**Growth performance of the Japanese quail in a semi arid area of Nigeria**



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**Abstract**

A study was designed to determine the growth performance of Japanese quails in a semi arid area of Nigeria at the poultry unit of the University of Maiduguri Livestock Teaching and Research farm, Maiduguri, using 300 chicks. Mean live weights of the quails at 1, 2, 4, 6, 8 and 10 weeks were 16.08, 49.3, 82.26, 104.8, 133.93 and 140.74 g respectively. The corresponding weight gain were 10.07, 33.19, 7.25, 10.54 and 1.08 g while feed intakes were 5.02, 9.64, 20.11, 23.6, 32.64 and 34.58 g. Live weights, gain and feed intake of Japanese quails for the two sexes were similar except between weeks 6 and 10 when females were significantly (P<0.001) heavier, gained and ate more than males. Generally, quails only utilized feed efficiently for growth in the first three weeks of life. During this period, FCR ranged from 2.08 to 4.28; subsequently, feed to gain ratio was poor ranging from 11.6 to 19.86. Hatch weight groups had significant effect on live weight, weight gain, feed intake and FCR of Japanese quails at the different ages while color did not. Thus as hatch weight increased, the value of most growth performance indices also increased. Thus, heavier chicks at hatch should be used for meat production since they had superior growth performance at the end of the study period.

**Keywords:** Growth, season, sex, Japanese quail, Nigeria.

**Introduction**

The Japanese quails are hardy and agile birds that can adapt easily to different environments. They show genetic variation for growth traits in most populations (1). Quails are the smallest avian species farmed for meat and egg production and are as important as chicken in this regard. Hence their commercial breeding is becoming widespread. They have also assumed worldwide importance as laboratory animals. In addition, the quail is considered a good and economical source of animal protein because of their small body size, early sexual maturity, high rate of egg production (290 - 300 eggs/year), short generation time, low maintenance cost and high resistance to common poultry diseases (2). Thus, they have the potential to serve as excellent and cheap source of animal protein for Nigerians.

Growth is related to all morphological and physiological processes that affect changes in the external and internal structures of animals (3). Growth is a fundamental property of biological systems which is defined as an increase in body size per time unit (4). Thus, growth is a measure of live weight associated with increasing size of an animal and is affected by both genetic and non genetic factors. Similarly it has been asserted that growth can be measured by observing differences in body weight recorded at different ages and /or in body gain obtained during different growth periods (5).

There have been many studies investigating and characterizing the growth of Japanese quail under practical and laboratory conditions (6, 7, 8). These authors agreed that growth of quails was quite rapid from hatching to five weeks old and slowed thereafter (9). In a typical Japanese quail growth curve there was an intial intense acceleration growth phase, followed by a long inhibition phase, indicating that growth probably continues after sexual maturity (9). This behavior has also been observed in broilers (10). The assessment of growth is therefore of importance in animal production because of its practical implication (11). The essential traits used in poultry breeding programs to increase poultry meat production are based on live weight and feed consumption (8). It was observed that growth traits such as body weight and body weight gain are affected by genetic and non-genetic factors such as genotype, year and season of production, sex, nutrition, adaptability, climatic conditions and management (12). These traits have been found to help in determining the efficiency of management and optimum managerial practices required to maintain weight gain at optimum at minimum feeding costs. Also age of the birds, particularly during the first 3 weeks of life, had a marked effect on the utilization of dietary nutrients (13). Unlike other poultry species, the quails are sexually dimorphic, with females having larger body size than males. Thus, females require more time to reach sexual maturity than males (14).

Raising quails for meat is a genuine alternative to other animals raised as sources of animal protein (15). In Europe, quails had been selected for increased body weight for meat production (15). These meat type quails are 2 -3 times heavier than the egg types. In Nigeria, though they were first introduced in 1984, commercial farming started in the early 1990s and has since been on the increase (17). However, there was scant information available on growth performance of Japanese quails in the semi arid region of Nigeria being kept in commercial farms or household settings. It was therefore found necessary to assess the growth performance of the Japanese quail in this environment, in order to obtain baseline information for their improvement and increased utilization.

**Materials and methods**

The study was carried out at the Poultry Unit of the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri, Borno State, Nigeria. Maiduguri, the Borno State capital is situated on latitude 1105’ N, longitude 13009’ E and at an altitude of 354 m above sea level. The area falls within the Sahelian region of West Africa, which is known for its great climatic and seasonal variations. It has very short period (3 – 4 months) of rainfall of 645.9 mm/annum with a long dry season of about 8 – 9 months. Three seasons are therefore identifiable: dry cold (October – January), dry hot (February – May) and wet (June – September). Relative humidity is 45% in August which usually lowers to about 5% in December and January. Day length varies from 11 to 12 hours.

Three hundred Japanese quails hatched chicks collected from unselected and random mating parents were studied for over three seasons. After hatching, the chicks were individually weighed and labeled according to color (light brown or wild type). The chicks are grouped according to the following hatch weights: ≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and >7.1 grams before brooding for two weeks. Hatched chicks were then fed a commercial broiler starter ration containing 23% Crude Protein and 3000 kcal/kg of Metabolizable Energy to 6 weeks of age. The birds were housed in cages measuring 30x30x45 cm fitted with improvised feeders and drinkers and fed breeders diet containing 18% crude protein and 2800 kcal/kg of Metabolizable Energy from 6 weeks of age. Birds were sexed according to plumage color and pattern at 3 weeks of age and had access to the feed and water *ad libitum* throughout the study period. All Chicks (males and females) were weighed in grams at hatching and weekly thereafter using a sensitive digital balance. Daily feed intake per bird was measured as the weight of left over feed deducted from total feed offered. Feed conversion ratio of growing quails was calculated as total feed consumed per bird per week as compared to weekly live weight gain.

