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Investigating the effects of divergence selection parameter and Japanese quail differences (Low-High) according to body weight

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Abstract
The study highlights on estimate some parameters of the body weight according to low – high body weight of Japanese Quails and investigate the effects of divergent selection on some productive traits and reproductive traits in 3 generations divergently selected Japanese Quail (Coturnix Coturnix Japonica) lines, in the parents (body weight, egg productions, egg weight, egg interior and exterior Qualification) and in the offspring (body weight, feed ratio conversion, increase body weight, carcass, feed consumption selaughter).The traits showed -Growth traits: body weights at (0, 2, 4, 6) weeks of age and average daily gains calculated among different growth periods studied (0-2, 2-4, 46, 0-6) weeks of age. Reproductive and egg production traits: total egg number and weights and daily egg mass produced among the first ten weeks. Carcass traits: meat, bone, giblets and dressing percentages. In addition study genetic parameters of body weight. The moderate to high heritability for most study traits suggested that selection to increase or decrease these traits will be successful. The genetic parameters of body weight at different ages, measurements were positive and tended to be moderate to high. These results showed that selection for weight at early ages will have appositive effect on weight.

Keywords: Japanese quail, Body weight, heritability, selection

Introduction

Most of the people in developing countries are suffering from starvation or malnutrition of protein and energy. Due to an ever-increasing global human population, there is a dire need to produce good quality animal protein in a large amount to fulfill the daily requirements of these essential items of food. The protein malnutrition is more acute and wide spread than energy malnutrition. (Jatoi, 2012) [23]. Quail are grown for meat and eggs and are attractive for farming due to rapid growth rate (marketable at 5- 6 weeks of age), early onset of egg production (6 -7 weeks of age) and the nutritive value of their eggs and meat (santos *et al*., 2011) [43]. Distinct characteristics of the Japanese quail which, include rapid growth, thus enabling the quail to be marketed for consumption at 5-6 weeks of age, early sexual maturity, which results in short generation interval, disease resistance, less capital requirement, high rate of lay and much lower feed and space requirement than domestic fowl (Adeogun and Adeoye, 2004) [3] have further given the birds advantage and attention from researchers in recent times. Moreover, the meat which is highly nutritive delicious, with low caloric value and high dry matter is preferred by all. It is rich in protein, vitamins, essential amino acids, saturated fatty acids, unsaturated fatty acids and phospholipids (Muthukumar and Dev Roy, 2005) [37]. In view of the importance of this small stock, it is necessary to initiate improvement programs that can genetically improve the birds for efficient and effective productivity. In order to establish a breeding program, it is essential to estimate genetic parameters for improving the most important economic traits. The magnitude of the genetic parameter, for example heritability, could indicate the amount of improvement that can be achieved by selection. A selection experiment was desined. Individual phenotypic selection was contemplated to facilitate development of superior breeder flock sutitable for production of optimum number of fast growing commercial meat type Japanese quails (Ashok and Prabakaran, 2012) [8]. The development of quail culture has led farmers to rear both meat and egg type quail breeders, which has demanded studies on the reproductive management of this species (Santos *et al*.

2011) [43]. Selection is a powerful means for genetic improvement of poultry meat and egg production (Baylan *et al*., 2009) [10]. Individual selection is particularly essential in selection experiments for body weight in quail. Individual selection is used based on breeding value for body weight at 5 weeks of age as the selection criterion (Islam *et al*. 2014) [22]. Japanese quail respond very quickly to the selection for higher body weight (Anthony *et al*., 1996) [7]. Japanes quail breeding programs rely on knowledge of genetic relationships and variation among individuals. Breeders aim to exploit these forms of variation by taking into account additive, and environmental factors variation and covariation within and among populations provide the basis for development of selection strategies. Selection for productive traits (egg number) could affect the performance of reproductive traits and might directly affect commercial production (Buis *et al*., 1994) [14]. The challenge of future breeding will be to take further advantge of the biological characteristics of this bird along with its Known genetic, both monogenic and quantitative, variation to build lines for producing a range of crossbred high yielding animals adapted to the local environment and market place (Minvielle. 1998) [33]. Estimation of genetic parameters for several traits in Japanese quail has been reported (Akbaş *et al*., 2004; Vali *et al*., 2005; Dionello *et al*., 2006; Mielenz *et al*., 2006; Saatci *et al*., 2006; Shokoohmand *et al*., 2007; Momoh *et al*. 2014; Khaldari *et al*. 2010; Narinc *et al*. 2013) [5, 48, 16, 32, 42, 46, 36, 24, 39].

