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Sexual dimorphism in growth and feeding of Japanese quails in Northern Guinea Savanah

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Abstract. The study was conducted to determine effect of sex on growth, feed consumption and reproductive pattern of Japanese quails over 16 weeks of age in the Northern Guinea Savannah of Nigeria. A total of 206 (84 males and 122 females) quails were used for the study and some of the traits measured were body weight, average daily gain, growth rate, feed intake, feed cost, feed cost to gain ratio, age at sexual differentiation and weight at sexual differentiation. There was significant (p<0.05) difference in all the parameters measured except in feed consumption and feed cost (p>0.05) at 0-3 weeks, body weight, weight gain and growth rate (p>0.05) at 13-16 weeks. There is also no significant difference in the sex differentiation traits of the age at sexual differentiation (p>0.05). It is, therefore, concluded that sexual dimorphism was observed for growth and reproductive traits with the females having more response than the males; also, the Japanese quail used for this study showed a good variation for growth and reproduction traits, thus these traits can be used as basis for selection to develop highly efficient and direct, improved lines of Japanese quails.

Keywords: quails, sexual dimorphism, productivity, Guinea-Savannah

Introduction

The demand for livestock product is increasing very rapidly owing to a combination of population growth, rising income and urbanization (Akpa, 2014). Nigeria has recorded a massive increase in the way its population grows. As at 2012, the Nigerian human population was 167 million as compared to 45.2 million in 1960 and it is estimated to rise above 220 million in the year 2020 (National Population Commission of Nigeria, 2012). In order to meet the animal protein need of the increasing population, several efforts have been directed towards boosting the livestock industry with micro-livestock such as quails that have fast growth, resistant to many diseases than domestic fowl, less expensive to rear, early maturing with short gestation, short generation intervals, high fecundity and high production (NVRI, 1994; Mitzutani, 2003; Ikani, 2006; Akpan and Nsa, 2009; Owen and Amakiri, 2010; Kaye et al., 2016). Growth, live weight, feed consumption and reproductive traits are essential traits used in breeding programs to increase poultry meat production (Sezer, 2008; Kaye, 2014). For many species of livestock, feed costs represent a major part of total production costs (Ikani, 2006). Japanese quails exhibit sexual dimorphism in body weight. The females are generally heavier than males, and this difference becomes apparent at about the third or fourth week of age (Aboul-Seoud, 2008; Kaye, 2014; Kaye et al., 2016). Recently, sex-linked brown plumage colour has been used for auto-sexing in the quails industry (Mitzutani, 2003). The body weight of females and males was found to be similar from hatch to four weeks of age; after this age the body weight of the females was found to be higher than that of the males (Balcıoğlu et al., 2005; John and Joseph, 2009). Young birds are ready for the table at the age of 40 days, with a live weight of 180 g (Muhammad, 2006). John and Joseph (2009) also observed sexual dimorphism in the feed consumption in Japanese quails.

With a higher quality protein and the innumerable health benefits accruing to quail meat and eggs, there is need to step up research towards characterization of the Japanese quail in the Guinea Savannah region of Northern Nigeria. Also, proper understanding of the growth, feeds, feeding and reproductive pattern as affected by sex of Japanese quails particularly in the Northern Guinea Savannah of Nigeria where farming of Japanese quail (Coturnix japonica) is gaining attention from farmers, entrepreneurs, and researchers, becomes important. The aim of this paper was to determine the level of sexual dimorphism in growth and sex differentiation traits so as to enable farmers, entrepreneurs and researchers to know how to manipulate quails farming so as to achieve maximum profit.

Material and methods

Experimental site

This experiment was executed at the Quail Unit of Diamond Farms, Chikun, Kaduna State, Nigeria. Kaduna State is located in the Northern Guinea Savannah and it lies between latitude 90° and 140° North of the Equator and longitude 70° and 100° East of the Greenwich meridian with a total landmass of about 70 210 km². The climate is relatively dry, with mean annual rainfall of 700-1400 mm, occurring between the months of April and September. The dry season begins around the middle of October, with dry cold weather that ends in February. This is followed by relatively hot, dry weather from March to sometimes in April when the rain begins. The mean minimum and maximum daily temperature is from about 14°C to 24°C, during the cold season and from about 19°C to 36°C during the hot season. The relative humidity varies between 19% and 35% in the dry season and between 63% and 80% in the wet season (NACD, 2012).
Experimental birds and management

