, 57(22), 8421-8431. doi:10.1021/jf050964f

Kumari, B. P., Gupta, B. R., Prakash, M. G., & Reddy, A. R. (2008). A study on egg quality traits in Japanese quails (Coturnix coturnix japonica). Tamil Nadu Journal of Veterinary and Animal Sciences, 4(6), 227-231.

May, K., Schmidt, F., & Stadelman, W. (1997). Strain variation in albumen quality decline of hen’s eggs. Poultry Science, 36(6), 1376–1379. doi:10.3382/ps.0361376

Minville, F., & Oguz, Y. (2002). Effects of genetics and breeding on egg quality of Japanese quail. World’s Poultry Science Journal, 58(3), 291-295. doi:10.1079/WPS20020022

Mushava, S. (2016). Another day, another quirk? The Herald. Zimbabwe. 30 April 2016. Zimbabwe newspapers ltd.

Perennou, C. (2009). European Union Management Plan 2009–2011. Common quail: Coturnix coturnix. Technical Report, 2009-032. European Commission. Brussels.

Rosen, S., Meade, B., Fuglie, K., & Rada, N. (2016). International food security assessment, 2014-2024. Economic Research, 2014, 2024.

Sanchez-Donoso, I., Viló, C., Puigcerver, M., Butkauskas, D., de la Calle, J. R. C., Morales-Rodriguez, P. A., & Rodriguez-Teijeiro, J. D. (2012). Are farm-reared quails for game restocking really common quails (Coturnix coturnix)? A genetic approach. PLoS One, 7(6), e39031. doi:10.1371/journal.pone.0039031

Shapouri, S., Rosen, S., Peters, M., Tandon, S., Gole, F., Mancino, L., & Bai, J. (2011). International food security assessment, 2011-21 (USDA outlook no. GFA-22). USAID. 1-64.

Swanepoel, M., Leslie, A. J., Rijst, M. V. D., & Hoffman, L. C. (2016). Physical and chemical characteristics of warthog (Phacochoerus africanus) meat. South African Journal of Wildlife Research, 46(2), 103-120. doi:10.3957/056.046.0103

Tokuşoğlu, Ö. (2006). The quality properties and saturated and unsaturated fatty acid profiles of quail egg: The alterations of fatty acids with process effects. International Journal of Food Sciences and Nutrition, 57(7-8), 537–545. doi:10.1080/09637480601049725

Tunstaringkarn, T., Tungjaroenchai, W., & Siriwong, W. (2013). Nutrient benefits of quail (Coturnix coturnix japonica) eggs. International Journal of Scientific and Research Publications, 3(5), 1–8.

USDA. (2016). USDA nutritional database for standard reference. Washington, DC: Author.

Varkoohi, S. M., Moradi Shahr Babak, A., Pardel, A., Nejati Javaremi, A., Zaghari, M., & Kause, A. (2011). Erratum to “Response to selection for feed conversion ratio in Japanese quail”. Poultry Science, 90(1), 295. doi:10.3382/ps.2011-90-1-0295

© 2018 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

You are free to:
Share — copy and redistribute the material in any medium or format.
Adapt — remix, transform, and build upon the material for any purpose, even commercially.
Under the following terms:
Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.
You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
No additional restrictions
You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Cogent Food & Agriculture (ISSN: 2331-1932) is published by Cogent OA, part of Taylor & Francis Group.
Publishing with Cogent OA ensures:
• Immediate, universal access to your article on publication
• High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
• Download and citation statistics for your article
• Rapid online publication
• Input from, and dialog with, expert editors and editorial boards
• Retention of full copyright of your article
• Guaranteed legacy preservation of your article
• Discounts and waivers for authors in developing regions
Submit your manuscript to a Cogent OA journal at www.CogentOA.com