Estimated genetic and phenotypic relationships between body weight, carcass and some of the organ parameters (Momoh *et al*. 2014; Khaldari *et al*. 2010; Narinc *et al*. 2013) [36, 24, 39]. Maternal effects in birds are different from those of other animals, because any maternal effect on chicks, incubated artificially, must be the residual effect of dam reflected in egg characteristics at laying. Estimation of genetic parameters for several traits in Japanese quail has been reported (Akbaş *et al*., 2004; Vali *et al*., 2005; Dionello *et al*., 2006; Miielenz *et al*., 2006; Saatci *et al*., 2006; Shokoohmand *et al*., 2007; Punya *et al*., 2009; Khaldari *et al*., 2010; Narine *et al*., 2010) [5, 48, 24, 16, 42, 46]. The importance of the maternal genetic effect has not been clearly evaluated, especially for body weight in Japanese quail (Lotfi *et al*. 2010). In any genetic improvement program, body weight is one of the most important traits for a number of reasons including its relation with other meat production traits and its' relative ease of measurement (Caron *et al*., 1990) [15]. Quail farming, despite having enormous potential, is still one of the neglected components of the poultry sector in the country, reason being, very little research work is done on its breeding, incubation, housing, nutritional requirements, feeding, management and disease control aspects (Hussain *et al*, 2013) [19]. A commonly occurring problem in all avian species studied is the relatively poor reproductive performance of birds selected for increased growth rate. Genetic studies on Japanese quail will enable breeders to design suitable improvement programs for this bird, therefore, reliable estimates of genetic parameters (heritabilities and correlations) are necessary to predict the direct and indirect selection responses. İn this study highlights on estimate some parameters of the body weight according to low – high body weight of japanese quails and study investigate the effects of divergent selection on some productive traits and reproductive traits in 3 generations divergently selected japanese quail (Coturnix Coturnix japonica) lines, in the parents (body Weigh, egg productions, egg weight, egg interior and exterior qualitfication) and in the offspring (body weight, feed ratio conversion, increas body weight, carcass, feed consomption, selaughter)

Body weight

The improvement in production performance of desi native breeds of chicken has been reported by (Anjum *et al*., 2012, Baylan *et al*., 2009,) [10]. Through selective breeding. In any genetic improvement program, body weight is one of the most important traits for a number of reasons including its relation with other meat production traits and its relative ease of measurement (Caron *et al*., 1990) [15]. Japanese quail respond very quickly to the selection for higher body weight. (Caron *et al* 1990 [15], Anthony *et al*., (1996) [7], and Several studies reported the effects of selection on body weight and egg production in poultry species (Akbas *et al*., 2004; Vali *et al*., 2005; Dionello *et al*., 2006; Mielenz *et al*., 2006; Saatci *et al*., 2006; Shokoohmand *et al*., 2007; Momoh *et al*. 2014; Khaldari *et al*. 2010; Narinc *et al*. 2013, Okuda *et al*., 2013) [48, 16, 32, 42, 46, 36, 39, 53].In the study experiment significant differences were observed in weekly body weight among different generations and selection methods. Generation 2 showed maximum weekly body weights at the age of day one, and 21 respectively. This might be due to selection for higher body weight which showed positive response to selection (Hussain *et al*., 2013) [19]. Similarly improved body weight in Japanese quail was also observed in birds selected for higher body weight in many other study as well (Baylan *et al*., 2009) [10]. The G4 had the highest BW at 14 and 21 days of age (66.09 and 109.19g, respectively). All BW's from 7 up to 35 days of age were significantly affected by line ($P \leq 0.000$) favoring the selected line which had heavier BW's at 7, 14, 21, 28 and 35 days of age (31.08, 65.61, 111.69, 153.63 and 202.01g, respectively) compared to the control line, except for BW1 (Bothaina *et al*., 2014) [13]. Oyetade (2011) [55] who reported all positively and mostly significant ($P < 0.05$) phenotypic relationship between body weight and all linear body measurement at various ages. İn the study shows that the body weight of four genotypes of quail at 2nd, 4th, 5th, and 6th week of age. Body weight of quails at 2nd, 4th, 5th and 6th week of age was significantly ($p < 0.001$) influenced by genotype. The 6th week body weight was 112.57±0.53, 131.86± 0.76, 128.35± 0.78 and 131.90± 1.24g respectively for Japanese, White, Brown and black genotype. Significantly higher body weight was found in White and black followed by Brown and Japanese quail genotype at different period of age (Islam *et al*., 2014) [22].

