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Research Article

Estimation of heritability and phenotypic correlations of certain productive traits of Japanese quail (*Coturnix japonica*)

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Abstract: The restricted Maximum likelihood Computer Programme was used to estimate heritability values for body weight at hatch (BWH) and at 2 (BW2), 3 (BW3), 4 (BW4), 5 (BW5), 6 (BW6), 7 (BW7) and 8 (BW8) weeks of age, age at first egg (AFE) and body weight at first egg (BWFE). The phenotypic correlations among these parameters were also determined. A total of 123 birds were allocated into 22 cages according to the full sib families (from one day old – 8 weeks of age). The results revealed that heritability of BW were 0.60, 0.51, 0.34, 0.32, 0.23, 0.11, 0.27 and 0.06 at hatch, 2, 3, 4, 5, 6, 7 and 8 weeks respectively. These results indicate that heritability decreased as the age increased, whereas heritability estimates for AFE and BWFE was 0.53 and 0.15 respectively. Phenotypic correlations between live body weights at different ages were positive and significant (P<0.001). These results point out that the growth in quails can be improved by direct selection for high body weight.
Keywords: Japanese quail, heritability, phenotypic correlations, restricted maximum likelihood.

INTRODUCTION

The poultry industry depends mainly on chicken production for both meat and egg, now there is an increase production in other poultry species either for food production or genetic conservation resources plan (1). Japanese quail is getting more important for commercial meat and egg production. It has marked advantages such as fast growth, early sexual maturity, high rate of egg production, short generation interval and short incubation period. The average age at start of laying for Japanese quail is 6-8 weeks (2) and quail hens can lay up to 280-300 eggs in their first year by proper care. In order to establish a breeding program, it is essential to estimate genetic parameters for improving the production traits. Despite the small body size of Japanese quail, its meat and eggs are widely consumed and therefore ameliorates the problem of animal protein shortage.

Other poultry species are sexually dimorphic with males having a larger body size than females, unlike Japanese quail bird with females having a larger body size than males. Sexual dimorphism is believed to evolve under the pressure of natural and sexual selection, which implies that genes controlling sexually dimorphic characteristics differ between males and females (3).

The Japanese quail have many advantages, which have been widely used for biological and genetic studies are because of this bird has a small body size, easily handled, a large number of birds can be kept in a limited space, sexual maturation is fast accomplished, turnover of generations is rapid, many offspring and high egg production can be available from certain number of parents (1, 4). Variance, covariance, heritability and genetic and phenotypic correlations are necessary parameters to predict direct and correlated response to selection. Also the genetic evaluation is based on these parameters (5). Several studies estimated genetic parameters for various traits of Japanese quail (6, 7, 8).

The heritability of the metric characters is one of the most important properties. It expresses, as we have seen, the proportion of the total variance that is attributable to the average effects of genes, and this is what determines the degree of resemblance between

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relatives. But the most important function of the heritability in the genetic study of metric characters has not yet been mentioned, namely its predictive role, expressing the reliability of the phenotypic value as a guide to the breeding value. Only the phenotypic values of individuals can be directly measured, but it is the breeding value that determines their influence on the next generation. Namely if the breeder or experimenter choose individuals to be parent according to their phenotypic values his success in changing. the characteristics of the population can be predicted only from a knowledge of the degree of correspondence between phenotypic values and breeding values. this degree of correspondence is measured by the heritability (9).

The objective of this study is to estimate the heritability and phenotypic correlations of some productive traits in Japanese quail.

MATERIAL AND METHODS

Study area:

This experiment was carried out in the Animal Production Research Centre at Kuku, Khartoum North, Khartoum State, Sudan during the period from April to July 2016. Minimum and maximum temperatures outside the poultry unit were 26.1˚C and 40˚C respectively.

