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(Original Article)

Indirect Response in Egg Production and Egg Quality Traits Due to Selection for Body Weight at 8 Weeks of Age in Dandarawi Chicken

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Abstract

The poultry industry mainly aims to produce genetically superior birds with high productivity of meat and egg. The current experiment was carried out on Dandarawi chickens selected for high body weight at 8 weeks of age through two successive generations to detect the indirect response in egg production and egg quality traits. Traits under study were age at sexual maturity, egg weight, laying rate, total egg mass and egg quality. Results indicated that age at sexual maturity, average of laying rate, and egg weight were highly ($P \leq 0.01$) affected by generations. Also, the effect of generation was significant ($P<0.05$) on total egg mass. The pullets in selected line matured (165.44 day) later than those in control line (161.47 day). Moreover, the birds in selected line had laying heavier egg weight than those in the control line. The results showed no interactions between generations and lines considering all egg production traits. Regarding egg quality traits, egg weights were greatly affected by lines ($P \leq 0.01$). Furthermore, albumen percentage and eggshell thickness were significantly ($P<0.05$) affected by lines.

In conclusion, selection for body weight at 8 weeks of age tended to delay the age at sexual maturity, decreased laying rate, increased egg weight, and decreased total egg mass in the selected line as an indirect response to selection. Egg quality was slightly affected indirectly by selection for high body weight at 8 weeks of age.

Keywords: *Selection; Body Weight; Egg Production; Egg Quality; Dandarawi*

Introduction

The current study is a part of a breeding program in the Poultry Production department, Assiut University to improve the productivity of an old Egyptian chicken strain named Dandarawi through selection. Despite the lower rates of growth and egg production of native chickens, native chickens are generally superior in disease resistance and can maintain a higher level of performance under poor nutrition and high environmental temperatures compared to standards breeds under tropically oriented (Horst, 1989). So, improving the productivity of local

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strains is considered one of the priorities for the Egyptian poultry industry (Sayed *et al.,* 2017).

Genetic artificial selection is one of the important breeding programs that play a major role in the improvement of the chicken's performance (Abdellatif, 1999; Abd El-Karim and Ashour, 2014; Ashour *et al.,* 2015; Abou El-Ghar and Abd El-Karim, 2016; and Abdelhady *et al.,* 2019). The usefulness of selection procedures for improving productive or reproductive traits depends not only on the direct response itself, but also on the relevant changes in other economic traits due to the response associated with selection. However, selection for body weight may indirectly affect other traits that were not considered in the selection program because the improved trait is correlated with these traits (Abd El-Ghany, 2005; Kosba *et al.,* 2002, and 2006; Ghanem *et al.,* 2007; Saleh *et al.,* 2008; Abd El-karim and Ashour, 2014; Ramadan *et al.,* 2014; Ashour *et al.,* 2015; and Ramzy *et al.,* 2019).

Egg production performance is usually assessed through traits such as age at sexual maturity, egg numbers, and egg weight during a defined period of production (Durmus *et al.,* 2017), these variables are correlated with body weight and with each other in the positive or negative correlation (Saleh *et al.,* 2006 and 2008; Younis *et al.,* 2014; Amin, 2015; and Ashour *et al.,* 2015). Increased egg numbers and egg weight have been the main aims of genetic improvement programs in egg laying (El-Attrouny and Iraqi, 2020).

Egg weight, shell weight, shell thickness, weight of egg yolk and albumen are the important egg traits influencing egg quality, chick weight and hatching performance if other management conditions and fertility are not the limiting factors (Khurshid *et al.,* 2003).

The present work was designed to determine the indirect response in egg production and egg quality traits due to selection for high body weight at eight weeks of age through two successive generations in Dandarawi chicken.

Materials and Methods

The present study was conducted in a Poultry Research Farm, Poultry Production Department, Faculty of Agriculture, Assiut University, through two successive generations from October 2016 until March 2019.

The study was conducted on the flock of Dandarawi chicken strain and the chicks in each generation were divided into two lines, line (S) selected for high body weight was individually selected according to body weights as equal or greater than average of the line (C) that was the control line at 8 weeks of age to the nearest gram. Data included a total of 2932 pedigreed chicks obtained from the mating between 96 sires with 935 dams through two successive generations as presented in Table 1.

Table 1. The number of parents (sires and dams) and progeny by each generation and line

Generation	Selected				Control			
	Sires	Dam	Progeny		Sires	Dam	Progeny	
			Male	Female			Male	Female
1	29	290	365	478	15	150	167	411
2	28	270	409	399	24	225	341	362
Total	57	560	774	877	39	375	508	773

At hatching time, all chicks were weighed, and wing banded according to their pedigree. At 20 weeks of age, all birds of the two lines were leg banded, transferred to laying house, and provided with single nests. During the laying period, mating was applied by assigning about ten females to one male with minimizing inbreeding. During the period of laying the lighting period increased to 16 hours/day by using artificial lighting. All birds in the experiment over generations were kept and reared under the same environmental conditions feeding with a commercial ration and water were supplied *ad-libitum.*

Throughout 7 successive laying periods (28 days each) average of laying rate (ALR%), average of egg weight (AEW) were recorded, and total egg mass (TEM) was calculated by multiplying the number of eggs × weight of eggs. Age at sexual maturity was estimated as the number of days from hatching to the day of laying rate 10% egg production as Al-Harthi (2014).