Body weight (High-low)

Body weight has been found to increase over generation in birds selected for increased body weight in a long- term selection programme while the reverse has been reported in birds selected for decreased body weight (Aggrey *et al*., 2003; Balcioglu *et al*., 2005; Marks, 1991) [29]. Study showed the selection differentials (S) by sex and experimental lines for 35 day BW. As result of the fewer males selected, the selection differential of males in each generations for both sexes were used to produce the H and L weight lines, therefore the selection differential were not quite different. where selection differentials for 35 days body weight in two generations of male and female Japanese Quail were in G0 M and F (30.90, 24.57) for high body,(30.67, 23.14) for low body respectively, in G1 M and F(22.42, 28.78) for high body,(22.87, 21.37) for low body respectively, in G2 M and F(24.26, 21.34) for hogh body,(26.88, 23,63) for low body respectively (Ojo, *et al*., 2010) [52].

Body weight gain

İndicate (Okuda *et al*, 2013) [53] to the least squares means (standard error) and coefficient of variation for growth traits for generation 1 and 2. Body weight at 2, 4 and 6 weeks was averaged 39 gm, 96.66 gm and 163.29 gm respectively after two generation of selection. At different ages significant differences among strains and generations on body weight were also reported by Mohammed *et al*., (2006) [34] and Varkoohi *et al*. (2010). Marks (1996) [29] reported that there was an absence BW differences between sexes at four weeks of age in the L line. The interaction effect of line by sex was not significant at four weeks of age, and another study pointed to means of body weight at different ages as affected by generation and line. There were significant ($P \leq$ 0.000) differences due to generation effect for all BW's tested, except at 35 days of age. Higher BW's at one, seven and 28 days of age (9.12, 31.44 and 151.76 g, respectively) were observed in G3 which had numerically higher BW35 than other generations. Body weights at 35, 42 and 49 days of ages were significantly different, while there was no significant difference for body weights at 63 days of age (p>0.05) (Vali *et al*. 2005) [48] (Mohammed *et al*. 2015) [35]. Significantly higher body weight gain (108.90g) in generation 02 may be attributed to birds selected for higher body weight having positive response to selection which lead to improved weight gain in progressive generations. Maximum weight gain in pedigree based selected group in generation two and the minimum in random bred controls in same generation might be attributed to better feed utilization in pedigree based selected birds which resulted in improved body weight gain.

Measurement of production characteristics

Egg production

Several studies reported the effects of selection on egg production in poultry species (Akbas *et al*., 2004; Vali *et al*., 2005; Vali *et al*,. 2006, Dionello *et al*., 2006; Mielenz *et al*., 2006; Saatci *et al*., 2006; Shokoohmand *et al*., 2007; Momoh *et al*. 2014; Khaldari *et al*. 2010; Narinc *et al*. 2013, Okuda *et al*., 2013) [48, 49, 16, 32, 42, 46, 36, 24, 39, 53]. Showed study that was mean egg weight for 584 number of females 11.06 (Sezer, 2007) [45]. In contrast, the study found negative correlated significant changes were shown for all egg production-related studied traits (Eggs mean 30, Eggs mean 60, Days needed to produce the first ten eggs 30, Days needed to produce the first ten eggs 60, age at first 10 eggs 30 and age at first 10 eggs 60 being -3.98,-8.55,-1.41,- 3.26,-2.06 and -4.07, respectively), except EM10 (1.75g, $P \leq$ 0.01). The average genetic response per generation in ASM, Body weight SM, Days needed to produce the first 10 eggs and age at first 10 eggs were -3.74days, -3.06g, - 0.22day and -4.12 days, respectively (Bothaina *et al*., 2014) [13].

Egg weight

İn the study showed that Least-square means for body weight 2 weeks of Japanese quail during three generations of selection for egg weight of the first 10 eggs, the means of body 2 weeks for both sexes ranged from 37.49-63.88 g with estimated overall mean was 49.69 g (Bahie El-Deen *et al*., 2016) The overall means of body weight 2 weeks showed in the study for females (50.72 g) or males (48.72 g) are in line with similar findings by Balcioglu *et al*. (2005), Magda *et al*. (2010) [28].