The data generated was analyzed using the General Linear Model (GLM) of SPSS 13.0 with season, color, sex and hatch weight as independent factors. Significant means where applicable were separated by Duncan’s Multiple Range Test. The model for the analysis was as described:

Yijklm = Ai + Bj + Ck + Dl + eijklm

Where Yijklm **=** observation on individual measurements based on the ijklm classification

Ai = effect of Season

Bj = effect of color

Ck = effect of sex

Dl = effect of hatch weight

eijklm = random error

**Results**

The effects of season, color, sex and hatch weight on live weights of Japanese quails from 1 to 10 weeks of age were as shown in Table 1. Mean live weights of Japanese quails at 1, 2, 4, 6, 8 and 10 weeks were 16.08, 49.3, 82.26, 104.8, 133.93 and 140.74 g respectively. The effect of season on live weights from 1 to 10 weeks of age was not significant.

The effect of color on the live weights of Japanese quails was not significant for all the ages considered during the study.

Live weights of Japanese quails for the two sexes were similar except between weeks 6 and 10 when females were significantly (P<0.001) heavier than males. There was very highly significant (P<0.001) effect of sex, on live weight observed in this study, from six weeks of age.

Table 1. Live weight (grams) of Japanese quails as affected by season, color, sex and hatch weight

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factors | Age (weeks) | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Overall mean | 16.08 | 49.30 | 75.00 | 82.26 | 94.25 | 104.8 | 120.6 | 133.93 | 139.78 | 140.74 |
|  |  |  |  |  |  |  |  |  |  |  |
| Season | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Dry cold | 16.00a | 49.02a | 74.64a | 81.85 a | 92.09 a | 99.88 a | 115.54a | 129.84a | 135.80a | 137.24a |
| Dry hot | 16.17a | 49.43a | 75.10a | 82.34 a | 92.74 a | 113.70a | 119.42a | 135.74a | 141.04a | 138.92a |
| Rain | 16.08a | 49.45a | 75.26a | 82.58 a | 92.91 a | 100.82a | 116.84a | 131.22a | 137.50a | 136.07a |
|  |  |  |  |  |  |  |  |  |  |  |
| Color | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Wild type | 16.14a | 49.58a | 75.52a | 82.82a | 94.78 a | 104.93a | 120.11a | 133.10a | 139.42 a | 140.42a |
| Light brown | 16.02a | 49.02a | 74.48a | 81.69a | 93.71a | 104.67a | 121.09a | 134.76a | 140.14 a | 141.06a |
|  |  |  |  |  |  |  |  |  |  |  |
| Sex | ns | ns | ns | ns | ns | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| Male | 16.05a | 49.14a | 74.76a | 81.95 a | 93.20 a | 102.29b | 115.29b | 126.82b | 133.13 b | 131.19b |
| Female | 16.11a | 49.46a | 75.24a | 82.56 a | 95.29 a | 107.31a | 125.91a | 141.05a | 146.43a | 150.29a |
|  |  |  |  |  |  |  |  |  |  |  |
| Hatch |  |  |  |  |  |  |  |  |  |  |
| Weight (g) | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| ≤ 4.0 | 11.59e | 35.40e | 54.10e | 59.09 e | 70.49 e | 79.74 e | 95.29 e | 107.26e | 113.27 d | 116.04d |
| 4.1 – 5.0 | 13.45d | 41.36d | 62.79d | 68.96 d | 79.97 d | 90.95 d | 106.34d | 119.85d | 122.59 d | 126.39d |
| 5.1 – 6.0 | 15.82c | 48.69c | 74.11c | 81.26 c | 92.42 c | 103.40c | 119.16c | 131.42c | 137.55 c | 140.01c |
| 6.1 – 7.0 | 18.61b | 56.16b | 85.50b | 93.83 b | 106.03b | 116.17b | 130.80b | 144.03b | 150.56 b | 149.87b |
| > 7.1 | 20.93a | 64.90a | 98.50a | 108.15a | 122.32a | 133.73a | 151.40a | 167.11a | 174.93 a | 171.41a |
| SEM | 0.23 | 0.61 | 0.96 | 1.06 | 1.26 | 1.42 | 1.7 | 1.84 | 3.38 | 3.41 |

Means in a column within a subset with different superscripts a,b are significantly different.

ns = not significant, \* = P<0.05, \*\* = P<0.01, \*\*\* = P<0.001

Hatch weight groups (≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and ≥7.1 g) also had significant (P<0.001) effect on live weight of Japanese quails at the different ages, that is, birds weighing ≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and ≥7.1 grams at hatch were significantly different from each other at all the ages studied. At one week of age, the corresponding live weights of Japanese quails weighing ≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and ≥7.1 grams at hatch were 11.59, 13.45, 15.82, 18.61 and 20.93 g respectively. This trend continued up to ten weeks of age where the corresponding live weights were 116.04, 126.39, 140.01, 149.87 and 171.41 g. Thus, as hatch weight increased, live weight at all ages also increased.

