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GeneticsStudies in Three Generations of Japanese Quails *(Coturnixcoturnix japonica)*

[1*]J. Kaye, [2]G.N. Akpa, [3]I.A. Adeyinka, and [4]B.I. Nwagu,

[1]Department of Animal Production, University of Jos
[2]Department of Animal Science, Ahmadu Bello University, Zaria
[3,4]National Animal Production Research Institute, Ahmadu Bello University, Shika Zaria

Corresponding author e-mail: jokaye2003@gmail.com

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Abstract - Genetic study was conducted on Japanese quails at the Animal Science Department Ahmadu Bello University, Zaria, Nigeria. At first a total of 100 birds were used. Those were the base population. The first and second generation birds originated from 20 females and 10 malesmated in ration of 2 females to 1 male to obtain 100 hatch birds for each of the first and second generation**.**The following traits were recorded at each generation from each male bird: body weight, age at maturity, testicular weight, pectoral major weight and abdominal fat weight. The following traits were recorded at each generation from the female birds: body weight when birds were 35 days old, body weight at the time first egg was laid, weight of the first laid egg, age of the bird when the first egg was laid, follicle number, follicle size, oviduct weight, and ovary weight, pectoral major and abdominal fat weight. Response to selection, Selection differential and heritability were calculated for each of the above characters. These three characters were also calculated for carcass weight of males and live body weight of the females when they were 35, 42, 49 and 56 days old. The base population had significantly higher mean values while the first generation had the lowest mean values in all of the above male traits except in average age of the male birds, Similarly, the base population of the female birds had significantly higher mean values while the first generation birds had the lowest mean values in all of the above female characters except in mean age, follicle number and ovary weight. Age of males at sexual maturity and weight of testis had the highest and second highest heritability, respectively. Among the females, egg weight had the highest heritability. Results of this paper seems to be suggest that selection for body weight may be effective where birds are 35 days old because the 35 days old birds had the highest response to selection, selection differential and heritability, irrespective of sex.

Key words: *Japanese quail, Sexual maturity, Reproductive performance, Generation, Heritability*

1. INTRODUCTION

The Japanese quails are economically important avian species which provide an alternative to the more commonly used chicken. They require less space and low initial investment and have good export potential. They belong to the genus *Coturnix*, family *Phasianidae* and order *Galliformes*
[1**].** They are gaining popularity as an experimental animal in research and education, mature early and highly efficient egg and meat producers.
Studies on the effect of chronological age, body weight and body composition on sexual maturity in quails revealed that their interaction with the onset of sexual maturity was generally inseparable **[**2, 3, 4 **]**. Japanese quails would reach their adipose threshold well before other physiologic systems involved in sexual maturation reach minimal stage of development needed for the onset of egg production **[**5, 7 **]**. Early sexual maturity promotes sufficient production and increase laying performance of the birds. The Japanese quail is a sexually dimorphic bird with females having a larger body size than males, unlike other poultry species; and females that require more time to reach sexual maturity than males **[**4**]**. The differences in growth pattern between the sexes are also a well- known phenomenon**[**8**]**. Sexual dimorphism is believed to evolve under the pressure of natural sexual selection, which implies that genes controlling sexually dimorphic characteristics differ between females and males**[**9**]** . Therefore, it has been suggested that genetic parameters for male and female Japanese quails be estimated separately **[**10,8**]** otherwise, it would be assumed that genetic correlations between male and female traits are equal; so also are the variances of both traits, which is not often the case.
Research reports by **[**11, 12, 13,14,15 and 16**]** on heritability of age at sexual maturity in female quails ranged from 0.11 to 0.42. However, in the males the heritability estimates for reproductive traits ranged from 0.28 to 0.31**[**17,18, 19, 16**].**

The heritability estimates of sexual maturity and some economic traits in the Japanese quail can give a complementary understanding of the evolutionary consequences of sexual dimorphism in live body weight of Japanese quails. This research therefore, was conducted in order to estimate the heritability of some reproductive traits in Japanese quail(*Coturnixcoturnix japonica*),so as to aid in the determination of the amount of improvement necessary to predict their response to selection in relation to age at sexual maturity in sex of Japanese quail.