In general, the characteristics of egg quality have genetic basis. Egg quality is factor which contributes for better economy price of fertile and table eggs (Hanusova *et al*., 2015) [18]. Egg quality has been defined as the characteristics of an egg that affect its acceptability by the consumers. Egg quality is the more important price contributing factor in table and hatching eggs. Genetic relationship between body weights at various ages were all high and positive (Momoh *et al*., 2014) [36]. The effect of genotype for egg weight, chick weight and chick: egg weight ratios of quail are shown the egg weights were 10.35 ± 0.3, 11.60± 0.42, 10.30± 0.42 and 9.78± 0.65 for J, W, Br and B1 respectively, which were influenced ($p<$ 0.05) by genotype. chick weight and chick egg weight ratios of four genotypes of quails also significantly ($p<$ 0.001) influenced by genotype. White genotype of quail is significantly better for egg weight, chick weight and chick: egg ratio than that of their counterparts (Islam *et al*., 2014) [22].

Egg internal and external quality

Coturnix eggs are characterized by a variety of color patterns, ranging from dark brown, blue, and white to buff, each heavily mottled with black, brown, and blue. Average weight of a coturnix egg is approximately 10 grams (about 8% of the hen's body weight) (Woodard *et al*., 1973) [51]. Egg quality is usually commented in connection with consumers' requirements and is performed by groups of methods, which give a general characteristics of egg with intact egg shell (freshness, weight, size and shape, eggshell appearance) and the quality of egg parts (albumen, yolk and egg shell). (Genchev, 2012) [17]. Egg shell integrity is important not only from economic point of view, but also with regard to human health safety (Genchev, 2012) [17]. Investigate the impact of selection for increased body mass on external and internal egg quality traits of Japanese quail detect the effect of selection on egg quality. In addition, correlation between external and internal egg quality traits was measured. The results revealed that HBM quail laid heavier eggs (p=0.03 compared with LBM but not significantly different with control quail) (Mohammed *et al*. 2015) [35], with ahigher external (Shell thickness, Shell weight, egg Shell ratio and egg Shell density, p= 0.0001) and internal egg quality score (albumen weight, p = 0.003; albumen ratio, p= 0.01; albumen height, Yoik height, yolk index and haugh unit, p= 0.0001). Egg quality is presented by its weight, percentage of eggshell, thickness and strength of eggshell (Hanusova *et al*., 2015) [18]. It was further reported that different body weight groups significantly differed in shape index, yolk color, albumen index and Haugh unit parameters; Shell strength, yolk colour and yolk index values were also affected by weight groups and age period interaction (Lacin *et al*. 2008). A study conducted to investigate the effects of selection on egg weight, shell thickness, shell weight, shape index, albumen index, yolk index and Haugh Unit in 11 generations of high (HL) or low (LL) body weight selected Japanese quail lines, their random bred control line (C) and layer line (L) revealed significant differences among the lines in terms of all egg quality traits (Alkan *et al*. 2010) [4]. (Okuda *et al*., 2014) [54] Shows the least square means of egg quality parameters of Japanese quails for generation 0, 1 and 2. The average egg weight T6, egg weight T8, egg weight T12, egg number, and Daily egg mass were found to be 8.72gm, 9.04gm, 8.95gm, 46.04, and 8.61gm/day respectively. These values are similar to what is found in literature. Abdul-Hasan (2004) reported egg weight T and Ddaily egg mass as 10.56gm and 9.18gm/day respectively. (Okuda *et al*., 2014) [54] Shows the estimates of genetic and phenotypic correlation for egg quality traits. The genotypic correlation estimates between egg number and Shell thickness at 6 week was negative (-1.36). However, the genotypic correlation estimates between egg number and other egg quality traits (Haugh Unit at 6 week., Haugh Unit at 12 week, Yok Index at 6 week, YLI12, and Shell thickness at 12 week) ranged between – 1.35 and 1.09. The same trend was reported by Abdel-Mounsef (2005), who reported estimates which ranged between -1.03 and 1.18.