A total of 440 day-old quail chicks were procured from Nigerian Veterinary Research Institute, Vom, Plateau State of Nigeria for the experiment. The management of the young chicks included the provision of supplementary heat for 4 weeks under 24 hours lighting, and thereafter 13 to 16 hours light and 6 to 8 hours dark cycle. The birds were brooded on the deep litter floor using 200W electric bulbs at temperature of 36°C to 37.5°C in the first week and in subsequent weeks; the temperature was decreased by 3°C per week. Birds were allowed *ad libitum* access to feed and water. They were fed with starter and grower diet containing 24% crude protein (CP) and 2904 Kcal/kg ME between 1-30 days of age. Thereafter a breeder diet containing 23% CP and 2800 Kcal/kg ME was fed. The minerals and vitamins were adequately supplied to cover the requirements according to NRC (1994).

In the 4th week, two hundred and six (206) comprising 84 male and 122 female quails were wing-tagged and randomly transferred into individual cages (26×28×43cm) and given a measured quantity of feed for the remaining weeks.

Data on body weight, feed consumption, weight gain, feed conversion ratio, growth rate, feed cost, feed cost to gain ratio and some reproductive characteristics were recorded and calculated using the following formulae:

1. **Body weight**: The live body weights of the chicks at various ages (0-3, 4-6, 7-9, 10-12 and 13-16 weeks) were measured using an electronic digital top scale balance (model SF-400).

2. **Weight gain (WG)** = Final weight – Initial weight

3. **Average body weight gain**: Average body weight gain (ABWG) was estimated using the formula:

   \[
   \text{Average body weight gain} = \frac{W_2-W_1}{N},
   \]

   Where: \(W_1\) is the initial weight; \(W_2\) is the final weight; \(N\) is the number of days taken from initial weight to the present weight.

4. **Growth rate**: The daily body weight changes during the period of 0-3, 4-6, 7-19, 10-12 and 13-16 weeks of age was determined from the weekly body weight changes using the formula:

   \[
   \text{Growth rate} = \frac{W_2-W_1}{N},
   \]

5. **Feed Intake (FI)**: Feed intake was recorded for 16 weeks. This was estimated on a daily basis using the formula:

   \[
   \text{FI} = \text{Fed supplied} – \text{orts or left over feeds}
   \]

6. **Feed cost per gain ($) (FCPG)** = cost of feed ($) / weight of the feed (g) and the answer ($) multiplied by the weight gained.

7. **Feed cost to gain ratio** = feed cost / weight gained

---

**Table 1. Effect of sex on feed consumption (g) in quails over 16 weeks of age**

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>26.0±0.05*</td>
<td>25.94±0.04*</td>
<td>0.03</td>
<td>ns</td>
</tr>
<tr>
<td>4-6</td>
<td>225.08±3.33*</td>
<td>239.42±2.76*</td>
<td>2.18</td>
<td>**</td>
</tr>
<tr>
<td>7-9</td>
<td>428.77±7.18*</td>
<td>520.40±5.96*</td>
<td>5.55</td>
<td>**</td>
</tr>
<tr>
<td>10-12</td>
<td>513.80±5.88*</td>
<td>631.04±4.88*</td>
<td>5.50</td>
<td>**</td>
</tr>
<tr>
<td>13-16</td>
<td>653.05±7.27*</td>
<td>796.32±6.02*</td>
<td>6.75</td>
<td>**</td>
</tr>
</tbody>
</table>

\(n = \text{Number of quails}; \quad **p<0.01; \quad *p<0.05; \quad \text{SEM} = \text{standard error of the mean; LOS} = \text{Level of significance}\)

---

**Results and discussion**

The influence of sex on feed consumption pattern of quails is presented in Table 1. There was no significant (p>0.05) difference in the pattern of feed intake between the males and females within the first 3 weeks of age; apparently as bevy. However, from the fourth week there was an increasingly highly significant (p<0.01) difference in the sexes as evidenced in the females being superior to males to the end of the experiment. John and Joseph (2009) who worked on daily basis reported a feed intake of 50 g for both sexes at 2 weeks; showing there was no influence of sex on feed consumption at this age. The progressive trend in dimorphic feed consumption agreed with the reports of other researchers (Hyankova et al., 2001; Aggrey et al., 2003; Sezer and Tarhan, 2005; John and Joseph, 2009). The female consuming more feed at maturity was probably due to the sex-linked hormonal factor needed to meet the reproductive physiological needs.