The objectives of the study were to carry out significant tests among three generations of Japanese quails in 6 and 10 characters of male and female, respectivelyandto determine response to selection, selection differential and realized heritability for each of the above characters.

2. MATERIALS AND METHODS

One hundred Japanese quails aged 14 days were sourced from the National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria. These quails werethen taken to the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Samaru, Zaria, Kaduna State-Nigeria. Zaria is found within the Northern Guinea Savannah zone of Nigeria with a latitude of 11^0 12' N and longitude 7^0 33'E. The elevation above the sea level is 610m. Day season of the sea level is 610m. Dry season of the area begins around middle of October and ends in February with temperature ranging from 14^0c to 24^0C. This is followed by hot, dry weather from March to April with a temperatuire of 19 to 360C. Rainfall stands toward the end of April. The relative humidity varies between 19% to 60% in the dry season and between 63% and 80% in the wet season **[**20**]**.

The quails were place in 200 x 100cm cages. Each caged had 5 males and 5 females. There were 10 cages in total with a spacing of 20 x 10 cm each. Furthermore, each 5 were separated individually so that data can be collected on individual quail bases. This was done in three phases from January to October. There was supplementary heat for about 3 weeks with 24 hours lightening. Thereafter 16 hour light and 8 hours dark cycle used. The indoor temperature was 36^0C. The birds had ad libitum acess to food and water. They were fed with starter and grower diet containing 24% crude protein and 2904kcal/kg, ME up to 35 days of aged. Thereafter, they were fed with breeder diet containing 23% crude protein and 2800k, cal/kg ME.

Monitoring sexual maturity started when the birds were 35 days old when they were fully feathered. The females were considered matured when they dropped the first egg while the males were considered matured when they produced the first proctodeal gland. The following traits were recorded from each male bird:

- Testicular weight (g): Weight of testis at the beginning of proctodeal gland foam Production;
- pectoral major (g): recorded the weight of pectoral major.
- abdominal fat weight (g): The fat was obtained by removing the abdominal part of the bird and then extracting the fatin a soxhlet apparatus using petroleum ether as a solvent and then it. weight.
- The following characters were recorded from each female bird
- Body weight(g) one: recorded when the female birds were 35 days old.
- Body weight(g) two: recorded when the first egg was laid.
- Egg weight (g): The weight of first laid egg.
- Age in days: when the first egg was laid.
- Follicle number: This is the number of yellow follicles recorded when the females sexually matured.
- Follicle size (cm): This is the length of the follicle recorded when the birds were sexually matured, vernier was used to measure the length.
- oviduct weight (g) at sexual maturity: This was weight using digital weighing balance;
- ovary weight (g): This was weight using digital weighing balance;
- Pectoral major (g): This was weighted using digital weighing balance
- Abdominal fat weight (g): The fat was obtained by removing the abdominal part of the bird and then extracting the fatin a soxhlet apparatus using petroleum ether as a solvent and then it weight.

A. Mating plan

Paired mating was the plan adopted. Fertile eggs were obtained, hatch and the hatched birds were used to study the sexual maturity characteristics in the three generations monitored.

B. Management of Fertile Egg

The eggs were collected daily at 35, 42, 49 and 56 days of age for G_s around March, G_1 May and G_2 August. The various eggs were identified by their family groups (10), stored at room temperature lower than 20^0C and 65% relative humidity (RH) for a week, and then disinfected with tetra hydroxyl(TH4) mixed with 1 liter of water by spraying on egg surface. Pedigreed eggs were set in the setting trays, according to their sire families in a forced draft incubator of 37.5^oC and 65% RH. Eggs were turned automatically every three hours. At the end of the 14^{th} day of incubation, eggs were set in pedigreed baskets and transferred to the hatcher where the temperature was 37.5^o C and RH was 70%.

C. Incubation and Hatching of the Fertile Eggs

During the collection Pre-incubation of the fertile eggs collected was made for two weeks by storing them at a temperature of 15°C. Fumigation was done 12 hours before placing them in the incubator. When eggs were set in the incubator, temperature requirement was put at 37.5°C with humidity of 60% and turning of eggs was at 45° for 4-6 times a day and the chicks were hatched at day 18 of incubation.

