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RESEARCH ARTICLE

The Differences in Some Production and Clutch Traits in Divergently Selected Japanese Quails

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Summary

The aim of the research was to investigate the effects of divergent selection on some production and clutch traits in Japanese quail *(Coturnix coturnix japonica).* Over 5 generations divergently selected two Japanese quail lines (HBW: High Body Weight and LBW: Low Body Weight) and control line (C) that derivate from a base random bred population were used in this study. Weight of first egg, age at sexual maturity, body weight at sexual maturity, total egg number, total egg weight, clutch length, clutch number, pause length and pause number were determined. Statistically important relationships were estimated among these studied traits except between average egg weight with age at sexual maturity. The HBW and LBW were differentiated in both body weight and egg yields (number and weight) by selection applications. Averages of the body weight and egg weight increased but the egg numbers decreased for HBW, in contrast for LBW through generations. When clutch number, pause number and pause length increased, total egg number and total egg weight decreased. The results of this study indicated that divergent selection for body weight resulted in important changes on some production and clutch traits in Japanese quails.

Keywords: *Selection, Production traits, Clutch, Japanese quail*

Farklı Yönlerde Selekte Edilmiş Japon Bıldırcınlarında Bazı Verim ve Clutch Özelliklerindeki Farklılıklar

Özet

Bu çalışmanın amacı Japon bıldırcınlarında canlı ağırlık için iki yönlü seleksiyonun bazı verim özellikleri üzerine etkisini araştırmaktır. Aynı bıldırcın populasyonundan 5 generasyon farklı yönlerde selekte edilerek elde edilen iki Japon bıldırcını hattı (HBW: High Body Weight ve LBW: Low Body Weight) ve kontrol (C) hattı bu çalışmada kullanılmıştır. İlk yumurta ağırlığı, cinsel olgunluk yaşı, cinsel olgunlukta canlı ağırlık, toplam yumurta sayısı, toplam yumurta ağırlığı, clutch uzunluğu, clutch sayısı, pause uzunluğu ve pause sayısı belirlenmiştir. İlk yumurta ağırlığı ile cinsel olgunluk ağırlığı arasındaki hariç çalışılan özellikler arasındaki ilişkiler istatistiki olarak önemli bulunmuştur. HBW ve LBW seleksiyon uygulamaları sonucunda canlı ağırlık ve yumurta verimleri (sayı ve ağırlık) bakımından farklılaşmıştır. Generasyonlar boyunca ortalama canlı ağırlık ve yumurta ağırlığı HBW hattında artmış fakat LBW hattında azalmıştır. Yumurta sayısı ise HBW hattında azalmış ancak LBW hattında artmıştır. Clutch sayısı, pause sayısı ve pause uzunluğu arttığında, toplam yumurta sayısı ve toplam yumurta ağırlığı azalmıştır. Bu çalışmanın sonuçları, canlı ağırlık için farklı yönde seleksiyonun Japon bıldırcınlarında bazı verim ve clutch özellikleri bakımından önemli farklılıklar ortaya çıkardığını göstermiştir.

Anahtar sözcükler: *Seleksiyon, Verim özellikleri, Clutch, Japon bıldırcını*

INTRODUCTION

Japanese quail are produced commercially as a source of both meat and egg. Most of the research on Japanese quail related increase live weight and growth characteristics [1] because they are small, less expensive than chickens and turkeys and have short generation interval. Commercially produced Japanese quail *(Coturnix coturnix japonica)* is reared mainly for meat in Europe and for eggs in Japan and is often bred as dual-purpose birds in other Asian countries [2]. Poultry breeders must consider so many traits that are economically important

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egg production rate, sexual maturity, egg size, feed efficiency, fertility and hatchability. Bozkurt and Tekerli [3] reported that faster and effective selection programs in last 50 years gave a rise to the production of high-yielding poultry lines. The reproductive performance and the relationships between egg size, clutch size, and female body size in poultry have been studied intensively [4,5]. A common finding is a large variation in both egg and clutch size within populations [6]. The purpose for egg-type quails was to increase total egg mass, to get an earlier sexual maturity, to optimize egg weight in order to augment laying performance. However, for the meat type quails the intention was to enhance body on account of carcass weight and to get an earlier cut age. For poultry, some researchers [7-9] reported that sort or long term selection for body weight causes a reduction in egg production in respect to the control line but increased sexual maturity. Although, a lot of research was conducted to determine the relationship between selection and production traits, it has not been such a study between selection and clutch traits.