The effects of season, color, sex and hatch weight on average weight gains of Japanese quails from 1 to 10 weeks of age were as shown in Table 2. Average weight gains of Japanese quails at 1,2, 4, 6, 8, 10 weeks were 10.07, 33.19, 7.25, 10.54 and 1.08 g respectively.

The effect of color and sex (one to five weeks of age) on average weight gain of Japanese quails was not significant. However, females gained (P<0.001) more than males from six to nine weeks of age.

Hatch weight also had very highly significant (P<0.001) effect on average weight gain of Japanese quails at 1, 2, 3, 4 and 8 weeks and significant effect (P<0.05) at 6, 7, 9 and 10 weeks.

The effects of season, color, sex and hatch weight on feed intake of Japanese quails from 1 to 10 weeks of age were as shown in Table 3. Mean feed intake of Japanese quails at 1, 2, 4, 6, 8 and 10 weeks were 5.02, 9.64, 20.11, 23.6, 32.64 and 34.58 g respectively.

The effect of color on the feed intake of Japanese quails from one to ten weeks of age was not significant. Similarly, sex did not significantly affect feed intake except between weeks six and ten when females had higher (P<0.001) feed consumption.

The feed intake of different chick hatch weight group were very highly significantly different (P<0.001) from each other at all the ages studied. At one week of age, the corresponding feed intake of quails ≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and ≥7.1 grams at hatch were 3.72, 4.32, 5.08, 5.96 and 6.72 g. Similar differences continued up to ten weeks of age when the corresponding feed intakes were 29.50, 30.81, 35.31, 38.13 and 44.05 g.

The effects of age, season, color, sex and hatch weight on Feed Conversion Ratio (FCR) of Japanese quails from 1 to 10 weeks of age were as shown in Table 4. Feed conversion ratio of Japanese quails at 1, 2, 3, 4, 6, 8 and 10 weeks of age were 3.58, 2.08, 4.28, 19.86, 17.65, 19.52 and 11.6. Season had significant (P<0.001) effect on FCR at 2, 5, 6, 8 and 10 weeks and (P<0.01) at 7 weeks of age. The effect of sex on FCR was significant (P<0.001) at weeks 5, 6 and 9, and (P<0.05) at 7 weeks of age. It was however not significant at weeks 1, 2, 3, 4, 8, 10. Feed conversion ratio was significantly (P<0.001) affected by hatch weight at weeks 1, 5 and 6 and (P<0.05) at 2, 4 and 10. However the effect was not significant at 3, 7, 8, 9 and 10 weeks of age.

Table 2. Average weight gain (grams) of Japanese quails as affected by season, color, sex and hatch weight

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factors | Age (weeks) | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Overall | 10.07 | 33.19 | 25.67 | 7.25 | 12.0 | 10.54 | 15.8 | 13.33 | 5.86 | 1.08 |
|  |  |  |  |  |  |  |  |  |  |  |
| Season | \* | \* | \* | \*\* | \*\*\* | \*\*\* | ns | \*\*\* | \*\*\* | \*\*\* |
| Dry cold | 10.08a | 33.38 a | 25.81 a | 7.32 a | 10.33 b | 7.91 b | 16.01 a | 14.38 a | 6.29 b | -1.74 c |
| Dry hot | 10.00 b | 33.01 b | 25.62 b | 7.21 b | 10.26 b | 7.79 b | 15.66 a | 14.32 a | 6.34 b | 1.39 b |
| Rain | 10.17 a | 33.27 a | 25.66 a | 7.25 a | 15.38 a | 15.96 a | 15.72 a | 11.30 b | 7.46 a | 3.52 a |
|  |  |  |  |  |  |  |  |  |  |  |
| Color | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Wild type | 10.14 a | 33.43 a | 25.94 a | 7.31 a | 11.96 a | 10.15 a | 15.18 a | 13.00 a | 6.53 a | 1.75 a |
| Light brown | 10.02 a | 33.00 a | 25.46 a | 7.21 a | 12.02 a | 10.96 a | 16.42 a | 13.67 a | 6.87 a | 0.36 a |
|  |  |  |  |  |  |  |  |  |  |  |
| Sex | ns | ns | ns | ns | ns | \*\*\* | \*\*\* | \*\*\* | \*\*\* | ns |
| Male | 10.05 a | 33.09 a | 25.62 a | 7.19 a | 11.24 a | 9.09 b | 13.00 b | 11.52 b | 6.02 b | 0.27 a |
| Female | 10.11 a | 33.35 a | 25.78 a | 7.32 a | 12.74 a | 12.01 a | 18.60 a | 15.15 a | 7.38 a | 1.85 a |
|  |  |  |  |  |  |  |  |  |  |  |
| Hatch |  |  |  |  |  |  |  |  |  |  |
| Weight(g) | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\* | \* | \* | \*\*\* | \* | \* |
| ≤4.0 | 7.59e | 23.81 e | 18.70 e | 4.99 e | 11.41ab | 9.25 b | 15.55 b | 11.97 c | 5.85 b | 2.46 a |
| 4.1 – 5.0 | 8.45d | 27.90 d | 21.43 d | 6.17 d | 11.02b | 10.98 ab | 15.39 b | 13.51 b | 6.50 b | 2.40 a |
| 5.1 – 6.0 | 9.82c | 32.87 c | 25.43 c | 7.14 c | 11.18ab | 10.99 ab | 15.75 b | 12.28 c | 6.44 b | 1.91 a |
| 6.1 – 7.0 | 11.61b | 37.55 b | 29.34 b | 8.34 b | 12.18ab | 10.14 ab | 14.64 b | 13.22 c | 6.61 b | 0.21 ab |
| ≥7.1 | 12.93a | 43.97 a | 33.60 a | 9.65 a | 14.15 a | 11.42 a | 17.67 a | 15.69 a | 8.09 a | -1.71 b |
| SEM | 0.23 | 0.43 | 0.37 | 0.16 | 0.56 | 0.66 | 0.94 | 0.71 | 0.42 | 1.55 |

