



GROWTH RESPONSES TO SELECTION FOR HIGH BODY WEIGHT IN MEAT LINE OF JAPANESE QUAIL

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ABSTRACT: The main objectives of the present study were to estimate the direct response to individual selection for high body weight at six weeks of age (BW_6) with estimated the realized heritability of BW_6 from two successive selected generations of this line. Besides that, estimate the correlated responses for other growth traits in meat line of Japanese quail. The results were obtained from this work; the means of body weight at different ages for selected line were higher than for control line with highly significant differences in both selected generations. with respect to generation, the results were shown the heaviest body weight at all different ages in the second generation and the lightest in the base with highly significant differences. The results revealed improving of daily weight gain during different periods for selected line in both selected generations compared control line with significant differences. Among generations, the daily weight gains during all different periods of second selected generation were the highest than the rest of generations with highly significant differences. Direct selection response of BW_6 was in the first generation (16.76 g). However, selection response decreases in the second generation (5.97 g). Finally of two selected generations, the body weight at 6 weeks of age increased by 22.73 g. for selected line comparing with control line. Also, the selection for BW_6 had positive correlated responses on body weight at hatch, 2 and 4 weeks of ages. The daily weight gains have improved after two generations of BW_6 selection by 0.41, 0.67, 0.50 and 0.53 g/d during 0 (hatch) – 2, 2 – 4, 4 – 6 and 0 – 6 weeks of ages, respectively. It can conclude that the results of selection for high body weight at 6 weeks of age was caused improvement body weight at the same age and also improvements both of body weight at different ages and daily weight gain during different periods of quail growth stage. Moreover, these improvements were higher in the first generation of selection than the second.

Key words: Selection, Growth traits, Direct and correlated response, Quails

INTRODUCTION

Recently, Japanese quails (*Coturnix Coturnix Japonica*) have been recommended as a good alternative source of animal protein. Quail strains of meat and/or eggs have become increasingly popular all over the world. In comparison with many sources of animal protein, Japanese quail has many desirable traits such as fast growth, early sexual maturity, high egg production and short generation interval therefore it showed quick response to selection (Alkan *et al.*, 2010). On the other hand, characterizes of population are differing from farm to others and these trait are deteriorated rapidly. Growth can be improved by improving environmental influences such as diet, housing and management which differ by choosing the suitable mating system, sex ratio and parental age (Parks, 1971). While, for improving its genotypic value were by selection and/or by crossing.

Body weight at 6 weeks of age is considered as a marking age of meat quails, also it is the age to begin laying eggs (Yalcin *et al.*, 1995). Body weight at marketing age and egg production are considered the most important economic traits of Japanese quail which are influenced by a complex genetic structure and environmental factors (Narinc *et al.*, 2013). Moreover, the majority of the selection studies on quail have been conducted on meat production (Shahin *et al.*, 2000, Abdel Fattah, 2006, Hussen *et al.*, 2016 and El-Attrouny *et al.*, 2020).

In selection studies, the value of selection response influenced by the genetic correlation between selection criterion and other traits ,the heritability of tested traits and either sign or strength of the genetic covariance among them (Jensen

et al., 2003). Positive genetic correlations among body weight at 42 days of age and other body weights at different ages were found (Abdel Fattah, 2006).

Several selection experiments indicated that the correlated response for unselected characteristics showed a positive correlation for increasing all body weight at different ages (El-Attrouny *et al.*, 2020) and body weight gain during different periods (Ayatollahi Mehrgardi, 2013, Varkoohi and Kaviani, 2014, Hussen *et al.*, 2016 and El-Attrouny *et al.*, 2020).

The main objectives of the present study were to estimate the direct response of selection for high body weight at 6 weeks of age with estimate the realized heritability of body weight at 6 weeks of age for this line from the selected experiment. Besides that, estimate the correlated responses for other growth traits in meat line of Japanese quail.

MATERIALS AND METHODS

This study was conducted at the Poultry Production Department, Faculty of Agriculture, Alexandria University which selected quails for high body weight at 6 weeks of age during two successive generations. Finally, direct and correlated responses for the growth performance in this meat line of Japanese quail were estimated.

Selection Program

Throughout a selection experiment, a total of 2855 quails as a base population were obtained from this random mating which pedigree and weighted individual biweekly from one-day to 6-week of age, then divided into two groups (75% of selected line and 25% of control line). Individual (phenotypic) selected for 140 sirs and 280 dams of selected line (SL) by high body weight at 6-week of age (BW₆)

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as a criterion of two successive generation, while the control line (CL) was kept under random mating without selection for two successive generations.