The influence of sex on body weight pattern of quails over 16 weeks of age as in Table 2 showed that there was no significant (p>0.05) difference between the sexes at birth and at wk16 but there was significant (p<0.05) difference at wk3, (p<0.05) at wk6, (p<0.01) at wk9 and (p>0.05) at wk12. Also, the ranking of the means revealed the female's superiority from wks 3-12 but at wk 16 the males closed up with the females.

Sexual dimorphism in weight was observed from 3 weeks of age. This agrees with the statement by Cheng et al. (1985), that at day old, the weights of the male and female quails were at par and also the result of John and Joseph (2009), where the weight for both
sexes at 2\textsuperscript{nd} week was 40 g each. The dimorphism in weight, with the females being heavier than the males continued till week 12, when the adult males weighed between 110-141.4 g and the females 116-144.8 g, in accordance with Feather (1945), Mills et al., (1997) and Mitzutani (2003) who reported that adult Japanese quail females were generally larger than the males, with the range of 100 to 140 g and 120-160 g for males and females, respectively, but contrary to general weight of 91–131 g and 100-120 g for males and females, respectively (Hubrecht and Kirkwood, 2010). The variation in weight as influenced by sex could be as a result of increase in body fat threshold required for different sexes of Japanese Quails (Soller et al., 1984; Reddish et al., 2002; Akbas et al., 2004; Kaye et al., 2016). However, Hubrecht and Kirkwood (2010) pointed out that weight among domesticated lines varied considerably; as commercial strains bred for meat production could weigh up to 300 g.

Table 2 shows a significant (p<0.05) difference between the males and the females in the weight gained by the quails from 0-12 wks of age. It also showed no significant (p>0.05) difference between the males and the females from the 13\textsuperscript{th} week till the termination of the research. From the table, females tend to have higher growth rate compared to their male counterparts.

The influence of sex on the Growth Rate was in line with the report by Balcıoğlu et al. (2005) but Bonos et al. (2010) did not observe any difference in the first 3 weeks at all, whose GR could have been inhibited by dietary anti-nutritional factor. However, Momoh et al. (2014) reported that at 2wks there was no variation in GR of both sexes; all indicating that the sexual dimorphism in Growth Rate becomes apparent at the 3\textsuperscript{rd} week. The vivid significant (p<0.05) difference shown in the sexual dimorphism in GR between the males and the females at 4-6\textsuperscript{th} week, with the females showing superiority is in conformity with Bonos et al. (2010), Kaye, (2014) and Momoh et al. (2014) but contrary to Balcıoğlu et al. (2005) who stated that the GR at 4 wks are similar. The retarded GR may be due to insufficient energy from low intake or poor quality feed and inadequate management practices or the strain of the birds (Islam et al., 2014).

Table 5 shows the influence of sex on the cost of the quails over 16wks of age. There was no significant (p>0.01) difference between the males and the females at 0-3wks. From the 6\textsuperscript{th} week, the females

### Table 2. Effect of sex on body weight (g) in quails over 16 weeks of age

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>53.4±1.13(^a)</td>
<td>56.8±0.94(^a)</td>
<td>0.73</td>
<td>*</td>
</tr>
<tr>
<td>4-6</td>
<td>110.8±1.73(^a)</td>
<td>116.2±1.43(^a)</td>
<td>1.11</td>
<td>*</td>
</tr>
<tr>
<td>7-9</td>
<td>128.3±1.89(^a)</td>
<td>139.0±1.57(^a)</td>
<td>1.27</td>
<td>**</td>
</tr>
<tr>
<td>10-12</td>
<td>141.4±1.85 (^a)</td>
<td>144.8±1.53 (^a)</td>
<td>1.19</td>
<td>*</td>
</tr>
<tr>
<td>13-16</td>
<td>145.0±1.98(^a)</td>
<td>144.3±1.64(^a)</td>
<td>1.26</td>
<td>ns</td>
</tr>
</tbody>
</table>