Means in a column within a subset with different superscripts a,b are significantly different.

ns = not significant, \* = P<0.05, \*\* = P<0.01, \*\*\* = P<0.001

Table 3. Feed intake (grams) of Japanese quails as affected by season, color, sex and hatch weight

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Age (weeks) | | | | | | | | | |
| Factors | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Overall | 5.02 | 9.64 | 15.4 | 20.11 | 22.08 | 23.6 | 25.92 | 32.64 | 34.04 | 34.58 |
|  |  |  |  |  |  |  |  |  |  |  |
| Season | \*\* | \*\*\* | \*\* | \*\* | ns | ns | ns | ns | ns | \*\*\* |
| Dry cold | 5.12a | 8.32 c | 15.67 a | 20.45 a | 21.98 a | 22.83 a | 25.12 a | 31.96 a | 33.47 a | 34.05 a |
| Dry hot | 4.82 b | 9.56 b | 14.76 b | 19.27 b | 22.05 a | 24.84 a | 25.18 a | 31.59 a | 33.81 a | 32.14 b |
| Rain | 5.14 a | 10.87 a | 15.79 a | 20.64 a | 22.19 a | 23.03 a | 25.34 a | 32.26 a | 33.77 a | 33.48 a |
|  |  |  |  |  |  |  |  |  |  |  |
| Color | ns | ns | ns | Ns | ns | ns | ns | ns | ns | ns |
| Wild type | 5.03 a | 9.66 a | 15.42a | 20.14 a | 22.17 a | 23.80 a | 26.12 a | 32.85 a | 34.25 a | 34.90 a |
| Light brown | 5.01 a | 9.49 a | 15.23 a | 19.88 a | 21.39 a | 22.19 a | 24.43 a | 31.08 a | 32.55 a | 32.25 a |
|  |  |  |  |  |  |  |  |  |  |  |
| Sex | ns | ns | ns | ns | \*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| Male | 4.75 a | 9.16 a | 14.56 a | 19.00 a | 20.69 b | 21.80 b | 23.56 b | 29.53 b | 30.93 b | 30.81 b |
| Female | 5.27 a | 10.07 a | 16.14 a | 21.09 a | 23.32 a | 25.21 a | 28.02 a | 35.41 a | 36.82a | 37.95 a |
|  |  |  |  |  |  |  |  |  |  |  |
| Hatch |  |  |  |  |  |  |  |  |  |  |
| Weight(g) | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| ≤4.0 | 3.72 e | 7.10 e | 11.39 e | 14.81 e | 17.16 e | 18.86 e | 21.42 e | 27.19 e | 28.69 d | 29.50 d |
| 4.1 – 5.0 | 4.32 d | 8.46 d | 13.28 d | 17.36 d | 19.32 d | 20.96 d | 23.09 d | 29.32 d | 30.15 d | 30.81 d |
| 5.1 – 6.0 | 5.08 c | 9.68 c | 15.65 c | 20.43 c | 22.39 c | 24.08 c | 26.41 c | 32.95 c | 34.56 c | 35.31 c |
| 6.1 – 7.0 | 5.96 b | 11.23 b | 18.03 b | 23.57 b | 25.43 b | 26.51 b | 28.83 b | 36.39 b | 38.06 b | 38.13 b |
| ≥7.1 | 6.72 a | 13.76 a | 20.87 a | 27.30 a | 29.38 a | 30.41 a | 33.48 a | 42.60 a | 44.65 a | 44.05 a |
| SEM | 0.07 | 0.17 | 0.21 | 0.28 | 0.28 | 0.3 | 0.32 | 0.4 | 0.42 | 0.48 |

Means in a column within a subset with different superscripts a,b are significantly different.

ns = not significant, \* = P<0.05, \*\* = P<0.01, \*\*\* = P<0.001

Table 4. Feed conversion ratio (feed:gain) of Japanese quails as affected by season, color, sex and hatch weight