Studied Traits

The following growth traits were recorded:

1. Body weight (BW) at different ages:

Body weights for each bird in grams at 0 (hatch), 2, 4 and 6 weeks of ages were recorded.

2. Daily weight gain (DWG) during different period:

Daily weight gain through the periods from hatch to 2 (0-2), 2- 4, 4- 6 and 0-6 weeks of age were calculated as follows:

Daily weight gain = $(W_2 - W_1)/\text{period}$

Where:

W_1 = weight at the beginning of the period.

W_2 = weight at the end of the period.

Statistical analysis:

Data of BW at different ages, daily weight gains during different periods were analyzed using (SAS,1992) for statistical analysis program, all percentage data were transformed to their corresponding arcsine angles according to Sndecor and Cochran (1981) before analysis. The significant tests for the differences between each two means for any studied trait were done according to Duncan (1955). Two different statistical models were used as follows:

$$Y_{ijk} = \mu + G_i + L_j + G_i \times L_j + e_{ijk}$$

Where:

Y_{ijk} : is the observation on the l^{th} individual,

μ : is the overall mean,

G_i : is the fixed effect of the generation,

L_j : is the fixed effect of the line,

$G_i \times L_j$: the effect of interaction of the i^{th} generation with the j^{th} line

e_{ijk} : is the random error

Selection parameters:

Selection parameters for direct selection and correlated responses were measured in the present study for the two selected generation as following (Falconer, 1989).

1. Selection differential (SD):

The magnitude of the selection differential depends on two factors, the proportion of the population included among the selected group and the phenotypic standard deviation of the character. Selection differential at two selection generations was obtained according to Falconer (1989) as follows:

$$SD = X_p - X_0$$

Where, X_p : the selected parents' mean , and X_0 : the population mean.

2. Selection intensity (i):

Selection intensity in standard units through different generations of selection was calculated according to Falconer (1989) as follows:

$$i = SD / \delta_p$$

Where, SD : the selection differential, and δ_p : the phenotypic standard deviation of the trait.

3. Selection response (R):

The actual response of selection for high body weight at 6 wks of age and correlated responses for other studies traits which we did not selected for them from generation to generation was estimated according to Guill and Washburn (1974) as follows.

$R = (\text{Means of selected progeny} - \text{Means of previous selected population}) - (\text{Means of control progeny} - \text{Means of previous control population})$

4. Realized heritability (h^2_r):

The realized heritability (h^2_r) was estimated from selected experimental according to Falconer (1989) as follows:

$$h^2_r = R / SD$$

where, R: actual response of selection, and

SD: the selection differential of previous generation.

RESULTS AND DISCUSSION

Body weight at different ages (BW):

Least squares means and standard errors for body weight at hatch, 2, 4, and 6 wks of ages for control and selected lines of Japanese quail during base and two generations of selection for BW₆ are presented in Table (1). The means of body weight at different ages for selected line were higher than control line with highly significant differences in both selected generations. In first generation the different between selected line and control line were 0.83, 5.59, 11.41 and 16.76 g. for BW₀, BW₂, BW₄ and BW₆, respectively. The corresponding values in second generation were 0.54, 6.36, 15.69 and 22.73, respectively.

Similarly, selected lines in the literature for BW at different ages had significantly heavier BW's than the CL (Khalidari *et al.*, 2010, Abou Khadiga *et al.*, 2014, Taskin *et al.*, 2017 and El-Attrouny *et al.*, 2020). These differences increased in second selected generation for all body weight expect body weight at hatch.

In respect of generation, the results shown the heaviest body weight at all different ages in the second generation and the lightest in the base with highly significant differences. These results may be caused by environmental and management improvements. Similarly there were significant differences due to generation effect for BW's days (Emam, 2015, Meabed, 2015 and Semida *et al.*, 2019).

Daily weight gain during different periods:

Least squares means and standard errors for daily weight gain during hatch (0) - 2, 2 - 4, 4 - 6 and 0 - 6 wks of ages for control and selected lines of Japanese

quail during base and two generations of selection for BW₆ are presented in Table (2). These results are shown improving of daily weight gain during different periods for selected line in both selected generations compare by control line with significant differences. These improvements may be due to selection process for BW₆.