D. Estimation of Genetic Traits

Realized Heritability

The selection intensity (i), selection response (R), realized heritability (h^2) of Japanese quail is as follows: Realized heritability denote as h^2= R/S/

S= Selection differential, i.e. the difference of mean phenotypic value between selected parents and the population mean.

R= Final population mean- parent, where both are measured before selection

. Statistical analysis

Data were analyzed using the General Linear Model (GLM) procedure of the Statistical Analysis System **[**21**]** using the following Modal:

Yij= μ + Si + eij

Where: Yij =Overall mean,

μ = record of the j^{th} progeny of the i^{th} generation,

Si = effect of the ithgeneration (i=0.1,2)

eij= residual error. Significant differences between means were ranked by using Duncan's Multiple Range Test **[**22**]**.

3. RESULTS

Mean values for the different characters of the males in each of the generations are presented inTable 1. The base population had the highest mean values followed by mean of generation two while generation one had significantly lower (P=0.05) mean values than the other two generations. This was true for all characters except for the average age of the male birds.

Table 1: Least square means for sexual maturity characteristics of males in Japanese quail by Generations (n=50)

Traits	G_s	G_1	G_2
	M±SE	M±SE	M±SE
Body weight at 35(d)	158.5±1.47[a]	136.6±1.32[b]	155.5±0.57[a]
Age at sexual maturity	37.9±0.45[b]	40.7±0.71[a]	39.6±0.69[a]
Body weight at sexual maturity (g)	169.4±1.10[a]	156.7±1.54[b]	169.0±0.60[a]
Testicular weight(g)	5.6±0.84[a]	3.1±0.18[c]	5.4±0.14[a]
Pectoral major weight(g)	69.2±1.71[a]	52.0±0.92[c]	62.8±1.49[b]
Abdominal fat weight (g)	3.9±0.06[a]	2.8±0.11[c]	3.3±0.06[b]

G_s = Base population; G_1= Generation one; G_2 = Generation two.

Mean values for the different characters of the females in each of the generations are presented in table 2. The base population had highest mean values followed by mean of generation two in all of the characters except in mean age of the female birds, follicle number and ovary weight. Generation one had the lowest mean value in all of the female characters (Table 2).

Table 2: Least square means and standard error for sexual maturity characteristics of females in Japanese quail by generations (n =50)

Traits	G_s	G_1	G_2	
	M±SE	M±SE	M±SE	
Body Weight at 35(d)	165.0±1.60[a]	150.7±1.43[b]	161.1±1.26[a]	
Age at Sexual Maturity	40.9±0.97[b]	42.3±0.95[a]	42.6±0.64[a]	
Body W(g) at sexual maturity	176.8±1.25[a]	162.4±1.39[c]	173.1±1.53[b]	
Egg Weight of first egg(g)	10.1±0.22[a]	7.4±0.22[b]	9.9±0.93[a]	
Follicle Number	75.5±0.53[a]	70.7±0.67[b]	71.8±0.47[b]	

Follicle weight (g)		8.4±0.25[a]	6.9±0.19[c]		7.7±0.26[b]	
Oviduct weight(g)		8.8±0.31[a]	5.7±0.23[c]		7.4±0.40[b]	
Ovary weight(g)		7.9±0.17[a]	4.2±0.23[b]		5.4±0.35[b]	
Pectoral major weight(g)		68.1±1.61[a]	63.2±1.54[c]		66.9±1.36[b]	
Abdominal fat weight(g)		3.5±0.04[a]	2.7±0.10[b]		3.4±0.04[a]	

G_s=Base population, G_1=Generation one; G_2= Generation two

Weight of testis had the highest response to selection, selection differential and second highest in heritability. On the other hand, age of male at sexual maturity had the lower response to selection, selection differential but the highest in heritability (Table 3).

