COMPARATIVE EVALUATION OF EGG PRODUCTION AND EGG QUALITY CHARACTERISTICS OF PANDA WHITE AND CINNAMON BROWN STRAINS OF JAPANESE QUAIL

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ABSTRACT

A total of 24 parent quails, 12 from each of Panda White and Cinnamon Brown strains were mated naturally by pure breeding in the ratio of 1 cock to 5 hens. The mating produced 40 chicks per strain in 4 batches, giving a total of 80 F_1 progeny. The female F_1 progeny were used to study their egg production and egg quality traits. Parameters measured were body weight at first egg, age at first egg, weight of first egg, short-term egg number to 28 days, hen day production, hen house production, egg weight, egg length, egg width, egg index, albumen height, albumin weight, yolk weight, yolk height, yolk width and Haugh unit of individual quails. Data generated were subjected to T-Test analysis. Panda White strains were significantly better (P<0.05) than Cinnamon Brown quails in body weight at first egg (70.78±0.48g; 68.78±0.44g), egg weight (10.73±0.06g; 9.84±0.04g), shell weight (1.38±0.03g; 1.24±0.01g), yolk height (10.42±0.05mm; 9.72±0.06mm), yolk index (44.15±0.02%; 41.41±0.29%) and albumen weight (1.38±0.03g; 1.24±0.05g). There was no significant difference (P>0.05) between the two strains in all other traits studied. It was concluded that Panda White strain possesses greater genetic potential comparative to Cinnamon Brown strain of Japanese quail for improvement of egg production and egg quality traits.

Keywords: Quails, Panda White, Cinnamon Brown, Egg production, Egg Quality.

INTRODUCTION

Quails (*Coturnix coturnix Japonica*) have attained economic importance as poultry species, producing meat and eggs of high nutritional value (Cain and Cawley, 2000). Quails are capable of laying between 200 and 300 eggs in their first year of lay (NRC, 1991). Quail meat and eggs are renowned for their high quality protein, high biological value and low caloric content (Haruna *et al*., 1997). Quails can be used in many poultry research works because of their low maintenance cost, small body size, short generation interval (4-5 in a year), resistance to diseases and high egg production (Minvielle, 2004). Quail eggs have mottled brown colour with a characteristic shell pattern. Some strains lay only white eggs. Egg weight from mature quails ranges between 10 and 11 g (Mielenz *et al*., 2006). The eggs are rich in vitamin D and antioxidants which according to Sahin *et al*. (2008) improve the quality of animal food in terms of colour, oxidative stability, storage properties and have positive effects on people with stress problem, depression and anxiety. The cholesterol content of quail eggs has been found to be lower than those of chicken, duck and ostrich but only slightly greater than that of pheasant (Kaźmierska *et al*., 2005). It is therefore nutritionally safe for consumption and can be recommended for diabetic patients. Quails, therefore, have the potential for improving the current scarcity and high cost of animal protein compared to other poultry species. The objective of this research was to compare egg production and egg quality characteristics of Panda White and Cinnamon Brown strains of Japanese quail.

MATERIALS AND METHODS

Experimental site

This research was conducted at the Poultry unit of Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Nigeria. The University is located on latitude 05^{0}29´ N and longitude 07^{0}33´E, approximately 122 m above sea level within the rainforest zone of South-Eastern Nigeria. Maximum daily temperature of the area ranges from 27 ^{0}C to 36 ^{0}C during the hot period of the year (November – April) and minimum daily temperature ranges from 20 ^{0}C to 26 ^{0}C during the cold rainy season (May – September). Relative humidity ranges from 57 % - 91 %. It has a bimodal rainfall pattern and total annual rainfall of 1700 – 2100 mm (Nwachukwu *et al*., 2006). The climate is described as hot humid tropics.

Acquisition and management of parent stock

Twenty-four (24) quails of breeding age were obtained from ongoing research at the University's Poultry unit. The quails consisted of two strains, namely Panda White and Cinnamon Brown. Each strain had 12 quails (2 cocks and 10 hens), which were mated naturally in the ratio of 1 cock to 5 hens. The mating produced 40 chicks per strain, making a total of 80 F_1 progeny used for this research. Each mating group was managed on deep litter. Feed and water were given to the quails *ad libitum*. They were fed layer mash containing 2500 Kcal/kg metabolizable energy (ME) and 16.5% crude protein (CP). Vitamins and minerals were supplemented to the quails in form of drugs.