Birds and Management:

Eighty (Black44 males and females and Brown 36 males and females) of quails which were developed previously by selection for body weight and used in this study. One male and one female parent were kept together in individual cages .50×.50 m^2, parents were 24 weeks old. Eggs were collected separately from individual cages and eggs of each parents were placed separately and then transferred to the incubator. The incubation period for quails is 17-18 days, at incubating temperature of 37.5° ± 0.3°C (99.5° ±0.5°F) and relative humidity of 60% wet bulb reading of 30° ± 0.5°C (86° ± 1.0°F) until the 14^{th} day of incubation. Eggs were turned every 2 hours to prevent embryos from sticking to the shell until the 14^{th} day after that the eggs were transferred to hatching trays and turning was stopped. Hatchery was operated at 37.2°C (99°F) and relative humidity of 70% wet bulb 32.2°C (90°F) as was mentioned by Randall and Bolla.(2008).The chicks were removed on the 17^{th} or 18^{th} day of incubation. After hatching, each offspring was identified manually for each cage. All offspring were raised in battery brooders until 3 weeks of age and then were transferred to growing cages until 8 weeks of age. Feed and water were supplied adlibitum and light provided for 24 hours.

A total of 123 comprising 22 full-sibs families of Japanese quail were used in this study. The birds were fed on two (starter and grower) balanced rations according to (NRC.1994). Starter ration (26% crude protein and 2914 kcal ME/kg) was provided from day one up to week six and the grower ration (22% crude protein and 2835 kcal ME/kg) was provided from week seven up to week eight. The birds were kept in an open sided building and standard management practices were adopted, **dimension of each cage were** (50×50×40 cm).

Measurements and Determinations

Hatched chick weight was taken at the hatchery before transferred to the farm. The study was extended from day one to week eight of age, hatch weight, live body weight, age and weight at first egg were recorded and the heritability of these parameters was estimated according to Falconer(9).

$$h^2 = 2\times \frac{\text{Total genetic variance}}{\text{Total phenotypic variance}}$$

The equations generated using the linear model:

simple regression: Y = a + b X

Y = weight of quail (g)

a = intercept, (constant).

b = slope, the regression coefficient the change in Y per unit change in X.

X = age of quail. (Week)

Statistical analysis:

Heritability was estimated by variance components using restricted maximum likelihood. Pearson's correlation was used in estimating the association between the studied parameters. The SPSS software program, version 16 (2007) was used for data analysis.

RESULTS

The estimation of sir and dam variance ($\sigma^2_{\text{sire and dam}}$) and error variance ($\sigma^2_{\text{error}}$) were 0.154, 13.064, 25.536, 26.934, 29.605, 14.978, 50.783, 8.462, 7.546, and 26.264 and 0.357, 38.504, 123.224, 143.917, 223.886, 264.648, 326.797, 20.955 and 320.962 respectively in the 2con 3rd , 4th 5th, 6th , 7th , 8th weeks, (AFE) and (BWFE). With the exception of hatch weight the phenotypic correlation for body weight of Japanese quails at different weeks revealed gradual significant (P<0.01) increase in correlation coefficients by increasing in age, the correlation coefficients ranged from 0.331 between hatch, week 6 and 0.848between week 7, week 8.

$$\text{Body weight} = -27.260 + 22.141 \times \text{age} \quad (r^2 = 0.94)$$

DISCUSSION

Body Weight:-

In the literature several reports on estimates of genetic parameters for live weight of Japanese quail based on the attributed to method of estimation.

The heritability estimations for body weights at hatch, two, three, four, five and six weeks of age were 0.60, 0.51, 0.34, 0.32, 0.23, and 0.11 respectively, heritability estimate reduced with age. There is great influence of the environment effect on [body weights at hatch]. This effect increases when age increases. This result agrees with the estimates reported by Bahie El-Deen, (10), who reported that heritability estimate for body weight in Japanese quails from sire components for hatch, two, four and six weeks of age were 0.62, 0.39, 0.36 and 0.29; respectively.