The purpose of the study was to investigate the effects of divergent selection on some production traits and clutch traits in over 5 generations divergently selected Japanese quail *(Coturnix coturnix japonica)* lines.

MATERIAL and METHODS

This study was conducted in the quail-breeding unit at the Department of Animal Science, Akdeniz University. Quail chicks were wing-banded at hatching and reared in separate quail battery brooders. Over 5 generations divergently selected two Japanese quail lines (HBW: High body weight and LBW: Low body weight) for increased and decreased 5-week body weights and control line (C) that derivate from a base random bred were used in this study. Selection intensities were adjusted for males and females as 10% and 40% respectively.

Approximately 200 fertile eggs from HBW, LBW and C were set for hatch. Chicks were wing-banded on day of hatch and raised in separate brooder batteries. Their diet contained 240 g crude protein/kg and 10.8 MJ ME/kg at 0-5 weeks and unlimited water was supplied during the experiment. Sex identification was carried out according to plumage and color pattern at four week of age. Reasonable 42, 47 and 54 female quails were random chosen from HBW, LBW and C, respectively, and placed randomly in separate individual cages. All the birds had ad libitum access to a ration containing 200 g crude protein and 10.1 MJ ME/kg and water during the experimental period, as proposed by the NRC [10]. All birds were housed in individual cages that had windows at both sides with curtains, exposed to 16 hours of light.

Individual egg yield of all females were recorded daily until 195 days of age from hatching. A clutch was described as an uninterrupted laying period during the egg yield term. Each non-laying period between two clutches was defined as a pause [5]. The clutch length is the number of eggs laid on consecutive days, which is one of the components of the total number of the eggs laid during a production cycle. The average clutch length was the arithmetic means of all clutches recorded [11]. Age at sexual maturity was determined as the first egg laying-day of females. Weight of first egg (WFE), total egg number (TEN), total egg weight (TEW), age at sexual maturity (ASM), body weight at sexual maturity (BWSM), clutch length (CL), clutch number (CN), pause length (PL) and pause number (PN) were recorded for each female in all lines. Weights were measured by digital balance (sensitivity of 0.01 g). All data were analyzed using SAS [12]. PROC ANOVA was applied for variance analyses and PROC CORR was applied for deriving simple correlations among those traits. Tests for goodness of fit were made by the Chi-square method. The following model was used for analysis of the each traits data:

$$Y_{ij} = \mu + L_{ij} + e_{ij}$$

Where μ is the common mean; L_{ij} is the effect of the i^{th} quail line; e_{ij} is random error. Statements of significance are ($P<0.01$ and $P<0.05$) unless otherwise indicated.

RESULTS

Averages of studied traits were compared for lines and presented in *Table 1*. WFE and TEN in LBW were found same as the C but was found significantly different than HBW in this study ($P<0.01$). Statistically significant differences were presented for TEW, AEW and BWSM among all lines ($P<0.01$). TEW, AEW and BWSM in the HBW were higher than LBW and C. However, the differences among lines were not significant for ASM.

It was found that distribution of clutch numbers was dependent on the selection lines in respect of the results pertaining to clutch number ($P<0.01$). CL in the HBW was found lower than the LBW and C, while CN, PL and PN were higher. Thus, it was caused by a reduced total egg number for the HBW, CN and PN were found lowest in the LBW. Therefore, CL was higher in LBW than HBW and C *(Table 1)*. It was concluded that egg yields decreased when clutch numbers increased.

Pearson correlations among pooled means of studied production traits of quail lines presented in *Table 2*. As shown, significant positive correlations were found between ASM with WFE and BWSM by pooled data. Negative relationships were observed between TEN with

Table 1. *Comparisons of studied production traits in quail lines ($\bar{X}\pm S\bar{x}$)*

Tablo 1. *HBW, LBW ve C bıldırcın hatlarında verim özellikleri ($\bar{X}\pm S\bar{x}$)*

Traits	Quail Lines		
	LBW	HBW	C
WFE (g) **	8.8±0.1 [b]	11.2±0.5 [a]	9.4±0.2 [b]
TEN **	146.5±2.0 [a]	137.1±1.8 [b]	144.1±1.7 [a]
TEW (g) **	1573.5±25.2 [c]	1843.3±34.4 [a]	1756.7±25.6 [b]
AEW (g) **	10.8±0.12 [c]	13.4±0.2 [a]	12.2±0.1 [b]
ASM (day)	39.7±0.5	42.2±0.9	39.7±2.0
BWSM (g) **	179.2±2.3 [c]	310.1±3.5 [a]	216.8±2.9 [b]
CL (day) **	146.5±2.0 [a]	137.7±1.8 [b]	144.1±1.7 [a]
CN **	5.8±0.6 [c]	11.6±0.9 [a]	9.2±0.8 [b]
PL (day) **	13.4±2.0 [b]	22.9±1.8 [a]	15.9±1.7 [b]
PN **	6.0±0.6 [c]	11.8±0.9 [a]	8.9±0.8 [b]