Table 3: Heritability estimates of male sexual reproductive traits in Japanese quail at sexual maturity

Traits	Response to Selection	Selection Differentials	Realized h^2
	%	%	
Body weight 35d(g)	12.15	14.01	0.85
Age at sexual maturity(d)	-2.78	7.39	0.39
Body weight (g)	7.28	7.50	0.97
Testis Weight (g)	42.59	44.64	0.92
Pectoral Major Weight(g)	17.20	24.86	0.43
Abdominal fat Weight (g)	15.15	28.21	0.45

Among the females, pectoral major weight had the highest response to selection while weight of the oviduct had the highest selection differential. The female character with the highest heritability was egg weight (Table 4).

Table 4: Heritability estimates of female sexual reproductive traits in Japanese quail at sexual maturity

Traits	Response to Selection	Selection Differentials	Realized h^2
	%	%	
Body weight 35d(g)	6.46	8.67	0.73
Age (d)	0.70	-3.42	0.21
Body weight (g) at sexual	6.18	8.14	0.74
Egg weight (g)	26.26	27.73	0.96
Follicle number (n)	1.53	6.36	0.41
Follicle size (cm)	10.40	17.86	0.73
Oviduct weight (g)	22.97	235.22	0.55
Ovary weight (g)	22.52	34.12	0.44
Pectoral major Weight (g)	68.52	7.20	0.76
Abdominal fat weight (g)	20.59	22.85	0.88

Carcass weight of 35 days old birds had the highest response to selection, selection differential and heritability than carcass weight of birds which were 42, 49 or 56 days old (Table 5)

Table 5: Realized heritability of carcass weight of male in Japanese quail

Body weight at different ages	Response to Selection	Selection Differential	Realized h^2
	%	%	
35d Carcass Weight $_g$	14.08	25.61	0.48
42d Carcass Weight $_g$	5.15	16.09	0.28
49d Carcass Weight $_g$	3.76	14.33	0.23
56d Carcass Weight $_g$	5.67	14.87	0.34

The body weight at 35 days old birds had the highest response to selection, selection differential and heritability than body weight of birds which were 42, 49 or 56 days old except that body weight of females which were 56 days old had the highest heritability (Table 6).

Table 6: Realized heritability of live body weight of female Japanese quail

Body weight at different ages	Response to Selection %	Selection Differential %	Realized h^2
35d body Weight $_g$	14.84	23.31	0.57
42d body Weight $_g$	12.20	18.69	0.61
49d body Weight $_g$	7.33	12.82	0.54
56d body Weight $_g$	6.92	8.24	0.83

4. DISCUSSION

Male Sexual Maturity

The result for male sexual maturity in Japanese quail as shown in table 1 in this study differed significantly among generations, with 37.9, 40.7 and 39.6 day for base, first and second generation, respectively. The male age at sexual maturity was relatively shorter in the first generation than the base and second generation of selection. Birds of the first generation reached sexual maturity earlier than those of the base and second generation. Generally, generation of selection in this study show increased in body weight at day 35, age at sexual maturity, testicular weight pectoral major weight and abdominal fat weight. Selection base on high body weight most have necessitated improvement in reproductive performance of the Japanese quail. Similar studies were reported by Hussein, *et al*. **[**23**]**.

Similar studies on first day of egg laid was reported by Lilburn *et al*.**[**34**]** and Steigner*et al*. **[**25**]**, they stated that improvement on reproductive traits was influenced by dietary environment. However, selection for body weight in generations in these studies for sexual maturity was effective interms of increase in body weight in generations of bird; this might have altered some physiological relationships that are critical with respect to optimizing sexual development in terms of age. This finding is in agreement with finding of Reddish et al. **[**26**]**; Oruwari and Brody **[**3**]**, who stated that chronological age alone is not primary effectors of sexual maturity.