\(n=\) Number of quails; **P<0.01; *P<0.05; SEM = standard error of the mean; LOS = Level of significance

### Table 3. Effect of sex on weight gain (g) in quails over 16 weeks of age

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>47.0±1.13(^a)</td>
<td>50.4±0.94(^a)</td>
<td>0.73</td>
<td>*</td>
</tr>
<tr>
<td>4-6</td>
<td>104.4±1.73(^a)</td>
<td>109.8±1.43(^a)</td>
<td>1.11</td>
<td>*</td>
</tr>
<tr>
<td>7-9</td>
<td>121.9±1.89(^a)</td>
<td>133.4±1.57(^a)</td>
<td>1.27</td>
<td>**</td>
</tr>
<tr>
<td>10-12</td>
<td>135.0±1.85(^a)</td>
<td>138.4±1.54(^a)</td>
<td>1.19</td>
<td>*</td>
</tr>
<tr>
<td>13-16</td>
<td>138.6±1.98(^a)</td>
<td>137.9±1.64(^a)</td>
<td>1.26</td>
<td>ns</td>
</tr>
</tbody>
</table>

\(n=\) Number of quails; **P<0.01; *P<0.05; SEM = standard error of the mean; LOS = Level of significance

### Table 4. Effect of sex on growth rate (g/day) in quails over 16 weeks of age

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>2.24±0.05(^a)</td>
<td>2.40±0.04(^a)</td>
<td>0.03</td>
<td>*</td>
</tr>
<tr>
<td>4-6</td>
<td>4.97±0.08(^b)</td>
<td>5.23±0.07(^b)</td>
<td>0.05</td>
<td>*</td>
</tr>
<tr>
<td>7-9</td>
<td>5.80±0.09(^b)</td>
<td>6.35±0.08(^b)</td>
<td>0.06</td>
<td>*</td>
</tr>
<tr>
<td>10-12</td>
<td>6.43±0.09(^b)</td>
<td>6.59±0.07(^b)</td>
<td>0.06</td>
<td>*</td>
</tr>
<tr>
<td>13-16</td>
<td>6.60±0.09(^b)</td>
<td>6.58±0.8(^b)</td>
<td>0.06</td>
<td>ns</td>
</tr>
</tbody>
</table>

\(n=\) Number of quails; **P<0.01; *P<0.05; SEM = standard error of the mean; LOS = Level of significance
had superior ranking of the mean till the termination of the research. The influence of sex on the feed cost showed that there was no significant (p>0.05) difference between the males and the females at 0-3 wks as was also reported by Bonos et al. (2010) and Momoh et al. (2014). At week 4-6, when the quails were matured and had come into lay, the cost of production was $0.057 and $0.061 for males and females, respectively. This points out that hen quails costs ($0.061) are about 28 times cheaper than pullets ($1.74) at their various points of lay. The highest cost for the quails was $0.174 and $0.213 at 13-16 wks for males and females, respectively, as seen in Table 5. The females having higher overall mean cost of $0.118 above the $0.098 for males, is in conformity with the reports of Balcıoğlu et al. (2010) and Bulus et al. (2013), which invariably patterns after the feed consumption in meeting the reproductive needs.

Table 5. Effect of sex on feed cost ($/bird) in quails over 16 weeks of age

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>0.007±0.00</td>
<td>0.007±0.00</td>
<td>0.00</td>
<td>ns</td>
</tr>
<tr>
<td>4-6</td>
<td>0.057±0.29</td>
<td>0.061±0.24</td>
<td>0.19</td>
<td>**</td>
</tr>
<tr>
<td>7-9</td>
<td>0.114±0.70</td>
<td>0.139±0.58</td>
<td>0.54</td>
<td>**</td>
</tr>
<tr>
<td>10-12</td>
<td>0.137±0.56</td>
<td>0.168±0.47</td>
<td>0.53</td>
<td>**</td>
</tr>
<tr>
<td>13-16</td>
<td>0.174±0.69</td>
<td>0.213±0.57</td>
<td>0.65</td>
<td>**</td>
</tr>
</tbody>
</table>

n = Number of quails; **P<0.01; *P<0.05; SEM = standard error of the mean; LOS = Level of significance

The effect of sex on the sex cost to gain ratio in quails over 16 weeks of age was shown in Table 6. Sexual dimorphism of quails in this study differs significantly (p<0.01) at 0-3, 7-9, 10-12 and 13-16 weeks of age. There was no significant (p>0.05) difference at weeks 4-6 between the males and the females.