The obtained heritability of body weight at hatch was 0.60. This result disagreed with the findings of Daikwo, (11), who reported higher heritability values at hatch 0.91 The low heritability estimates of body weight at week six imply that response to selection for body weight at the 6th week could be slow while the moderate to high heritability estimates obtained for body weight at age hatch, two, four, five and seven weeks indicates that response to selection for body weight at these ages could be rapid. The low to moderate heritability of body weight at grown-up ages may point to that environmental effects were more important in influencing body weight at these ages than additive genetic effects.

Age and Weight at First Egg:

Age at first egg can be highly variable because it is affected by feeding and management practices. Early age at first egg can be advantageous because selection for it could lead to reduced generation interval.

The high heritability estimate (h^2=0.53) of age at first egg reported in this study is similar with the findings of Daikwo and Momoh *et al*. (12) who reported heritability estimates for age at first egg 0.31±0.08 and 0.48±0.17 respectively. This result disagree with the estimates reported bySezer *et al.* (13) who reported heritability estimates for age at sexual maturity in Japanese quails was 0.24± 0.118 and 0.33± 0.136 for male and female respectively.

As well Magda*et al*. (14) reported heritability estimates of age at sexual maturity ranged from low to high (0.07 to0.44) for the three generations.

The consequent values for body weight at first egg disagreed with Lotfi*et al*.(15)who declared that heritability estimate for weight at first egg was 0.36.This result agrees with that range of 0.17 to 0.78 reported by Strong *et al*. (16)and Farahat (17). On the other hand Momoh *et al*., (18) reported the value 0.38 for the same trait.

Phenotypic Correlation:

Phenotypic correlation among body weights at different ages in Japanese quail are presented in Table1

Table 1: Heritability (diagonal), phenotypic (above diagonal) and genetic (below diagonal) correlations for body weight of Japanese quails at different ages, Age at Sexual Maturity (ASM) and weight at first egg(WFE).

weight	BW0	BW2	BW3	BW4	BW5	BW6	BW7	BW8	ASM	WFE
BW0	0.60	0.488**	0.414**	0.364**	0.337**	0.331**	0.374**	0.386**	0.021	
BW2	0.247**	0.51	0.773**	0.716**	0.559**	0.522**	0.585**	0.521**	-0.082	
BW3	0.210*	0.773**	0.34	0.721**	0.722**	0.674**	0.660**	0.593**	-0.150	
BW4	0.226*	0.738**	0.766**	0.32	0.744**	0.695**	0.603**	0.504**	-0.198*	
BW5	0.132	0.575**	0.795**	0.793**	0.23	0.835**	0.704**	0.667**	-0.277**	
BW6	0.056	0.509**	0.667**	0.666**	0.848**	0.11	0.791**	0.704**	-0.201*	
BW7	0.178	0.503**	0.580**	0.661**	0.754**	0.872**	0.27	0.848**	-0.257**	
BW8	0.236*	0.390**	0.446**	0.543**	0.599**	0.718**	0.825**	0.06	-0.170	
ASM	0.041	-0.13	-0.058	-0.122	-0.204	-0.194	-0.252*	-0.221*	0.53	
WFE	0.455**	0.021	0.106	0.169	0.042	0.004	0.082	.240*	0.414**	0.15