A. Female Sexual Maturity

The age at sexual maturity in female Japanese quail in this study differed significantly among generation selected, with 40.9, 42.3 and 42.6 day for the base, first and second, respectively as indicated in table 2. The values obtained in this study were lower than the 58.04, 54.32 and 42.56 days reported for base, first and second generation by Magda *et al*. **[**27**]**. The first generation of selection in this study had relatively shorter age at sexual maturity than the base and second generation. This suggested that selection for improvement in age at sexual maturity was more effective at the first generation of selection. This was contrary to the findings of Magda *et al*. **[**27**]**who reported shorter age at sexual maturity in the second generation of selection in females. Other researchers also reported significant variation in age at sexual maturity across generations of selection**[**28**]**. Body weight at 35 day and weight at onset of sexual maturity are hypothesis that said growth and sexual development are process that occurs overtime, and a single body weight is not necessarily reflective of the entire growth increment. This agreed with Oruwari and Brody **[**3**]**who stated that the relationships between chronological age, body weight, body composition and sexual maturity are complex. Other studies**[**7,8**]** have also shown that fat deposition is an important factor in the process of sexual maturation.

Selection for body weight in quail for this study enable the birds to reach their adipose threshold well before other physiological systems involved in sexual maturation reached the minimal stage of development needed for the onset. This is similar to the concept of multiple thresholds **[**7**]**in which body weight and some selected aspects of body composition must exceed a threshold value in order for sexual development to proceed **[**5,6**]**The significant differences between sexual maturity and reproductive traits are far ranging than simple effects of selection. This emphasis the fact that caution must be used when trying to understand a complex process such as sexual development and when measurements are taken from a single group of animals.

The mean body weight for birds at first egg for base, first and second generations in this studied were 154.64, 150.02 and 135.61g, respectively.Aboul-Seoul**[**29**]**reported that base on selection on high egg weight found an irregular selection response averaging 12.24, 11.59 and 10.06g in the first, second and third generation. This irregularity of the selection response has been observed in many selection experiments reported in literature. Differences in natural selection differential, fertility and/ or genetic environmental interactions might likely be the cause of such irregularities in

selection response[29]especially in small numbers of generations as it was in the case for the present study.

B. Realized Heritability for Male Sexual Maturity

The realized heritability values for male sexual reproductive traits in Japanese quail indicated in table 3. The realized heritability for body weight 35d, age at sexual maturity, body weight, Testicular weight, pectoral major weight and abdominal fat weight ranges between moderate to high (0.39 – 0.97). There is scanty information on male sexual maturity in poultry. However, Kawahara and Saito [34] stated h^2 value for testis weight in male Japanese quail value to be 0.73. The moderate to high heritability obtained in this study may be as a result of some non additive genetic effect and environmental factors that might has influence the traits, therefore selection for high body weight can salvage the situation.

C. Realized Heritability for Female Sexual Maturity

The realized h^2 estimates of female sexual maturity and some reproductive traits in Japanese quail are shown in table 4. The h^2 values for all the traits were high (0.41 – 0.96) except age at sexual maturity which h^2 value was low 0.21. Similar reports on low $h^2$for age at sexual maturity (15, 30 and 30). But high h^2 values than this finding were reported by El – Fiky[17] to be 0.42. The h^2 for egg weight at sexual maturity which is high 0.96 in this studied agreed with the finding of Strong *et al.* [32],(32) and Farahat[33] who reported 0.78 but disagreed with El –Full [30]that reported low h^2 estimate of egg weight at sexual maturity to be 0.0001 and Daikwo[31]who also reported 0.04 for same traits.The low h^2 values in age of Japanese quail at sexual maturity appears that additive genetic effects were controlling the traits have not been seriously tempered by environmental and non additive genetic factors. The high h^2 values recorded for the other traits suggest that improvement may be rapid using random selection base on high body weight. However, differences in heritability estimates for different populations can be expected since heritability is a property of the population and the size or the magnitude of the estimate is highly affected by such factors as selection, environmental deviations and method of estimation. The heritability for oviduct weight of female Japanese quail was 0.54 as stated by Kawahara and Saito [4].