Feed consumption in the offspring

Inbreeding caused adecline in the mean for all of the traits, but its effect was only significant for 4- WK BW and carcass weight ($P < 0.05$). Selection for 4 – WK BW improved feed conversion ratio 0.16 over the selection period. (Khaldari, *et al*., 2010) [24]. Significant differences were observed in feed conversion ratio among different generations and selection methods. Improved FCR (2.30) in generation 2 as compared to generation 0 (2.35) might be attributed to birds having higher body weight in adjustment to increased feed intake in progressive generations which resulted in improved FCR (Hussain *et al*., 2013) [19].

Carcass traits

Carcass traits such as carcass weight, dressing percentage, bone to meat ratio and chemical analysis of meat are important factors in determining the income from meat production from Japanese quail because the profitability of a quail enterprise depends largely not only on the number of birds produced per female, but also on the weight and quality of carcasses the birds produced (Aboul-Seoud, 2008) [1] İn given set of environment, selective breeding is one of the most important techniques to improve the genetic potential of animals. Selective breeding is found to be a majör tool behind the significant improvement in growth rate and carcass yield of indigenous breeds (Bhatti and Sahota, 1994: Bhatti *et al*., 1992) [11, 12]. Body weight and carcass traits are under intensive selection for more than half a century, and are considered as the most important economic traits in broiler breeding programs (Nassar *et al*., 2012) [40]. observed that selected lines of Japanese quail produced heavier carcasses and more meat.

Khaldari *et al*., (2010) [24] recorded a genetic improvement of 4-wk body weight as 9.6, 8.8, and 8.2 g in generation 2, 3, and 4 respectively, in Japanese quails. In a very recent study Akram *et al*., (2012) [6] observed significant differences between two generations (G0 and G1) of Japanese quail being selected for higher four week body weight through mass selection procedures. There were significant differences among the lines in respect to body weight and carcass weight. Highest and lowest body weight and carcass weight were measured in HL and LL lines, respectively, where was body weight (g) average 180.67±53.09 and carcass weight (%) average 120.57±34.32, whilewas carcass yield (%) average 67.1±4.96 (Alkan *et al*., 2010) [4].

Heritability of growth traits

Genetic studies on quail will enable breeders to design suitable improvement programme for the bird. Therefore, reliable estimates of genetic parameters (heritabilities and correlations) are necessary to predict response to direct or indirect selection (Adeogun and Adeoye, 2004) [3].

Body weight

Selection has an important role in genetic improvement in animal production. Individual selection is particularly indispensable in selection experiments for BW in poultry. In such experiments, high heritability of body weight provides major benefits (Baylan *et al*., 2009) [10].

İn the study indicated that the heritability of MEW was high at the beginning of the laying period (week 9), decreased at second period (week 10), and increased at the rest of periods (weeks 11 and 12) (Lotfi *et al*., 2012). Mehrgardi (2012) [31] also estimated lower heritability values in advanced generations of Japanese quail being selected for higher four week body weight depicting a decrease in additive genetic variance as the generations progressed in long term selection experiments. Genetic correlations among body weight traits were generally high. In most investigation, high genetic correlations among weights at different ages were found (Akbaş *et al*., 2004, Vali *et al*., 2005, Shokoohmand *et al*., 2007, Narine *et al*., 2010, Islam *et al*., 2014) [5, 48, 22, 46]. The highest genetic and phenotypic correlations were found between body weight 28 and body weight 35 (0.99 and 0.83, respectively), which is similar to report of (Resende *et al*., 2005) [41], There was Selection response for 4-wk BW is presented Genetic improvement was 9.6, 8.8, and 8.2 g for generations 2, 3, and 4, respectively (Khaldari *et al*., 2010) [24], The heritability estimates for the body weight at the age of three, four, six, fourteen and twenty weeks were 0.0126, 0.0315, 0.200, 0.200 and 0.200 respectively (Hussain *et al*., 2014) [20], Indicate that the body weight at first egg was 0.56± 0.21 (Hrncar *et al*., 2004) [21].

Body weight (High-low)

Study İndicted that the result obtained for the realized heritability estimates by sex, generation and experimental lines. The Clines were used to correct for environmental fluctuation in the calculation of the realized heritability. Heritability for males was higher in the first generation but lower than that of females in the sec and generation. combined estimates at the end of the sec and generations were however higher (0.44 and 0.46 for H and L lines respectively).An increase in the heritability estimate in the secand generation over the first suggests that variation in body weight is much more due to genetic effect (Ojo *et al*., 2010) [52].