Generally among generations, the daily weight gains during all different periods of second selected generation were the highest than the rest of generations with highly significant differences. Also, the daily weight gains during different periods of first generation were higher than the base generation. These previous results may be due to improve of environmental and management conditions for flocks which were accompanying with improvement of selected line from generation to another. In agreement with the current findings, El-Attrouny *et al.*, (2020) reported that generalized least squares estimates of the selection for the four generations were superior ($P < 0.05$) for most BW and BWG comparing with the base population.

Selection body weight at 6 weeks of age:

Least square means for body weight at 6 weeks of age (BW₆) of control and selected lines and some parameters of selection during base and two generations of selection are presented and calculated in Table (3). The selected parents were 263.7 and 292.7 g. for base and first generation, respectively which choice from selected line. The high selection differential (37.12 g) calculated in the base generation allow to increase selection response in the first generation (16.76 g). In the next generation, selection differential was 28.63 g (lower

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than SD of base generation), so the response to selection in the second generation was decreased (5.97 g). These results were proving by increase selection intensity of base generation (1.25 units) that of the first generation (0.83 units). The cumulative response of the two selected generations was 22.73 g. according to Guill and Washburn (1974). From these results, we can estimate the realized heritability which found 0.45 and 0.21 for first and second selected generation. These previous findings indicated that high actual genetic gain of the first selected generation and then decreased in the second selected generation which reflected at high h^2_r estimate (0.45) of BW_6 at first generation and moderate h^2_r estimate (0.21) at next generation. These results may be due to decrease the genetic variance from G_1 to G_2 which expected in selection experimental. These results agreed with Marks, 1975 in quails who found that the rapid genetic improvement was occurred during the early generations, however in later ones, improving appeared to be diminished. These results found in the quails more than in the other avian species. h^2 estimates of BW were increased with the advancement of age of Japanese quail (Saatci *et al.*, 2003, Nasiri Foomani *et al.*, 2014, and Karami *et al.*, 2017), Conversely, h^2 for BW_6 was moderate (0.22) as reported by El-Attrouny *et al.*, (2020).

This increased direct selection response in the selected generations showed the efficiency of selection for BW at 6 weeks of age. The estimation of selection responses were necessary for the assessment of the breeding programs. The results in this work, were disagreed with those of Hussain *et al.*, (2014) and El-Attrouny *et al.*, (2020), who found a

linear increasing trend of selection criterion in selected populations as the generations advanced.

Correlated growth responses to selection for body weight at 6 weeks of age:

The correlated responses for body weight at 0 (hatch), 2 and 4 weeks of ages at first and second generations and the cumulative of both generations of selection for BW_6 were calculated in Table (4). There is a positive impact on body weight at different ages of each generation expect BW_0 at the second generation due to selection for BW_6 . The increases of body weight in first selection were higher than the second generation for all studied ages. Generally, there are increased in body weight at 0, 2, 4 weeks of ages by 0.54, 6.36 and 15.69 g., respectively after two generations of selection for BW_6 These results indicated that the selection for BW_6 had positive responses on body weight at hatch, 2 and 4 weeks of ages. The present results of the studied correlated estimates for BW and BWG traits were in the range of reviewed studies (Abdel Fattah, 2006, Ayatollahi Mehrgardi, 2013; Varkoohi and Kaviani, 2014; Hussien *et al.*, 2016 and El-Attrouny *et al.*, 2020).

The correlated responses for daily weight gain during 0 (hatch) – 2, 2 – 4, 4 – 6 and 0 – 6 weeks of ages at first and second generations and the cumulative of both generations of selection for BW_6 were calculated in Table (5). The same trends of body weight at different age were found in daily weight gain during different periods at both selected generations. So, we found that the improvements of daily weight gain during different periods at first generation were higher than the second generation of selection. Generally, the daily weight

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gains were improved after selection of two generations by 0.41, 0.67, 0.50 and 0.53 g/d during 0 (hatch) – 2, 2 – 4, 4 - 6 and 0 – 6 weeks of ages, respectively. A similar trend was observed for the magnitude of correlated responses to selection for body weights at different ages and body weight gain during different periods decreased with the advance of generations (Ayatollahi Mehrgardi, 2013, Varkoohi and Kaviani,

2014, Hussen *et al.*, 2016 and El-Attrouny *et al.*, 2020).