Table 6. Effect of sex on feed cost to gain ratio in quails over 16 weeks of age

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>0.86±0.004</td>
<td>0.85±0.003</td>
<td>0.002</td>
<td>**</td>
</tr>
<tr>
<td>4-6</td>
<td>1.55±0.030</td>
<td>1.58±0.025</td>
<td>0.020</td>
<td>ns</td>
</tr>
<tr>
<td>7-9</td>
<td>2.35±0.040</td>
<td>2.56±0.033</td>
<td>0.027</td>
<td>**</td>
</tr>
<tr>
<td>10-12</td>
<td>4.75±0.063</td>
<td>4.99±0.052</td>
<td>0.041</td>
<td>**</td>
</tr>
<tr>
<td>13-16</td>
<td>3.09±0.053</td>
<td>3.73±0.044</td>
<td>0.042</td>
<td>**</td>
</tr>
</tbody>
</table>

n = Number of quails; **P<0.01; *P<0.05; SEM = standard error of the mean; LOS = Level of significance

The sexual dimorphism between the males and females was determined using the distinct rusty, reddish chest and slim appearance of the males and the white chest with mottled black of the females, which are generally heavier with a broader chest than the males (Reddish et al., 2001; Mitzutani, 2003; Akbas et al., 2004; Kaye, 2014). The effect of sex on the sexual dimorphism of FCTGR showed that the males had superiority in 0-3 wks and 13-16 wks, whereas the females had superiority from 4-12 weeks. However, the overall FCTGR showed that females had higher FCTGR than males as stated by Ngele et al. (2011). This difference in the FCTGR might be due to hormonal effects which affects these characteristics.

Table 7. Effect of sex on reproductive traits in quails over 16 weeks of age

<table>
<thead>
<tr>
<th>Period (wks)</th>
<th>Male (n=84)</th>
<th>Female (n=122)</th>
<th>SEM</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bwt@3wks (g)</td>
<td>53.25±1.08</td>
<td>57.35±1.03</td>
<td>0.76</td>
<td>**</td>
</tr>
<tr>
<td>Growth rate (g)</td>
<td>2.23±0.05</td>
<td>2.40±0.05</td>
<td>0.36</td>
<td>**</td>
</tr>
<tr>
<td>ASD (days)</td>
<td>26.00±0.00</td>
<td>26.00±0.00</td>
<td>0.00</td>
<td>ns</td>
</tr>
<tr>
<td>Bwt@ASD (g)</td>
<td>53.25±1.08</td>
<td>57.35±1.03</td>
<td>0.76</td>
<td>**</td>
</tr>
</tbody>
</table>

n = Number of quails; **P<0.01; *P<0.05; SEM = standard error of the mean; LOS = Level of significance

The ASD was 26 days old. This is in conformity with Shim (1990) and Daehut (2006) who reported that it is only at 3° week that their sex could be differentiated accurately without mistake; but contradicted the 4 weeks of ASD by Haruna et al. (1997). The variation in ASD could be as a result of photoperiod or lowered crude protein which retards development. However, Shim (1990) noted that partial sexing is possible by three weeks of age by the cinnamon-colored feathers on the breast of the male bird, but there are some birds that defy definite sexing by this method, even when adults. It should be noted that age at maturity was at the 5° wk when the foamy gland (cloacal gland or bulbulous structure) at the males’ genitals became prominent (Mitzutani, 2003; Kaye, 2014).

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Conclusion

Sexual dimorphism was observed for growth and reproductive traits of Japanese quail with the females having more response than the males in all parameters measured except age at sexual differentiation. This implies that birds, irrespective of their ages, can be clearly differentiated at 5th week of age. Information emanating from this study can be used as basis for selection to develop highly efficient and direct, improved lines of Japanese quails.

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