Production and Management of F_1 Progeny

Fertile eggs produced from each cross were collected, identified differently and hatched artificially in 4 consecutive batches at weekly intervals. Eighty (80) day-old quails, 40 from each of Panda White and Cinnamon Brown strains were produced. Chicks of each hatch were identified and brooded separately for 2 weeks. Quail chicks (0 – 3 weeks old) were fed starter mash (2800 kcal/kg ME and 20% CP) while growers (3 – 5 weeks of age) received grower mash (2550 kcal/kg ME and 15% CP). Quails from 5 weeks old till end of lay were fed layer mash (2500 kcal/kg ME and 16.5% CP). Feed and water were provided *ad libitum.* Birds were vaccinated against Newcastle disease with Newcastle disease vaccine at day-old intraocularly and at 2 weeks with Newcastle disease vaccine lasota through drinking water. Anti-coccidial drugs were also administered to the quails to control incidence of coccidiosis.

Measurement of traits

Egg production traits measured were body weight at first egg, determined in grams (g) as live weight of a hen at its first egg; age at first egg, determined as the difference in days between the date of hatch and date of first egg laid; weight of first egg, measured in g; short-term egg number to 28 days, counted as the number of eggs laid in first 28 days of lay; hen-day production, expressed in percentage as the ratio of the number of eggs to number of hen days, where number of hen days was given as the product of number of hens alive and number of days in lay (Singh and Kumar, 1994) and hen-house production, expressed in percentage as the ratio of the number of eggs laid to number of hens in stock.

External egg quality traits measured were egg weight in g; egg length in centimeters (cm); egg width in cm; egg index, determined as the ratio of egg width to egg length and expressed in percentage (%); shell thickness in cm, determined as average of three measurements taken at different points on shells of individual dry eggs to the nearest 0.01mm using a micrometer screw gauge and shell weight (g). Weight was determined using a sensitive Mettle electronic balance (Model: CS 5, 000) with sensitivity of 0.01 while length and width were determined using venier calipers. Internal egg traits were measured after cracking each egg with a table knife along the egg's widest circumference and pouring onto a petri dish. The yolk was separated from the albumen using an egg separator. Yolk height was measured by inserting a thin glass rod into the center of the yolk and the height estimated using a meter rule in millimeter (mm). Yolk width was measured as the diameter of an egg with a pair of venier calipers in mm. The yolk together with a petri dish was weighed on an electronic sensitive balance and the weight of the dish, which was predetermined, subtracted from the total weight to obtain the weight of the yolk in g. A petri dish whose weight was also predetermined was weighed together with albumen on the sensitive scale and the weight of the dish subtracted from the entire weight to obtain the albumen weight in g. Yolk index was determined as a ratio of yolk height to yolk width expressed in percentage. Albumen height was measured by inserting the rod of the venier calipers into the petri dish containing the albumen and reading from the scale in mm. Haugh unit was calculated according to Haugh (1937) with the formula as expressed in (1)

Haugh unit = 100log (albumen height + 7.57 – 1.7 egg weight$^{0.37}$)…….. (1)

Statistical Analysis

Independent T- test analysis was carried out to compare the egg production and egg quality traits of Panda White and Cinnamon Brown strains of Japanese quail using IBM SPSS Statistics (2011) software. The T statistic used for the comparison was given as in expression (2).

$$t = (\overline{X_1} - \overline{X_2}) \div \left(\sqrt{\frac{SP^2}{n_1} - \frac{SP^2}{n_2}}\right), \ldots\ldots\ldots (2)$$

where $\overline{X_1}$and $\overline{X_2}$ are means of Panda White and Cinnamon Brown quails with n_1 and n_2 being their respective number of observations. Sp^2 is pooled variance, given as in expression (3).

$$SP^2 = (n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 \ / \ n_1 + n_2 - 2, \ldots\ldots (3)$$

where s^2 is the variance of any trait, obtained with expression (4).