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Age (weeks) | | | | | | | | | |
| Factors | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Overall | 3.58 | 2.08 | 4.28 | 19.86 | 14.04 | 17.65 | 13.28 | 19.52 | 38.5 | 11.6 |
| Season | ns | \*\*\* | ns | ns | \*\*\* | \*\*\* | \*\* | \*\*\* | ns | \*\*\* |
| Dry cold | 3.60a | 1.77 c | 4.27 a | 19.90 a | 15.75 a | 20.89 a | 11.78 b | 16.41 b | 39.14 a | -38.44 b |
| Dry hot | 3.56 a | 2.15 b | 4.29 a | 19.92 a | 10.91b | 11.44 b | 16.06 a | 25.42 a | 37.19a | 50.68 a |
| Rain | 3.59 a | 2.28 a | 4.28 a | 19.76 a | 15.68 a | 21.07 a | 11.80 b | 16.31 b | 39.25 a | -50.80 b |
|  |  |  |  |  |  |  |  |  |  |  |
| Color | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Wild type | 3.58a | 2.08a | 4.28a | 19.84a | 13.82a | 17.15a | 13.50a | 19.96a | 38.30a | -6.55a |
| Light brown | 3.58a | 2.09a | 4.29a | 20.03a | 15.63a | 21.24a | 11.72a | 16.39a | 39.87a | -47.97a |
|  |  |  |  |  |  |  |  |  |  |  |
| Sex | ns | ns | ns | ns | \*\*\* | \*\*\* | \* | ns | \*\*\* | ns |
| Male | 3.58a | 2.09a | 4.28a | 19.95a | 14.79a | 19.14a | 14.32a | 19.97a | 40.40a | -13.67a |
| Female | 3.58a | 2.07a | 4.28a | 19.78a | 13.37b | 16.31b | 12.35b | 19.12a | 36.80b | -9.76a |
|  |  |  |  |  |  |  |  |  |  |  |
| Hatch |  |  |  |  |  |  |  |  |  |  |
| Weight(g) | \*\*\* | \* | ns | \* | \*\*\* | \*\*\* | ns | ns | ns | \* |
| ≤ 4 | 3.43 b | 2.08 b | 4.26 a | 20.74 a | 11.63 c | 15.36d | 10.30a | 18.70a | 37.54a | 8.10a |
| 4.1 – 5.0 | 3.56 a | 2.11 b | 4.30 a | 19.65 b | 13.33b | 16.62cd | 14.03a | 17.27a | 36.31a | 8.57a |
| 5.1 - 6.0 | 3.60 a | 2.05 b | 4.28 a | 20.00ab | 14.10b | 17.03 c | 12.94a | 21.98a | 38.98a | -27.62a |
| 6.1 – 7.0 | 3.60 a | 2.08 b | 4.28 a | 19.67 b | 15.36 a | 20.23 b | 14.18a | 18.64a | 40.97a | 7.76a |
| ≥7.1 | 3.63 a | 2.17 a | 4.30 a | 19.55 b | 15.57 a | 21.77 a | 11.72a | 16.41a | 38.13a | -120.9b |
| SEM | 0.01 | 0.02 | 0.01 | 0.1 | 0.26 | 0.45 | 0.76 | 0.74 | 0.82 | 9.44 |

Means in a column within a subset with different superscripts a,b are significantly different.

ns = not significant, \* = P<0.05, \*\* = P<0.01, \*\*\* = P<0.001

**Discussion**

This study showed that the effect of season on live weights from 1 to 10 weeks of age was not significant. However, elsewhere it has been observed that live weights of Japanese quail was higher for those grown in spring than summer and this occurred as a result of higher temperature in summer (18). Earlier, it had also been reported that growth traits such as body weight and weight gain were affected by season of production (12).

It was found that there was no effect of color on the live weights of Japanese quails during this study. A similar observation had earlier been reported on Japanese quail (19). However, in contrast, a significant effect of color on body weight of Japanese quail from two to six weeks of age with the wild type recording higher estimates than the light brown had been reported (20, 21).

Live weights of Japanese quails for the two sexes were similar except between weeks 6 and 10. During this period the females were significantly heavier than males. This may be because it’s the period of sexual maturity when the reproductive organs of the female are rapidly developing in preparation for egg production.The live weight values at two weeks reported for males and females (49.14 and 49.46 g) in this study were similar to those in an earlier study (22) of 49.2g and 49.2 g respectively but lower than those reported in another study (21) of 54.29g and 56.85 g respectively. They were however, higher than the reported values (43.0 and 43.3g) of another study (23).

The live weight of female and male birds at weeks 6,7,8,9 and 10 of age were 107.31 vs 102.29 g, 125.91 vs 115.29 g, 141.05 vs 126.82 g, 146.43 vs 133.13 g, 150.29 vs 131.19 g. Week 6 weights are close to values of 92.9 and 108.3 g reported by (24) who studied body weights of Japanese quails over eight consecutive generations. (21) obtained higher estimates 185.1 and 209.8 g at the same age. The values (91.2 and 95.2 g) obtained by (23) are however lower. Week 8 weights, 126.82 and 141.5 g are lower than 169.1 and 199.6 g reported by (22) but higher than 111.2 and 130.1 g reported by (23).

The significant effect of sex on live weight of Japanese quail observed during this study had previously been reported (21, 23, 25). The significant (P<0.001) effect of sex, observed in this study, from six weeks of age had also been reported by (23; 6; 26; 21). (22) observed significant (P<0.05) sex effect from 4 weeks and (27) from 7 weeks of age while (28) did not observe any significant sex effect in an experiment that lasted only six weeks. Literature (6, 21, 26, 29) generally indicates that sexual dimorphism was in favour of the female unlike in other poultry species. The significant difference in weight between gender from 6 weeks which is the reported point of maturity could be due to development of the reproductive tract of females in preparation for egg production.

Hatch weight groups had very highly significant (P<0.001) effect on live weight of Japanese quails at the different ages. The trend of increase of live weights from one to 10 weeks of age was similar (see Table 1). Thus, as hatch weight increased, live weight at all ages also increased. This phenomenon had earlier been reported (30). It was observed that the heavier the chick at hatch, the heavier the live and carcass weights.