It can conculcated that the results of selection for body weight at 6 weeks of age had positive responses on body weight at different ages and daily weight gain during different periods of quail growth period. Moreover, these improvements were higher in the first generation of selection than the second one.

Table (1) : Least Squares Means ± SE for body weight (g) at 0 (hatch), 2, 4 and 6 weeks of age for selected and control lines of experimental generations.

S. O. V	LSM ± SE			
	BW0	BW2	BW4	BW6
Base	8.96 ± 0.05	50.86 ± 0.62	161.04 ± 1.05	226.58 ± 1.45
Line				
CL ₁	8.41 ^b ± 0.26	65.61 ^b ± 3.13	170.71 ^b ± 5.64	247.31 ^b ± 7.23
SL ₁	9.24 ^a ± 0.25	71.20 ^a ± 3.12	182.12 ^a ± 5.60	264.07 ^a ± 7.18
Difference :	0.83	5.59	11.41	16.76
Level of significance	***	***	***	***
Line				
CL ₂	9.05 ^b ± 0.07	75.53 ^b ± 0.74	181.25 ^b ± 1.27	247.12 ^b ± 1.69
SL ₂	9.59 ^a ± 0.05	81.89 ^a ± 0.49	196.94 ^a ± 0.84	269.85 ^a ± 1.11
Difference :	0.54	6.36	15.69	22.73
Level of significance	***	***	***	***
Generation				
Base	8.96 ^c ± 0.05	50.86 ^c ± 0.62	161.04 ^c ± 1.05	226.58 ^c ± 1.45
G ₁	9.15 ^b ± 0.05	70.94 ^b ± 0.59	177.20 ^b ± 1.00	255.09 ^b ± 1.38
G ₂	9.59 ^a ± 0.04	81.67 ^a ± 0.54	197.24 ^a ± 0.92	270.56 ^a ± 1.27
Level of significance	***	***	***	***
GxL	***	***	***	***

CL : Control line, SL: selected line for high body weight at 6 weeks of age, BW₀, BW₂, BW₄ and BW₆ : Body weights at hatch, 2 , 4 and 6 weeks of ages, GxL: Interaction significance between generation and line, ***: significance at 0.001

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Table (2) : Least Squares Means \pm SE for daily weight gain (g/d) during different periods for selected and control lines of experimental generations:

S. O. V	LSM \pm SE			
	DWG 02	DWG 24	DWG 46	DWG 06
Base	2.99 \pm 0.04	7.87 \pm 0.06	4.68 \pm 0.10	5.18 \pm 0.03
Line				
CL ₁	4.09 ^b \pm 0.22	7.51 ^b \pm 0.30	5.47 ^b \pm 0.49	5.69 ^b \pm 0.17
SL ₁	4.43 ^a \pm 0.22	7.92 ^a \pm 0.30	5.85 ^a \pm 0.48	6.07 ^a \pm 0.17
Level of significance	***	***	**	***
Line				
CL ₂	4.75 ^b \pm 0.05	7.55 ^b \pm 0.06	4.71 ^b \pm 0.09	5.67 ^b \pm 0.04
SL ₂	5.16 ^a \pm 0.03	8.22 ^a \pm 0.04	5.21 ^a \pm 0.06	6.20 ^a \pm 0.03
Level of significance	***	***	***	***
Generation				
Base	2.99 ^c \pm 0.04	7.87 ^b \pm 0.06	4.68 ^c \pm 0.10	5.18 ^c \pm 0.03
G ₁	4.41 ^b \pm 0.04	7.59 ^c \pm 0.06	5.56 ^a \pm 0.09	5.86 ^b \pm 0.03
G ₂	5.15 ^a \pm 0.04	8.26 ^a \pm 0.05	5.24 ^b \pm 0.09	6.21 ^a \pm 0.03
Level of significance	***	***	***	***
GxL	***	***	***	***

CL : Control line, SL: selected line for high body weight at 6 weeks of age, DWG 02, DWG 24, DWG 46 and DWG 06: Daily weight gain through the periods from hatch to 2 (0-2), 2-4 , 4-6 and 0-6 weeks of age, GxL: Interaction significance between generation and line, ** and***: significance at 0.01 and 0.001, respectively.

Table (3): Least square means for body weight at 6 weeks of age of control and selected lines, selection differential, selection intensity, direct selection response and realized heritability of selection experimental.