D. Realized Heritability of Carcass weight of Male Japanese Quail

The realized heritability of carcass traits in male as indicated in table 5 shows that at day 35, 42, 49 and 56 theh^2were moderate (0.23 – 0.34) except day 35 which heritability was high (0.48), theh^2 value was the same with finding of Daikwo*et al.* [31]who stated that heritability estimates of carcass traits derived from the sire variance components in Japanese quail carcass weight is 0.42. The h^2 values of carcass weight in this study were lower than the h^2 estimates of 0.51 and 0.54 obtained in quailsbySoliman[35], respectively. Therefore heritability of carcass weight of male Japanese quail at day 49 was genetically associated with selection for higher body weight. That indicated that possibly the genes that increase body weight would tend to be inherited than day 42 and 34. The high h^2 value at day 35 (0.48) shows that quails are affected by environment and possibly managerial factors. In study conducted by Vali*et al.* [36]discovered the h^2 of carcass weight of male Japanese quail to be 0.27 at day 49. The moderate h^2 indicated that environment and non additive genetic factors might have influence the carcass weight at day 49 therefore continues selection will be the option.

E. Realized Heritability of Female Body weight in Japanese Quail

The realized h^2 of femalebody weight in Japanese quail is shown in table 6. It was realized that the h^2 values were higher, 0.57, 0.61, 0.54 and 0.83 for body weight at day 35, 42, 49 and 56, respectively. This is similar to findings of Vali*et al.* [37] and Resende*et al.* [36]who reported that heritability estimates increases with age in Japanese quail and broiler chicken; and Momoh*et al.* [38], who reported increasing heritability estimate with age in domestic pigeon. Caron and Minvielle[39]reported h^2 for body weight at day 45 to be low 0.13. Saatci*et al.* [40]and Akbas*et al.* [41], reported the h^2 estimates as 0.15 and 0.44, respectively. The female body weight in Japanese quail h^2 value was 0.85 as reported by Baumgartner[42]. High heritable in quails, 0.71, 0.67, 0.71, 0.64 and 0,62 are reported Ahuja*et al.* (43), El-fiky[44], Sharaf[44] and Solima[35].

5. CONCLUSION AND RECOMMENDATIONS

The sexual maturity characteristics of male and female Japanese quail affect the generations selected and as the birds advances in age the realized heritability obtained ranged from moderate to high based on selection for high body weight on age at sexual maturity which indicates that response to selection for age at sexual maturity could be rapid. The low heritability estimates were noticed in testicular weight, pectoral major weight and abdominal fat weight whichthey imply that response to selection could be slow. It is recommended that selection base on high body weight to improve on most of the traits of birds when they attain early sexual maturity in sexes of Japanese quails should be carried out at early generations of selection(first generation).

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REFERENCE

[1]. Ajay- kumar, S.B. Verma, M.M. and Mandal, K.G,'' Effect of sex on body weight and conformation traits in selected and control lines of Japanse quail''. Indian Vet. Journ. 77: 325-327,2000.

[2]. Siegel, H.S, '' Gordon Memorial Lecture. Stress, strains and resistance''. British Poult. Sci., 36:3-22, 1985.

[3]. Oruwari, B. M., and T. Brody, '' Roles of age, body weight, and composition in the initiation of sexual maturation of Japanese quail (*Coturnixcoturnix japonica*)'' Br. Poult. Sci., 29:481–488, 1988.

[4]. Reddish, J. M. , K. E. Nestor and M. S. Lilburn,''http://www.ncbi.nlm.nih.gov/pubmed/12619793'', Poult. Sci. **82**, 187, 2003.

[5]. Dunnington, E. A., and P. B. Siegel, '' Age and body weight at sexual maturity in female White Leghorn chickens''.Poult. Sci., 63:828–830, 1984.

[6]. Soller, M., T. Brody, Y. Eitan, T. Agursky, and C. Wexler, ''Minimum weight for onset of sexual maturity in female chickens: Heritability and phenotypic and genetic correlations with early growth rate'' .Poult. Sci., 63:2103–2113, 1984.

[7]. Zelenka, D. J., J. A. Cherry, I. Nir, and P. B. Siegel, ''Body weight and composition of Japanese quail (*Coturnixcoturnixjaponica*) at sexual maturity''. Poult. Sci., 48:16–28. 1984.

[8]. Sezer, M. and S. Tarhan, ''Model parameters of growth curves of three meat –type lines of Japanese quail'' Czech J. Anim Sci., 50: 22-30. 2005.