Wilson (31) reported that a gram increase in the body weight of newly hatched broilers resulted in 8 -13 g increase in final body weight and that the best production results should be expected from the heaviest hatchlings. Similarly, (32) grouped Japanese quail according to hatch weight (group I, 5.5-6.2, group II, 6.3-7.0 and group III, 7.1-7.6 g). They observed that Group III quails which were 25 and 12% heavier at hatching than group I and II, reached mature body weight that were also 38 and 12% heavier respectively. In contrast, (33) reported insignificant effect of hatch weight on further growth and development of birds.

Season had a very highly significant (P<0.001) effect on average weight gain at five, six, eight, nine and ten weeks, highly significant effect at four weeks (P<0.01) and significant effect (P<0.05) at one, two and three weeks. At one week of age, average weight gain was significantly higher in the dry cold (10.08 g) and rainy season (10.17 g) than the dry hot (10.00 g). A similar trend was observed up to four weeks. At five and six weeks, birds in the rainy season gained significantly higher weight than those in the other two seasons. At week seven, no significant difference was observed, however, significant effect of season was observed at weeks 8, 9 and 10.

Color and sex did not have effect on average weight gain of Japanese quails. Sex did not have significant effect on average weight gain from one to five weeks. However, females gained (P<0.001) more than males from six to nine weeks of age. (34) also observed that female quails gained significantly higher weights than males. Similarly, (25, 35) reported that females had higher growth rates than males. However, these reports contradict that of (36) who observed higher gain in males as compared to females. Furthermore, the high body weight gains observed during the rearing period of 2–4 weeks in this study are also similar to those reported by (35).

Hatch weight also had a marked effect on average weight gain of Japanese quails. At one week of age, the corresponding average weight gains of Japanese quails weighing ≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and ≥7.1 grams at hatch were 7.59, 8.45, 9.82, 11.61 and 12.93 g. There was a similar pattern up to four weeks when the corresponding average weight gains were 4.99, 6.17, 7.14, 8.34 and 9.65 g. (37) in an experiment with three hatching weight groups (5.5 – 6.2, 6.3 – 7.0 and 7.1 – 7.8 g) also reported significant effect of hatch weight on weight gain. (38) stated that the average daily gain in Japanese quail was at a maximum of 4.8 g/day during the first period from hatch to 3 weeks of age, and became lower during the second period from 3 to 6 weeks. Thus, indicating that the inflexion point of growth curve of Japanese quails might be at about 3 weeks of age.

Season had significant very highly marked (P<0.001) effect on feed intake at 2 and 10 weeks; and highly significant (P<0.01) at 1, 3 and 4 weeks. However the effect was not significant at 5-9 weeks of age. Feed intake was significantly higher for dry cold (5.12 g) and rainy (5.14 g) than dry hot (4.82 g) season in the first week of life, weeks three, four and ten. (18) observed that feed consumption in Japanese quail was higher in spring than summer due to higher summer temperatures. Similarly, (39) reported significant effect of season on feed intake in Japanese quail.

Color did not have effect on the feed intake. Similarly, sex did not significantly affect feed intake up to 5 weeks of age after wards females had very highly significant intake than males. This finding agreed with what had earlier been reported (25, 35).

Birds of different age groups at hatch were also significantly (P<0.001) different from each other at all the ages studied. At one week of age, the corresponding feed intake of quails ≤4.0, 4.1 – 5.0, 5.1 – 6.0, 6.1 – 7.0 and ≥7.1 grams at hatch were 3.72, 4.32, 5.08, 5.96 and 6.72 g. Similar differences continued up to ten weeks of age when the corresponding feed intakes were 29.50, 30.81, 35.31, 38.13 and 44.05 g. Thus, the higher the hatch weight, the higher the feed intake at all ages. Earlier study (37) also reported significant (P<0.05) effect of hatch weight on feed consumption. In contrast another study (32) reported that feed consumption rates were not significantly different among three hatch weight groups.

The feed intake of different chick hatch weight group were very highly significantly different (P<0.001) from each other at all the ages studied with chicks with higher the hatch weight, having higher the feed intake than chicks with lower hatch weight at all ages. Earlier study (37) also reported significant (P<0.05) effect of hatch weight on feed consumption. This was in contrast, to what was reported in another study (32) that feed consumption rates were not significantly different among three hatch weight groups.

It has been shown that age had effect on FCR of quail chicks. Generally, quails only utilized feed efficiently for growth in the first three weeks of life. During this period, FCR ranged from 2.08 to 4.28; subsequently, feed to gain ratio was poor ranging from 11.6 to 19.86. (27) reported that feed conversion ratios for 1st and 7th weeks were 1.96 and 6.20 respectively which are within the range of values observed in this study. Season had significant (P<0.001) effect on FCR at 2, 5, 6, 8 and 10 weeks and (P<0.01) at 7 weeks of age. Feed conversion ratio (FCR) was significantly (P<0.05) better for the dry cold (1.77) than dry hot (2.15) and rainy (2.28) seasons in week two of life. Color did not significantly affect FCR at all ages. The effect of sex on FCR was significant (P<0.001) at weeks 5, 6 and 9, and (P<0.05) at 7 weeks of age. It was however not significant at weeks 1, 2, 3, 4, 8, 10. (34) reported non significant effect of sex on feed conversion ratio with ratios of 3.51 for females and 3.88 for males. Better feed conversion ratio in female quails has also been reported by (40). Feed conversion ratio was significantly (P<0.001) affected by hatch weight at weeks 1, 5 and 6 and (P<0.05) at 2, 4 and 10. However the effect was not significant at 3, 7, 8, 9 and 10 weeks of age. Earlier study (37) also reported significant hatch weight effect on feed conversion ratio as has been found.

