Assessment of nutrient compositions of Japanese quail (*Coturnix coturnix japonica*) birds raised under farm conditions in Ruwa, Zimbabwe.

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Research article

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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 (ANOVA, $F_{2, 33}$= 4.13, p=0.02) and crude fat (ANOVA $F_{2, 33}$= 7.14, p=0.00) were significantly different among the three breeds. Total ash (one way ANOVA, $F_{2, 33}$=3.20, p=0.05) was marginally significantly different whilst crude fibre (ANOVA $F_{2, 33}$= 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 ($13.07\pm 0.18 g100g^{-1}$) 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 ($11.90 \pm 0.03g\ 100g^{-1}$) 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.

Key words: Breed, Japanese quail, Diet, Essential nutrient

About the Authors

Augustine Jeke is a researcher at Chinhoyi University of Technology, Zimbabwe; His research area is ethnobiology, including nutritional and phytochemical analysis in biological components.

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Public interest statement

Internationally, the consumption of eggs and meat from both farmed and wild Japanese quail birds has been widely adopted in many countries and cultures. However, the farming of Japanese quails and consumption of their eggs is still a novel practice in Zimbabwe and questions have been raised in regards to the authenticity of purported nutrient compositions of the eggs from the various breeds farmed in the country. Eggs from Japanese quail birds are nutritious and their consumption may have positive impacts on nutrition and food security. The results of this study are useful scientific evidence to demystify uncertainties surrounding consumption of eggs from farmed Japanese quails in Zimbabwe. The results will help farmers to know productive quail breeds and also help people to understand the compositions of eggs from the farmed quails in the country.

1.0 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 (FAO) 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 programs 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 (*Coturnix coturnix japonica,* Linneaus1758) 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 14th 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 weigh an average 11g to 13g (Chepkemoi et al., 2016). Regardless of their small size, the eggs are reportedly packed with nutrients which may be 3 to 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 lysome, ovomucoid and cystatins in the eggs (Douglas, 2003). 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, 2003). Kumari et al., (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, 2003). Further, the birds also exhibit low feed requirement, consuming an average of 20-30g per day of feed as compared to 120-130g 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.

2.0 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 (AOAC) methods (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 9litre scientific laboratory muffle furnace (BM Scientific, model 909, USA) at 500˚ C for 24 hours. Crude fibre was determined by the digestion and ignition method involving acid digestion using sulphuric acid (H_2 SO_4) and ignition of the digested sample in a 9 litre scientific laboratory muffle furnace (BM Scientific , model 909, USA) at 550˚C for six hours (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, ($p< 0.05$), Tukeys' HSD post Hoc tests were used to determine the difference in nutrient content across the three Japanese quail breeds.

3.0 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 ± 0.18 g $100g^{-1}$) among the three breeds (Figure 1). We 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 ± 0.03g $100g^{-1}$) 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).

4.0 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 et al, (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 and 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 12.7g $100g^{-1}$ crude protein, 9.89g $100g^{-1}$ crude fat and 1.06g $100g^{-1}$ 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 vigor 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 (2003). 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 (2003) 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.

5.0 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.

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Competing interests

All participating authors declare no competing interests in putting up this work.

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Table 1: Japanese quail egg nutrient content attributes (mean±SE) for three Japanese quail breed lines farmed in Zimbabwe.

Nutrient	Japanese quail breeds Mean ± S.E			$F_{2,33}$	P-value
	Jumbo Pharaoh	A&M giant	Manchurian gold		
Ash (%)	1.03±0.06[a]	0.96±0.05[b]	0.81±0.07[a]	3.20	**0.05**
Crude fat (%)	11.90±0.03[a]	11.33±0.15[a]	11.45±0.10[b]	**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[a]	13.07±0.15[b]	13.01±0.75[a]	4.22	**0.02**