******* P<0.01; Means with different superscript differ significantly*
WFE: *Weight of First Egg,* ***TEN:*** *Total Egg Number,* ***TEW:*** *Total Egg Weight,* ***AEW:*** *Average Egg Weight,* ***ASM:*** *Age at Sexual Maturity,* ***BWSM:*** *Body Weight at Sexual Maturity,* ***CL:*** *Clutch Length,* ***CN:*** *Clutch Number,* ***PL:*** *Pause Length,* ***PN:*** *Pause Number*

Table 2. *Pearson correlations among pooled means of production traits of quail lines*

Tablo 2. *Bıldırcın hatlarında verim özelliklerinin birleştirilmiş ortalamaları arasındaki korelasyonlar*

Traits	ASM (day)	BWSM (g)	AEW (g)	TEN
WFE (g)	0.320 **	0.473 **	0.496 **	-0.226 **
ASM (day)		0.293 **	0.137	-0.408 **
BWSM (g)			0.786 **	-0.312 **
AEW (g)				-0.271 **

******* P<0.01;* ***WFE:*** *Weight of First Egg,* ***ASM****: Age at Sexual Maturity,* ***BWSM:*** *Body Weight at Sexual Maturity,* ***AEW:*** *Average Egg Weight,* ***TEN:*** *Total Egg Number*

WFE, ASM, BWSM and AEW (P<0.01). This means that experimental lines were differentiated for both body weights and egg yields (numbers and weights) by selection applications. Averages of the body weight and the egg weight were increased but the egg numbers were decreased for HBW, in contrast for LBW through generations.

Pearson correlations among production traits of quail lines presented in *Table 3.* As demonstrated, positive

Table 3. *Pearson correlations among production traits of quail lines*

Tablo 3. *Bıldırcın hatlarında verim özellikleri arasındaki korelasyonlar*

Traits	TEN	TEW	AEW	CL	CN	ENEC	PL	PN
TEW	0.717 ** 0.817 ** 0.686 **							
AEW	0.215 0.194 -0.207	0.523 ** 0.722 ** 0.568 **						
CL	1.000 ** 1.000 ** 1.000 **	0.717 ** 0.817 ** 0.686 **	-0.215 0.194 -0.207					
CN	-0.680 ** -0.694 ** -0.796 **	-0.586 ** -0.624 ** -0.486 **	-0.013 -0.240 0.239	-0.680 ** -0.694 ** -0.796 **				
ENEC	0.535 ** 0.600 ** 0.501 **	0.404 ** 0.635 ** 0.397 **	-0.066 0.343 * -0.024	0.535 ** 0.600 ** 0.501 **	-0.720 ** -0.725 ** -0.668 **			
PL	-1.000 ** -1.000 ** -1.000 **	-0.717 ** -0.817 ** -0.686 **	0.215 -0.194 0.207	-1.000 ** -1.000 ** -1.000 **	0.681 ** 0.694 ** 0.796 **	-0.535 ** -0.600 ** -0.501 **		
PN	-0.716 ** -0.708 ** -0.799 **	-0.622 ** -0.636 ** -0.501 **	-0.019 -0.244 0.223	-0.716 ** -0.708 ** -0.799 **	1.000 ** 1.000 ** 1.000 **	-0.723 ** -0.731 ** -0.653 **	0.716 ** 0.708 ** 0.799 **	
DNEP	-0.574 ** -0.293 * -0.282 *	-0.293 * -0.078 -0.226	0.289 * 0.213 0.004	-0.574 ** -0.285 -0.282 *	-0.122 -0.367 * -0.173	0.039 0.424 ** 0.368 **	0.571 ** 0.293 0.282	-0.075 -0.364 * -0.220

****** P<0.05,* ******* P<0.01;* ***TEN:*** *Total Egg Number,* ***TEW:*** *Total Egg Weight (g),* ***AEW:*** *Average Egg Weight (g),* ***CL:*** *Clutch Length (day),* ***CN:*** *Clutch Number,* ***ENEC:*** *Egg Number of Each Clutch,* ***PL:*** *Pause Length (day),* ***PN:*** *Pause Number,* ***DNEP:*** *Day Number of Each Pause*
Not: *Values of LBW, HBW and C lines were shown one under the other at rows in each trait's, respectively*

relationships were derived between TEW with CL and ENEC and between TEN and ENEC, and negative correlations were calculated between CN with TEN and TEW in LBW line (P<0.01). Highly positive correlations were found between TEN with TEW and ENEC and between TEW with AEW, CL and ENEC in HBW line (P<0.01).