In conclusion the growth performance traits of Japanese quail were affected by factors such as season, sex and hatch weight. Sexual dimorphism was in favour of females unlike other poultry species. The values of growth traits increased with increase in weight of birds at hatch. Thus, birds with higher hatch weight had better growth performance. Heavier chicks at hatch should be used for meat production since they had superior growth performance at the end of the production cycle.

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**References**

1. **Marks, H. L. 1990.** Abdominal fat and test weights on diverse genetic lines Japanese quail. *Poult. Sci*. **69:**1627-1633.
2. **Hassan, S. M., Mady, M. E., Cartwright,** **A. L., Sabri, H. M., Mobarak, M. S. 2003.** Effect of acetyl salicylic acid in drinking water on reproductive performance of Japanese quail (Coturnix Coturnix japonica).*Poult. Sci*. **82:1174-1180.**

**3. Janusz, M., Jozer, Z. 1982**. Growth and development. In: Genetics and Animal Breeding. Elsevier Scientific Publishing, New York, U.S.A.

**4. Lawrence, T. L. J., Fowler, V. R. 1997.** Growth of farm Animals. CAB International Wallingford oxon 8DE UK, NewYork.

**5. Cole, H.H. 1966.** Introduction to livestock production. 2nd Edition by Freeman, W.H and Company. New York, U.S.A.

**6. Abdel Mounsef, N. A. 2005.** Non genetic factors affecting some productive traits in Japanese quail. M.Sc. Thesis Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. 214 pp.

**7. Narayan, R., Singh, D.P. 2006.** Japanese quail breeding: present status and future strategies. In: P.V.K. Sasidhar (Ed.). Poultry Research Priorities to 2020. Proceedings of National Seminar (November, 2-3). Central Avian Research Institute, Izatnagar-243122 (India).

**8** [**Narinc**](http://scialert.net/asci/author.php?author=Dogan&last=Narinc)**, D.,** [**Karaman**](http://scialert.net/asci/author.php?author=Emre&last=Karaman)**, E.,** [**Firat**](http://scialert.net/asci/author.php?author=Mehmet%20Ziya&last=Firat)**, M. Z.,** [**Aksoy**](http://scialert.net/asci/author.php?author=Tulin&last=Aksoy)**, T. 2010.** **Comparison of non-linear growth models to the growth in Japanese quail.** *J. Anim. Vet. Adv.* **9(14):**1961-1966.

**9. Anthony, N. B., Emmerson, D. A., Nestor, K. E., Bacon, W. L., Siegel, P. B., Dunnington, E. A. 1991**. Comparison of growth curves of weight selected populations of turkeys, quail and chickens. *Poult. Sci*. **70**:13–19.

**10. Goliomytis, M., Panopoulou, E., Rogdakis, E. 2003**. Growth curves for body weight and major component parts, feed consumption, and mortality of male broiler chickens raised to maturity. *Poult. Sci*.. **82**:1061-1068.

**11.Sabbioni, A., Superchi, P., Bonomi, A., Summer, A., Boidi, G. 1999.** Growth curves of Ostriches (Struthio camelus) in Northern Italy. Paper represented at the 50th EAAP Congress, Zurich, 22-26 Aug., 1999.

**12. Hafez, E. S. S. 1963.** Symposium on growth: Physio-Genetics of prenatal and postnatal growth*. J. Anim. Sci.* **22**:779-791.

**13. Carre, B. 1993.** Digestibility of carbohydrates in poultry. Proceedings, 9th European Symposium on Poultry Nutrition. PP.120-131 (Jelenia Gora. Poland).

**14.Reddish, J. M., Nestor, K. E., Lilburn, M. S. 2003**. Effect of selection for growth on onset of sexual maturity in random bred and growth of selected lines of Japanese quail. *Poult. Sci.* **82**: 187 – 191.

**15. Faitarone, A.B.G., Pavan, A.C., Mori, C., Batista, L.S., Oliveira, R.P., Garcia, E.A., Pizzolante, C.C., Mendes, A.A., Sherer, M.R. 2005.** Economic traits and performance of Italian quails reared at different cage stocking densities. *Rev. Bras. Ciên. Avícolas* **7(1):**19-22.

**16. Mizutani, M. 2003.** The Japanese quail. Laboratory Animal Research Station, Nippon Institute for Biological Science, Kobuchizawa, Yamanashi, Japan, 408-410.

**17. NVRI 1996.** National Veterinary Research Institute. Farmer training on quail production and health management. REFILS. Vom, Plateau State.

**18. Ozbey, O., Ekmen, F. 2000**. The effects of season and stocking density on growth rate, survivability and carcass performance on Japanese Quails. *J. Vet. Fac. Yüzüncü Yil Uni*. **11**: 28-33.