Body weight gain

Study showed that heritability estimates of body weight at various ages ranged from 0.10±0.02 to 0.82±0.14 while those of body weight gain were mostly moderate (0.19±0.05 - 0.42±0.02). Linear body parameters had moderate to high (0.23±0.13 - 0.49±0.16) heritability estimates except body length which was 0.08±0.15 heritable (Momoh *et al*., 2014) [36].

Heritability of reproduction and egg production traits

Egg production

Heritability estimates for egg production traits: For different egg production traits (age at 1st egg, 1st egg weight, average daily feed intake and the total egg number for six to 14 weeks of age) the heritability estimate was 0.20. For age at 1st egg comparatively higher heritability estimates were recorded as 0.53, 0.53, 0.42 and 0.55 respectively (Andre *et al*., 2011; Savegnago *et al*., 2011; Lwelamira *et al*., 2009; Khalil *et al*., 2004) [2, 44, 27].

Egg weight

Egg weight are important characters from the point of mechanical handling of eggs. weight egg and heigh egg has positive genetic and phenotypic correlations with egg shape index. and in the same study Show that heavier eggs are expected to have high Shell weight, which is also revealed by estimating positive phenotypic and genetic correlation between egg weight and Shell ratio where realized heritability values were 0.48 that is high (Kaye *et al*., 2016).

Egg internal and external quality

Heritability can tell us how closely genetic merit follows phenotypic performance, but it tell us nothing about the economic value of better performance. Some traits with low heritabilities, such as the survival and fitness traits, have low heritabilities but high economic value. Other traits, like stature, are moderately to highly heritable, but have insufficient economic value to be given much emphasis in selection programs. Producers should select to improve traits with low heritabilities when economic circumstances justify the attention. In addition, lowly heritable traits of substantial economic value should always be targeted for improvement through better environmental conditions (www.ext.vt.edu, 2009). (Sezer, 2007) [45] Reported that heritability, genetic and phenotypic correlations among the examined traits were shown that heritability of external egg quality traits were ranged high to moderate, except for Shell weight and Shell weight per unit surface area. Generally, traits related with the Shell (Shell weight, egg Shell gravity, Shell ratio, and Shell weight per unit surface area) had lower heritability than the traits related with egg size (Egg weight, width egg, height egg, egg shap index and egg surface area). Low heritability estimates for Shell weight (0.08±0.029) and Shell weight per unit surface area (0.19±0.036) Indicates that environmental factors such as feed, management and temperature have more effect on these traits than the additive genetic backup. Egg shap index and egg weight are important characters from the point of mechanical handling of eggs. Weight egg and heigh egg has positive genetic and phenotypic correlations with egg shape index. and in the same study Show that heavier eggs are expected to have high Shell weight, which is also revealed by estimating positive phenotypic and genetic correlation between egg weight and Shell ratio.indicated study to that the realized heritability for traits were 0.55, 0.07, 0.50, 0.74, 0.02, 0.25, 0.01, 0.33, 0.01, 0.01 to egg length, egg width, yolk weight, yolk length, yolk width, albumen weight,albumen length, albumen width, Shell weight, Shell thickness respectively,where indicated same study that realized heritability values were low in most of traits except albumen weight, albumen width that are moderately high while egg weight. egg length, yolk weight, yolk length that are high. The response to selection mean values of albumen length, Shell weight, and Shell thickness is negative. The response to selection mean values for egg length, egg width, yolk weight and percentage values for egg width, albumen thickness were higher than selection differential mean and percentage verse vassal (Kaye *et al*., 2016). in study showed weight of first egg 0.38± 0.18 (Hrncar *et al*., 2004) [21], The heritability estimate was of low magnitude (0.05 and 0.04). Whereas for average egg weight (0.41 and 0.39) and egg specific gravity (0.31 and 0.18) (Silva *et al*. 2013) [47]. Mentioned (Momoh *et al*., 2014) [36] that heritability values for egg traits were (0.48, 0.56, 0.38) fora ge at first egg 132 day, weight of first egg 132 (g), body weight at first egg 132 (g) respectively.

Conclusion

The results from this studies indicat that response to divergent selection in the linear part (5-week body weight) of the growth curve is evident in the growth pattern of quails and individual selection will be effective in improving the growth performance of Japanese quails. therefore body weight in the divergently selected lines could be considered as different traits.

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