$$s^2 = \frac{\Sigma x_i^2 - (\Sigma x_i)^2/n}{n-1} \ldots\ldots\ldots (4)$$

RESULTS

The egg production traits of Panda White and Cinnamon Brown strains of Japanese quail (*Coturnix coturnix Japonica*) are presented in Table 1. Panda White quails had significantly (P<0.05) greater body weight at first egg (70.78± 0.42 g) than Cinnamon Brown quails (68.78± 0.44 g). Age at first egg was 30.50 ± 0.11 days for Panda White and 30.59 ± 0.12 days for Cinnamon Brown, and this did not differ significantly (P>0.05) between the two strains. Short-term egg number to 28 days, hen-day production and hen house egg production did not differ significantly (P>0.0) between the two strains. The values of these traits obtained were 7.13 ± 0.13 eggs, 10.38 ± 0.13% and 9.12 ± 0.21% for Panda White and 7.10 ± 0.11 eggs, 10.34 151± 0.15% and

9.19 ± 0.23% for Cinnamon Brown quails, respectively.

The external egg quality traits of Panda White and Cinnamon Brown strains of Japanese quail (*Coturnix coturnix Japonica*) are presented in Table 2. Egg weight of Panda White (10.73±0.06g) was significantly greater (P<0.05) than that of Cinnamon Brown (9.84±0.04g). Egg length (30.78 ± 0.10 mm), egg width (25.45 ± 0.06 mm) and egg index (82.72 ± 0.29 %) of Panda White, although numerically superior, did not differ significantly (P>0.05) from egg length egg (30.67 ± 0.69 mm), egg width (25.41 ± 0.27 mm) and egg index (82.21 ± 0.29 %) of Cinnamon Brown quail. Shell weight (1.38± 0.03g) of Panda White was significantly greater (P<0.05) than shell weight (1.24± 0.01g) of Cinnamon Brown strain. Shell thickness means of 0.19±0.00 mm and 0.22±0.02 mm were obtained from Panda White and Cinnamon Brown strains, respectively, which did not differ significantly (P>0.05).

Table 1: ***Egg production characteristics of Panda White and Cinnamon Brown strains of Japanese quail (Cournix coturnix japonica)***

Trait	Strain	
	White	**Brown**
WTAFE (g)	70.78[a] ± 0.42	68.78[b] ± 0.44
AFE (days)	30.50 ± 0.11	30.59 ± 0.12
EN_{28}	7.13 ± 0.13	7.10 ± 0.11
HDP (%)	10.38 ± 0.13	10.34 ± 0.15
HHP (%)	9.12 ± 0.21	9.19 ± 0.23

[a,b]Means in the same row with different superscripts are significantly different (P<0.05).
WTAFE = Body weight at first egg, AFE = Age at first egg. EN_{28} = Short-term egg number to 28 days, HDP = Hen day egg production, HHP = Hen house egg production

Table 2: ***External Egg Quality Traits of Panda White and Cinnamon Brown strains of Japanese quail (Cournix coturnix japonica)***

Trait	Strain	
	Panda White	**Cinnamon Brown**
EWT (g)	10.73[a]±0.06	9.84[b]±0.04
EL (mm)	30.78±0.10	30.67±0.69
EW (mm)	25.45±0.06	25.41±0.27
EI (%)	82.72±0.29	82.21±0.29
SWT (g)	1.38[a]±0.25	1.24[b]±0.01
ST (mm)	0.19±0.00	0.22±0.02

[a.b] Means in the same row with different superscripts are significantly different (P<0.05).
EWT = Egg weight, EL = Egg length, EW = Egg width, EI = Egg index, SWT = Shell weight
ST = Shell thickness

The internal egg quality traits of Panda White and Cinnamon Brown strains of Japanese quail (*Coturnix coturnix Japonica*) are presented in Table 3. Yolk height of Panda White (10.42 ± 0.05 mm) was significantly different (P<0.05) from that of Cinnamon Brown (9.71 ± 0.06 mm). Yolk width and yolk weight of the two strains did not differ significantly (P>0.05). Yolk width and yolk weight means obtained for Panda White and Cinnamon Brown were 23.58 ± 0.06mm and 3.60 ± 0.03g; 23.58 ± 0.07mm, 3.53 ± 0.04g, respectively. The means of yolk index obtained for Panda White (44.15± 0.27%) differed significantly (P<0.05) from those of Cinnamon Brown (41.41 ± 0.29%) strain. Albumen weight (1.38±0.03g) of Panda White was significantly (P<0.05) higher than that of Cinnamon Brown (1.24±0.05g). The albumen height and Haugh unit of both strains were not significantly different (P>0.05). However, higher means of albumen height (4.95 ± 0.04mm) and Haugh unit (92.57 ± 0.18%) were obtained from Panda White compared with 4.76 ± 0.05mm and 92.23 ± 0.29% from Cinnamon Brown, respectively.