**19. Akpa, G.N., Odubu, E.S., Kabir, M., Joktan, E. 2009. Observations on color pattern, performance traits and sexual dimorphism in Japanese quails. In proceedings of the 34th annual conference of Nigerian Society of Animal Production held at University of Uyo, Uyo, Akwa Ibom State from 15th to 18th March, 2009.**

**20. Petek, M., Ozen, Y., Karakas, E. 2004.** The effects of recessive white plumage color mutation on hatchability and growth of quail hatched from breeders of different ages. *Brit. Poult. Sci*. **45**:769-774.

**21. Shokoohmand, M., Kashan, N. E. J., Maybody, M. A. E. 2007**. Estimation of heritability and genetic correlations of body weight in different age for three strains of Japanese quail. *Int. J. Agric. Bio*. **6**: 945-947.

**22. Balcıoğlu, M.S., Kızılkaya, K., Yolcu, H.I., Karabağ, K. 2005.** Analysis of growth characteristicsin short-term divergently selected Japanese quail. *South African J. Anim. Sci.* **35(2):** 83-89.

**23. Woodard, A.E., H. Abplanalp, W.O. Wilson, P. Vohra, 1973**. Japanese quail husbandry in the laboratory. Department of Avian Sciences University of California, Davis, CA, 95616.

**24.Collins, W. M., Abplanalp, H. and Hill, W. G. (1970).** Mass selection for body weight in quail. *Poultry Science* **49:** *926 - 933*.

**25. Kul, S., Seker, I., Yildirim, O. 2006.** Effect of separate and mixed rearing according to sex on fattening performance and carcass characteristics in Japanese quails (*Coturnix* *Coturnix* *Japonica*) *Arch. Tierz. Dummerstorf* **49(6):**607-614.

**26. Vali, N., Edriss, M.A., Rahmani, H.R. 2005.** Genetic parameter of body and carcass traits in two quail strains. *Int. J. Poult. Sci.* **4(5):**296-300.

**27. Vali, N. 2009.** Growth, feed consumption and carcass composition of *Coturnix* *japonica*, *Coturnix* ypisilophorus and their reciprocal crosses. *Asian Journal of Poultry Science* **4**:132-137.

**28. Seker, I., Kul, S., Metin, B.A. 2009.** Effect of group size on fattening performance, mortality rate, slaughter and carcass characteristics in Japanese quail (*Coturnix* *Coturnix* *japonica*). *J. Anim. Vet. Adv*. **8**(4):688-693.

**29. Wilson, W., Ursnia, O., Abbott, K., Abplanalp, H. 1961.** Evaluation of Coturnix (Japanese quail) as pilot animal for poultry breeding. *Poultry Science* ***40****:651-657.*

**30. Al-Murrani, W.K. 1978.** Maternal effects on embryonic and post embryonic growth in poultry. *Brit. Poult. Sci*. **19**:277-281.

**31 Wilson, H. R. 1991.** Interrelationships of egg size, chick size, posthatching growth and hatchability. *World Poultry Science Journal* **47**:5–16.

**32.** [**Laskey, J.W**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Laskey%20JW%22%5BAuthor%5D)**.,** [**Edens, F.W**](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Edens%20FW%22%5BAuthor%5D)**. 1985**. Hatch weight selection: effect on post-hatch growth in the Japanese quail (*Coturnix* *Coturnix* *japonica*). [*Comp. Biochem. Phy., A Comp Phy.*](http://www.ncbi.nlm.nih.gov/pubmed/2864190) **82(1):**101-104.

**33. Guill, R.A., Washburn, K.W. 1973.** Relationship between hatch weight as a percentage of egg weight and feed conversion ratio in broiler chicks. *Poult. Sci.* **52**:1646-1651.

**34. Buragohain, R., Kalita,G., Sarma, K., Hazarika, P. 2009.** Effects of managemental system on performance and economy of growing Japanese quails. *Ind. J. Anim. Sci*. **79**(11):1232-1238

**35. Ayasan, T., Baylan, M., Uluocak, A.N., Karasu, O. 2000.** Effects of sex on different stocking densities on the fattening characteristics of Japanese quails. *J. Poult. Res.* **2(1):** 47-50.

**36. Shrivastava, S.K., Ahuja, S.D., Bandyopadhyay, U.K., Singh, R.P. 1995.** Influence of rearing mixed and separate sexes on growth performance and carcass yield of Japanese quail. *Ind. J. Poult. Sci*. **30(2):** 158-160

37. Ipek, A., Sahan, U., Yilmaz, B. 2004. Effect of hatch weight on performance of Japanese quails egg (*Coturnix* *Coturnix* *japonica*) during growth and egg production period. *Archiv Geflugelk* 68(6):280-283

38. Jones, J. E., Hughes, B. L. 1978. Comparison of growth rate body weight and feed conversion between *Coturnix* DI quail and Bob white quail. *Poult. Sci*. 57: 1471-1472.

39. Dhaliwal, S.K., Nagra, S.S., Brah, G.S. 2007. Effect of cage stocking density and season on laying performance of Japanese quail (*Coturnix* *Coturnix* *japonica*). *Ind. J. Anim. Sci.* 42(3):121-130.

40. Okamoto, S., Kobayashi, S., Matsuo, T. 1989. Feed conversion to body weight gain and egg production in large and small Japanese quail lines selected for 6-week body weight. *Japan Poult. Sci.* 26:227–234.