Generations	Control line	Selected line	Selected parents	Selection differential	Selection intensity	Selection response	Realized heritability
Base	226.58	226.58	263.7	37.12	1.25	-	-
G ₁	247.31	264.07	292.7	28.63	0.83	16.76	0.45
G ₂	247.12	269.85	-	-	-	5.97	0.21
Cumulative				65.75	-	22.73	0.35

Table (4) : Correlated and cumulative responses for body weight (g) at different ages of experimental generations.

Traits	Generations	Correlated responses (g)	Cumulative responses (g)
BW ₀	G1	0.83	0.54
	G2	-0.29	
BW ₂	G1	5.59	6.36
	G2	0.77	
BW ₄	G1	11.41	15.69
	G2	4.28	

BW₀, BW₂ and BW₄: Body weights at hatch, 2 and 4 weeks of ages.

Table (5): Correlated and cumulative responses for daily weight gain (g/d) during different periods of experimental generations.

Traits	Generations	Correlated responses (g/d)	Cumulative responses (g/d)
DWG 02	G1	0.34	0.41
	G2	0.07	
DWG 24	G1	0.41	0.67
	G2	0.26	
DWG 46	G1	0.38	0.50
	G2	0.12	
DWG 06	G1	0.38	0.53
	G2	0.15	

DWG 02, DWG 24, DWG 46 and DWG 06: Daily weight gain through the periods from hatch to 2 (0-2), 2-4 , 4-6 and 0-6 weeks of age,

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الملخص العربي

استجابات النمو للإنتخاب لوزن الجسم العالى فى خط لحم من السمان اليابانى

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الهدف الأساسى من الدراسة الحالية هو تقدير الإستجابة المباشرة من الإنتخاب الفردى لوزن الجسم العالى عند عمر ٦ أسابيع مع تقدير المكافئ الوراثى المحقق لصفة BW_6 لجيلين متتاليين من الإنتخاب لهذا الخط. بالإضافة لهذا، يتم تقدير الإستجابة المرتبطة لصفات النمو الأخرى لخط اللحم المنتخب من السمان اليابانى. النتائج المتحصل عليها من هذه الدراسة، كانت متوسط أوزان الجسم عند الأعمار المختلفة للخط المنتخب أعلى من الخط المقارن بفروق معنوية عالية فى جيلين الإنتخاب. فيما يتعلق بالأجيال، أظهرت النتائج أن أوزان الجيل الثانى كانت الأثقل فى وزن الجسم عند الأعمار المختلفة وكانت أوزان الجيل الأساسى الأخف وزنا مع وجود فروق معنوية عالية. أظهرت النتائج تحسن فى معدل زيادة وزن الجسم اليومية خلال الفترات المختلفة فى الخط المنتخب بالمقارنة بالخط المقارن مع وجود فروق معنوية. بين الأجيال، كان معدلات زيادة وزن الجسم اليومية خلال الفترات المختلفة فى الجيل الثانى من الإنتخاب أعلى بفروق معنوية عالية عن باقى الأجيال. كانت الإستجابة المباشرة للإنتخاب لصفة BW_6 فى الجيل الأول ١٦,٧٦ جرام. بينما قلت الإستجابة للإنتخاب فى الجيل الثانى إلى ٥,٩٧ جرام. فى نهاية جيلين الإنتخاب كانت زيادة وزن الجسم عند عمر ٦ أسابيع ٢٢,٧٣ جرام فى الخط المنتخب عن الخط المقارن. أيضا كان الإنتخاب لصفة BW_6 له استجابة مرتبطة موجبة على وزن الجسم عند التفريخ و ٢ و ٤ أسابيع من العمر ووجد تحسن بعد جيلين من الإنتخاب لصفة BW_6 فى معدل زيادة وزن الجسم اليومى ب ٠,٤١، ٠,٦٧، ٠,٥٠ و ٠,٥٣ جرام/يوم خلال الفترات من التفريخ - ٢ و ٢ - ٤ و ٤ - ٦ و ٦ - ٦ أسابيع من العمر على الترتيب.

الخلاصة أن الإنتخاب لوزن الجسم العالى عند عمر ٦ أسابيع قد أدى إلى تحسن فى صفة وزن الجسم عند نفس العمر وكذلك تحسن كلا من صفات وزن الجسم عند الأعمار المختلفة ومعدل زيادة وزن الجسم اليومى خلال الفترات المختلفة أثناء مرحلة نمو السمان. وأكثر من ذلك، كان التحسن أعلى فى الجيل الأول عن الجيل الثانى للإنتخاب.