[9]. Mignon- GrasteaU, S., David, J., Gilbert, P., Legout, G., Petavy, G., Morelau, B. and Beaumont, C., ''REML estimates of genetic parameters of sexual dimorphism for wing and thorax length in Drosphila melanogaster.'' Journ. of Genet., 83: 163-170, 2004.

[10]. Sefion, A.E. & Siegel, P.B, ''Inheritance of body weight in Japanese quail''Poult. Sci., 53, 1597-1603, 1974.

[11]. Marks, H. L., and T. B. Kinney, Jr., ''Estimates of some genetic parameters in Coturnix quail.''Poult. Sci., 43:1338. 1964 (Abstr.)

[12]. Wilhelmson, M, ''Breeding experiments with Japanese quail . 1- The synthesis of random mated population'' . Report 39,Swedish Univ. Agric.Set. 1979.

[13]. Bahie El-Deen, M. ''Selection and correlated response for dressing percentage in Japanese quail''. M. Sc. Thesis, Fac. Agric., Alex. Univ., Egypt, 1991.

[14]. Aboul-Hassan, M. A. ''Selection for high egg production in Japanese quail : Direct and correlated responses''. Al–Azhar J. Agric. Res. 34 : 25-40, 2001.

[15]. Abdel-Mounsef, N.A. ''Non-genetic Factors Affecting some Productive Traits in Japanese Quail''. MSc. Thesis Fac. of Agric. Al-Azhar Univ. Cairo Egypt. 66pp. 2005.

[16]. Sezer, M., E.Berberoglu and Z. Ulutas,''Genetic association between sexual maturity and weekly live- weights in laying – type Japanese quail.'' S. Afr. J. Anim. Sci., 36:142-148, 2006.

[17]. El-Fiky, F.A.,''Genetic Studies of some Economic Traits in Japanese Quail''. Ph.D. Thesis, Fac. Agric. Al-Azhar Univ. Cairo, Egypt. 156Pp. 1991.

[18]. Bahie El-Deen M. ''Selection Indices and Crossing as a Tool for improving Meat and Egg Production in Japanese Quail''. Ph. D. Thesis Faculty of Agric. Alexandria Univ,. Egypt.138 pp. 1994.

[19]. Shebl, M. K., Bahie El-Deen, M. and Kosba, M. A., ''Selection for 6 weeks body weight in Japanese quail – Direct and correlated responses''.Egypt. Poult . Sci. 16:703-723.1996.

[20]. Akpa, G.N., Asiribo, O.E., Oni., O.O., Alawa, J.P., Dim. N.I., Osinowo, O.A. and Abubakar, B.Y, ''Milik production agrospastoral red sokoto goats in Nigeria''. Tropical Anim. Hlth. and prod., 34(6): 523-533, 2002.

[21]. SAS,'' Statistical Analysis system, user's guide: statistics ''8. 6ed. SAS's Institute Inc. carry, North Carolina USA,2002.

[22]. Duncan, D.B. ''Multiple Range and multiple F Test''. Biometrics., 11:1-42, 1955.

[23]. Hussein, J., M. Akram,A.W. Sahota, k., Javed., H.A. Ahmad., S. Mehmood., S. Ahmad., R. Sulaman, I. Rabbani and A.S. Jatoi, ''Selection for higher three week body weight in Japanese quail: 1. Effect on growth performance: Journ. Anim& Plant Sci., 23 (6): 1496-1500, 2013.

[24]. Lilburn, M. S., J. W. Steigner, and K. E. Nestor, ''The influence of dietary protein on carcass composition and sexual maturity in a randombred population of Japanese quail (R1) and a sub line of R1 selected for increased body weight. Comp''. Biochem. Physiol., 102A:385–388, 1992.

[25]. Steigner, J. W., K. E. Nestor, and M. S. Lilburn., '' Growth anddevelopment of lines of Japanese quail (Coturnixcoturnixjaponica) divergently selected for body weight at 4 weeks of age''. Comp. Biochem. Physiol., 102:389–393. 1992.

[26]. Reddish, J.M., Nestor, K.E. and Lilburn, M.S. ''The effect of selection for growth on onset of sexual

maturity in Random bred and growth-selected lines of Japanese quail'' .Poult. Sc., 82;187-191. 2002.