Table 3: ***Internal Egg Traits of White and Brown Strains of Japanese Quails (Coturnix coturnix Japonica)***

Trait	Strain	
	Panda White	**Cinnamon Brown**

YH (mm)	10.42[a] ± 0+.05	9.72[b] ± 0.06
YW (mm)	23.58 ± 0.06	23.58 ± 0.07
YWT (g)	3.60 ± 0.03	3.53 ± 0.04
YI (%)	44.15[a] ± 0.27	41.41[b] ± 0.29
AWT (g)	1.38[a] ± 0.03	1.24[b] ± 0.05
AH (mm)	4.95 ± 0.04	4.76 ± 0.05
HU (%)	92.57 ± 0.18	92.23 ± 0.29

[a..b]Means in the same row with different superscripts are significantly different (P<0.05).
YH = Yolk height, YW = Yolk width. YWT = Yolk weight, YI = Yolk index, AWT = Albumen weight, AH = Albumen height, HU = Haugh Unit.

DISCUSSION

The result of body weight at first egg (Table 1) agrees with the observation made by Nwaogwugwu *et al.* (2009) that heavy hens lay large eggs, indicating that body weight contributes significantly to the overall egg production in a flock. Earlier investigators (Ayorinde *et al.*, 1989) had reported significant positive correlation existing between body weight at first egg and egg weight, pointing out that body weight of a hen at sexual maturity could serve as a criterion for indirect selection and improvement of egg weight through correlated response. Indirect selection has advantages in reducing cost and annual genetic gain and improving genetic progress. The body weight at first egg of theses quails were lower than 154.64±0.06g reported by Okenyi *et al*. (2013) for Japanese quails at initial generation before selection. The observed differences may be due to differences in strain and environmental factors. The similarity of the two strains in age at first egg implies that any of the strains may be used for improvement of age for sexual maturity, which defines the age at which a hen lays its first eggs. The observed ages at first egg for the two trains were lower than the reported 42.6±0.4 days and 41.7±0.53 days; 49.7±1.21 days and 48.0±1.05 days for two hatches of randombred control and weight selected lines of Japanese quails, respectively (Reddish *et al*., 2003). The breeding and selection methods employed by these authors may account for the difference in age at first egg for their animals and those of the present study. The observed earlier age at first egg of these quails depicts them as light strains and may be suitable for egg production improvement since light breeds are known for high rate of egg production as a result of attainment of early sexual maturity (Yeasmin *et al.* 2003).

The short-term egg number of the quails in the present study was generally lower than the reported values by Okenyi, *et al*. (2013). The hen-day egg production and hen house egg production means of these strains were also found to be lower than the ranges of 69.67 to 86.33% and 69.00 to 81.67% reported for the two traits, respectively by Tuleun *et al*. (2013). Different protein levels and number of quails used by these investigators may account for the differences in the observed traits of the present study as these factors are capable of influencing proportion of eggs laid by hens in a flock. Hen-day egg production is an assessment of the strain effect on egg-laying rate (Oluyemi and Roberts, 2000) and contributes to reproductive fitness of quails (Decuypere *et al*., 2003). It differs from hen house egg production in its ability to account for mortality in the flock as egg production progresses. The non-significant difference between these two strains in short-term egg number to 28 days, hen-day egg production and hen house egg production implies that both strains can be engaged in selection process for improvement of these traits.

The difference in egg weight due to strains of these quails corroborates the finding of earlier investigators that strain, breed or genotype affects performance of animals (Iraqi *et al*., 2007; Nwaogwugwu *et al*., 2009; Agu *et al*., 2012). Hence, strain, breed or genotype of quails should be given prior consideration in genetic improvement of egg weight. Also genetic factors contribute immensely to egg weight compared to non-genetic factors. Heavier egg weight obtained from Panda White with body weight at first egg confirms the positive correlation found to exist between egg weight and body weight in quails (Chineke, 2001). The egg weight of quails in the present study fell within the reported values in literature. Panda and Singh (1990) determined egg weight in quails either subjected to selection for meat or egg traits as 10.58 and.76 g, respectively. Asasi and Jaafar (2000) reported a range of 9.76 to 11.63 g while Khaldari *et al*. (2010) obtained egg weights of 13.40 and 12.80 g in the selected and control populations, respectively, during selection for increased body weight at four weeks. Tabeekh, (2011) reported egg weight of 7.04 g while Stojčić *et al*. (2012) observed a range of 11.52 to 12.18 g egg weight of quails.