** Correlation is significant at the P< 0.01 level

* Correlation is significant at the P< 0.05 level

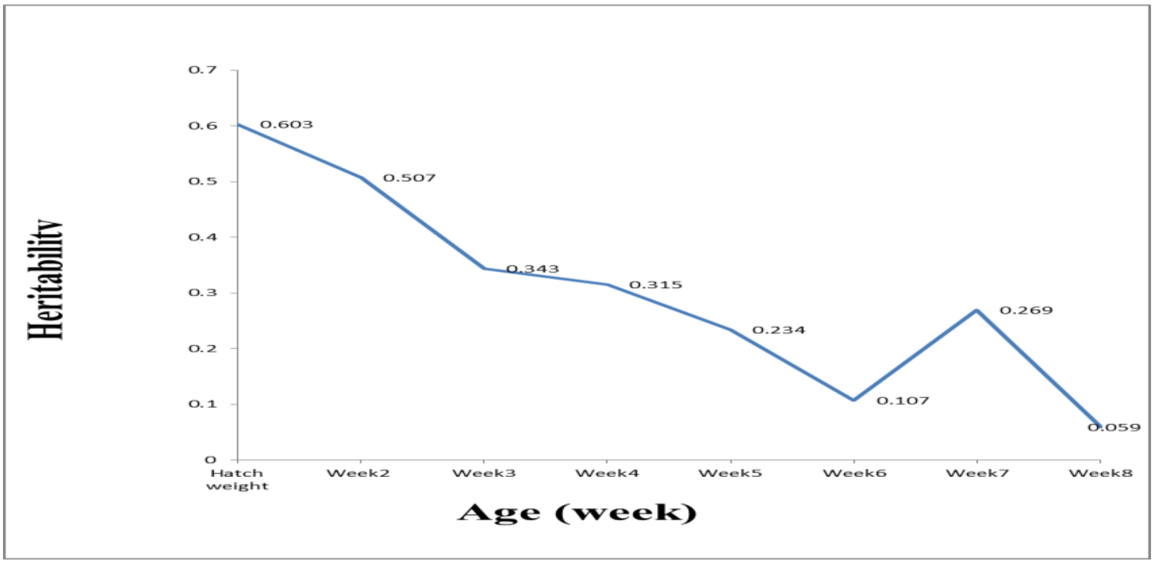

Figure (1): heritability estimations for body weights at different ages for Japanese quail.

Generally, phenotypic correlation between body weights at all ages in this study were significantly high (P < 0.001) and ranged from medium to high in positive direction. The phenotypic correlation estimates between body weights at different ages were similar in magnitude and direction and increasing in correlation coefficients by increasing in age. This result is in accordance with the findings of Magda *et al*. (14) who reported phenotypic correlation between the2nd week and those of 4th, 6th week body weight ranged from medium to very high (0.43 to 0.86) and between the 4th and 6th week body weight ranged from ?? (0.53 to 0.65),for the three generations. On the other hand, Momoh *et al*. (18) reported that phenotypic correlations between body weight at hatch and week 1, respectively, were weak and not significant with body weights at higher ages. However, at weeks 2, 3 and 4, body weights showed significant phenotypic associations with body weights at weeks 5 and 6. Negative significant phenotypic correlation between age at first egg and body weight at different ages shown in this study. This result agreed with Sezer *et al.*, (19) who reported that phenotypic correlations between age at sexual maturity and weekly live weight of females were negative. This means the increase in body weight is accompanied by early age at first egg.

These results point out that the growth in quails can be improved by direct selection for high body weight or it will be concluded that body weight of Japanese quails could be improved by direct selection for high body weight. And these high phenotypic correlations between live weights at younger and older ages support the general view of the possibility of selecting Japanese quails based on early body weight. And also these results point out that the strong and positive phenotypic relationships as observed between body weights at different ages could mean that the same genes are controlling body weight at different ages.

In this study linear mathematical model was used to estimate body weight of Japanese quails within the age of quails. The high correlation between age and weight of quails ($r=0.97^{**}$, and $r2=0.94$) would provide a good estimate for predicting body weight within the age.

CONCLUSION

These results indicate that heritability decreased with age. On the other hand, These results point out that the growth in quails can be improved by direct selection for high body weight or it can be concluded that body weight of Japanese quails could be improved by direct selection for high body weight. And these high phenotypic correlations between live weights at younger and older ages support the general view of the possibility of selecting Japanese quails based on early body weight. And also these results point out that the strong and positive phenotypic relationships as observed between body weights at different ages could mean that the same genes are controlling body weight at different ages.

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