[27]. Magda I, Abo Samaha, Sharaf MM, HemedaShA, Phenotypic And Genetic Estimates Of Some Productive And Reproductive Traits In Japanese Quails. Egypt. Poult. Sci., 30 (3): 875-892. 2010.

[28]. Yannakopoulos, A. L., E. Christaki, and P. Florou-Paneri, Effect of age and carcase composition on the onset of sexual maturity in quail under normal feeding regimens. Poult. Sci. 36:771–777, 1995.

[29]. Aboul-Seoud,Divergent Selection for Growth and Egg Production Traits in Japanese quail. Ph.D Thesis Animal Production Department, Faculty of Agriculture, Al-Azhar University. 198pp, 2008.

[30]. EL-Full, E.A., Ali, A. A., Abdel-Fattah, M. H. &Khalifa, M.A, ''Genetic parameters of some carcass characteristics and chemical composition in Japanese quail''. Egypt. Poult. Sci., 21:741-763. 2001.

[31]. Daikwo, I.S., ''Genetic Studies on Japanese Quail (Coturnixcoturnix japonica) in a Tropical Environment''. Ph.D. Thesis, College of Animal Science, University of Agriculture Makurdi, Nigeria. 167Pp, 2011.

[32]. Strong CF Jr., Nestor KE and Bacon W L, ''Inheritance of egg production, eggweight, body weight and certain plasma constituents in coturnix''. Poult. Sci., 57:1-9, 1978.

[33]. Farahat, G. S. '' Estimation of some Genetic and Phenotypic Parameters for Growth and Reproductive Traits of Japanese Quail''. M.Sc. Thesis, Fac, Agric. Fayoun, Cairo Univ. Egypt.98 pp. 1998

[34]. Kawahara, T. & Saito, K. ''Genetic parameters of organ and body weight in the Japanese quail''. Poult. Sci., 55: 1247-1252. 1976.

[35]. Soliman, F.N.K. Genetic parameters for carcass traits of Japanese quail at 56 days of age. Egyptian Poult. Sci., 12, 233-247, 1992.

[36]. Vali, N., M.A. Edriss and H.R. Rahmani, '' Genetic parameters of body and some carcass traits in two quail strains''. Int. J. Poult. Sci., 4:296-300, 2005.

[37]. Resende, R. O., E.N. Martins and P. C. Georg, E.Paiva and A. C. M. Corti, Variance components for body weight in Japanese quails (Coturnixcoturnix japonica). Rev. Bras. CienciaAvicola., 7: 23-25, 2005.

[38]. Momoh, O.M. Anebi, P.E. and Carew, S.N., Heritability estimates and phenotypic correlations of body and egg traits of domestic pigeon (Colombaliviadomestica) reared On-station in Benue State of Nigeria. Res. Opin. Anim. Vet. Sci., 3(10), 370- 373, 2013.

[39]. Caron, N., F. Minvielle, M. Desmarais and L. M. Poste ''Mass selection for 45- day body weight in Japanese quail. Selection response, Carcass composition, cooking loss properties and sensory characteristics,'' Poult. Sci, 69:1037- 1045. 1990.

[40]. Saatci, M. H. Omed and I. A. Dewi, ''Genetic parameters from univariate and bivariate analysis of egg and weight traits in Japanse quail''. Poult. Sci., 85:185-190, 2006.

[41]. Akbas, Y., C. Takma and E. Yaylak, ''Genetic parameters for quail body weights using a random regression model''. S. Afr. J. Anim. Sci, 34: 104-109, 2004.

[42]. Baumgartner, J. ''Japanese quail production, breeding and genetics''. World's Poult. Sci., 50: 227-235. 1994.

[43]. Ahuja, S.D., Dutta, O.P., Agarwa, S.K. and Kataria, M.C. Genetic parameter estimates of slaughter traits in Japanese quail. Avian research 67:9-12. 1983.

[44]. Sharaf, M. M. ''Genetic and nongenetic estimates of some reproductive and productive traits in Japanese quail''. Egypt. Poult. Sci. 12: 211-231, 1992.