Means of egg length, egg width and egg index obtained for these Panda White and Cinnamon Brown quails were slightly higher than 2.83± 0.14 cm, 2.25± 0.07 cm and 79.59 ±2.44 reported for the same traits, respectively (Tabeekh, 2011). Panda White quails may have greater potential for improvement of egg size based on its superior egg index value compared to that of Cinnamon Brown. The egg indexes of these strains of quails were higher than the standard egg index value of 0.75 (Smith, 1990), suggesting that these eggs were of good shape and could withstand cracking, especially when packed in containers (Peters *et al.*., 2007). Means of shell weight obtained for the strains corroborate with the findings of Jones (2006), who reported that both egg weight and shell weight were greater for the thick shelled eggs. Shell weight is one of the methods of assessing egg shell strength (Thompson *et al.*, 1982; Singh, 1990) which plays a vital role in the laying force, embryo growth, and chick quality (Altan *et al.*, 1995). The superiority of shell weight of Panda White over that of Cinnamon Brown therefore suggests improved reproductive ability including hatchability over Panda White quails in quail breeding business. The observed means of shell thickness fell within a range of 0.186 mm to 0.201 mm previously reported for quails (Stojčić *et al*., 2012). It could be recalled that Cinnamon Brown quails which had smaller egg weight recorded higher means of shell thickness. This result confirms the findings of Butcher and Miles (2003) that smaller eggs have stronger shells than larger ones, as hens have a finite capacity to deposit calcium in the shell and as a result, the same amount of calcium is spread over a larger area. Genetic implication of this result is that selection for egg size will result in reduced shell thickness due to negative correlated response. However, since the shell thickness of the two strains did not differ significantly, the superior egg size of Panda White may be selected with concomitant effect on its shell thickness as much as on that of the Cinnamon Brown.

The result of the present study reveals that body weight at first egg, egg weight and yolk height, which were all higher in favour of Panda White quails (Tables 1 and 2) are positively correlated. This observation suggests evidence of pleiotropic gene action controlling these traits. As such, selecting one of the traits for improvement will lead to the improvement of the others through correlated response. Similarly, positive and significant correlation had earlier been observed to exist between yolk height and body size (Ayorinde *et al*., 1989), implying that body size is an important trait that determines egg size. Yolk width and yolk weight means for Panda White (23.58 ± 0.06 mm, 3.60 ± 0.03 g) and Cinnamon Brown (23.58 ± 0.07 mm, 3.53 ± 0.04 g), respectively fell within the ranges of 2.22-2.44 cm and 2.79-3.98g reported by Tuleun *et al*. (2013) for the two traits in Japanese quails. The means of yolk index obtained for Panda White (44.15± 0.27 %) and Cinnamon Brown (41.41 ± 0.29 %) strains were similar to 43.22 ± 0.31 % and 45.8± 0.28 % while those of albumen weight of these strains were much lower than 6.75 ± 0.24 g and 7.52 ± 0.31 g for egg-type and meat-type quails, respectively (Hrnčár, 2014) but only slightly lower than 2.5+0.94 g obtained by Tabeekh (2011). Yolk index and albumen weight of Panda White eggs were found to be higher than those of Cinnamon Brown (Table 3). The yolk is an important indicator of internal egg quality. It has both economic and biological value. It is useful in confectionery industry and provides nutrients to the developing embryo. The hatchability of chicks depends much on the amount of yolk in the egg. Albumen contains proteins which are important for growth and repair of warn out tissues. Panda White eggs may be preferred to those of Cinnamon Brown in terms of quality chick development and economic use. The means of Haugh unit obtained in this research were higher than the range of 83.65 – 86.10 % reported by Stojčić *et al*. (2012). Haugh unit is the accepted commercial and research standard for measuring albumen quality (Silversides, 1994). The albumen quality of these eggs was of high standard since their Haugh unit was very much above the acceptable value of at least 40 % (Ayorinde *et al.*, 1999).

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