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

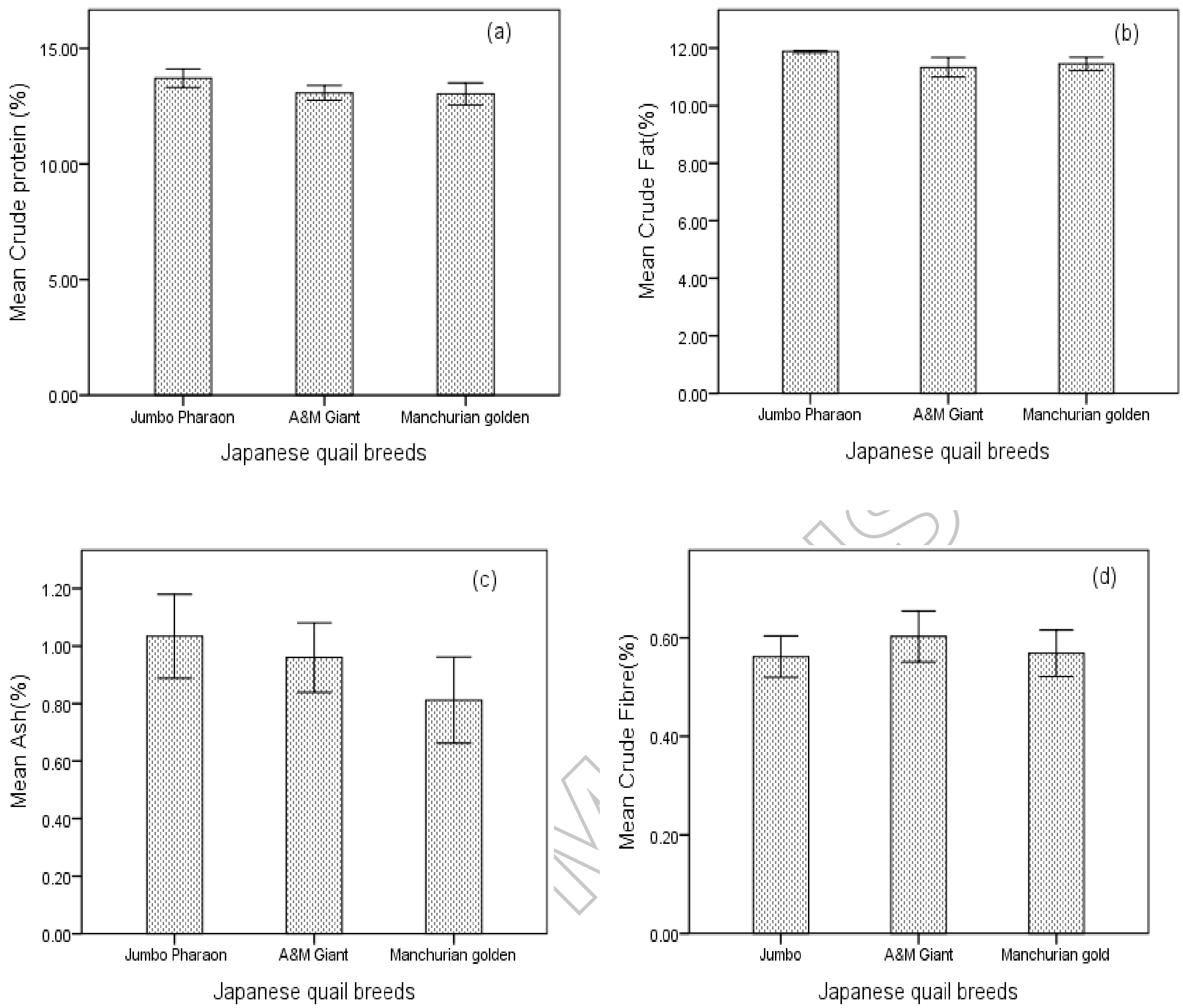

Figure 1: Mean nutrient content variation among Japanese quail breeds (Error bars at 95% confidence interval).