There were calculated high negative correlations between TEN with CN and PN, and also between TEW with CN, PL and PN in HBW line (P<0.01). Furthermore, the relationships between ENEC and AEW and between DNEP with CN and PN were calculated important only in HBW as seen in *Table 3* (P<0.05).

Significant positive correlations were found between TEN with TEW and ENEC and between TEW with AEW, and also important negative correlations were found between CL and CN, CN and ENEC, PN and CL, and PL and ENEC in C line (P<0.01). The correlation between DNEP and ENEC was found important in HBW and C but was not in LBW (P<0.01).

DISCUSSION

Camcı et al.[13] and Türkyılmaz et al.[14] reported AEW for the control line of quail as 12 and 13 g, respectively. These values were same our C line, but lower than HBW line (13.4 g) but higher than LBW line (10.8 g). Singh and Panda [15] determined an AEW in quails either subjected to selection for meat or egg traits as 10.58 and 9.76 g, respectively. These values were lower than both HBW and LBW. Inal et al.[16] reported that as quails selected for their body weight reached sexual maturity on 39.8-51.1 days of life, while their egg weights were 10.94-13.23 g. ASM was reported for unselected quail as 44.9 days [13], 48.9-49.6 days [17] and 63.3 days [18] in quails. The reported values were higher than presented ASM of HBW (42.2), LBW (39.7) and C (39.7). Total egg production during 160 days was determined as 137.1 for HBW which was minimal as per LBW and C. Thomas and Ahuja [17] reported that 126-days egg production was 55-64.9 number. Drbohlav and Metodiev [18] observed that egg production in quails aged 150 was 80.4. Their egg production values were lower as relative than HBW, LBW and C. Also, Darden and Marks [1] and Marks [9] reported that long-term selection for high body weight delayed sexual maturity.

A positive correlation between body weight and egg weight of female quail was noted [19]. Camcı et al.[13] reported an analogous relationship (-0.277) between the same properties. In this study a very high correlation was computed between BWSM and AEW (0.786). This value is more than 0.373 was reported [13]. It can be explained that sexual organs weight was grown when live weight increased in female quails. Selection for live weight affected body weight at sexual maturity accordingly first egg weight and average egg weight was increased in the quails.

According to all relationships for HBW, LBW and C when CN, PN and PL increased, TEN and TEW decreased. However, TEN and TEW increased when CL increased. Aggrey et al.[20], report the same results; this highlights the importance of the relationship between CL and PL in production traits of quail. Erensayın and Camcı [5] indicated a negative correlation between CL and CN (-0.942) and also a negative correlation between CN and hen-day egg yield (-0.438; P<0.01).

In addition, CL with 1-5 eggs, 6-10 eggs, 11-15 eggs, 16-20 and ≥21 eggs amounted to 38.46%, 28.67%, 20.98%, 7.69% and 4.19%, respectively. Abdallah and Harms [6] reported that CL changes between 2 and 20 in hens at 32 weeks laying-age. Erensayın and Camcı [5] found that CL changes between 1-34 and 14.3% of total clutches include one egg in Japanese quail. Also, CL with 1-5 eggs, 6-10 eggs, 11-15 eggs, ≥16 eggs amounted to 44.4%, 33.17%, 16.4% and 6.09%, respectively.

The results of this study indicated that divergent selection for body weight resulted in correlated changes pertaining to production and clutch traits. If aim of selection is to increase egg production and body weight, it must be investigated for various production traits connected with them. Because, any change in body weight should be directly reflected in egg yield in the quails. It was pointed out in the results that selection for higher body weight was caused heavy egg but less egg number; however, selection for lower body weight was caused lightly egg but many egg number. Also highly negative relationships of clutch number with clutch length, and total egg number and total egg weight were found. It is clearly pointed out in the results, clutch length and clutch number can use as a selection criteria. In such a way that clutch length increased when clutch number decreased and it is directly related with egg yield.

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