Regarding egg quality traits, at 48-weeks of age a total of 100 fresh eggs were collected from the two generations, 50 eggs from each generation (25 eggs from each line). An electronic scale was used to weighting the eggs, yolk, and shell to the nearest 0.0001g, while albumen weight was recorded by the difference using the following equation:

$$\text{Albumen weight} = \text{Egg weight} - (\text{yolk weight} + \text{shell weight})$$

Egg length and width (cm) were measured with sliding caliber verines to measure egg shape index from this equation:

$$\text{Egg shape index} = (\text{width of egg}) / (\text{length of egg}) \times 100$$

Table with a flat glass the eggs were broken on a table with a flat glass to measure the internal egg quality traits. The percentages of eggshell, albumen and yolk were expressed relative to egg weight. Yolk was separated gently from the albumen part was weighed. A micrometer sensitive to 0.01mm was used for measuring the height of yolk and albumen and the diameter of yolk was measured with sliding caliber verines to the nearest centimeter and transformed to millimeter. Haugh units were calculated by using the formula of (Haugh, 1937) as follow:

$$\text{Haugh unit} = 100\ \text{Log}\ (\text{H} - 1.7\ \text{W}\ 0.37 + 7.6)$$

Where: H = albumen height (mm), W = egg weight (g).

Yolk index was measured by using this equation:

$$\text{Yolk index} = (\text{yolk height}) / (\text{yolk diameter}) \times 100$$

After removing the albumen and yolk, eggshell and its shell membranes were dried by air carefully, and eggshell weighed to calculate eggshell percentage. Shell thickness was measured to the nearest millimeter (mm) by using a sensitive micrometer (0.01mm) as described by Brant and Shrader (1952).

Statistical Analysis

Data were statistically analyzed by using the international software program SAS 9.2 (SAS institute, 2009).

Egg production and egg quality traits were analyzed by using the following General linear model (GLM) of SAS software:

$$Yijk = \mu + GI + LJ + (GL)IJ + eIJK.$$

Where, Y_{ijk} = the observation for any individual in each variable, μ = population mean, G_I = effect of generation (i = 1, 2), L_J = effect of line (j = 1, 2), $(GL)_{IJ}$ = the interaction (generation × line), e_{IJK} = the experimental error.

Differences between means were tested by Duncan' s new Multiple Range Test (Duncan, 1955) at 5%.

Results and Discussions

Egg production traits

Least square means of age at sexual maturity (days) in both control and selected line over generations are presented in Table (2). Means of age at sexual maturity were 161.47 and 165.44 days for control and selected line over generations, respectively. As shown in Table 2, significant differences were found between generations in age at sexual maturity ($P\leq0.01$). Similar results were reported by EL-Dlebshany (2004) and Ashour *et al.* (2015), but the differences between lines and the interaction between generations by lines were not significant. On the contrary, they found significant differences ($P\leq0.01$) between lines and the interaction between generations and lines. The pullets of the second generation matured earlier than that in the first generation. In contrast, they found the pullets of the second generation were matured later than those in the base generation. It was noticed that selection to higher body weight at 8 weeks of age in selected line pullets matured later than those in the control line. Similar results were reported by Saleh *et al*. (2008) and Ashour *et al.* (2015).

Least square means of averages of egg weight (g), laying rate (%), and total egg mass (g) for 7 successive laying periods (each 28 days) of control and selected line over generations are presented in Table (2). Means of egg weight were 47.48 and 48.30 g for control and selected line over generations, respectively. As shown in Table 2, significant differences ($P\leq0.01$) were found between generations and lines, but their interaction was not significant. It was observed that selection for body weight led to increase egg weight in the selected line and the birds in selected line had heavier egg weight than those of the control line. Similar results were detected by Ashour *et al.,* (2015); Saleh *et al.* (2008); Abd El-Ghany (2005) and Saleh *et al.* (2002). Mean of laying rates, recorded 37.88 and 34.07 % for control and selected line over generations, respectively. The result indicated that the selected line had lower laying rate than that of control. There were highly significant differences (P≤0.01) between generations and lines, but their interactions were not significant as shown in Table (2). Similar results were claimed by EL-Dlebshany (2004) and Ashour *et al.* (2015). In contrast, Maloney *et al.* (1963) and Hossari (1974) reported that selection to increase body weight at 8 weeks of age had no significant effect on egg laying rate in Fayoumi hens.

The mean of total egg mass was 4021 and 3927 g for control and selected line over generations, respectively. There were significant differences (P≤0.05) between generations and lines, while the interaction between generations and lines were not significant as shown in Table (2). This result agreed with those reported by Ashour *et al.* (2015). On the contrary, they found significant interaction between generations by lines for egg mass. It noticed that selection for body weight decreased total egg mass in the selected line where the selected line birds had lower total egg mass than in the control line, because the laying rate in selected line (34.07 %) was lower than that of control line (37.88 %). Referring to the not significant interactions, it could indicate that the main effects affected directly on the studied traits.

Table 2. Least squares means* ± S.E of egg production traits in Dandarawi chicken as affected by generation, line, and their interaction

		ASM (d)	ALR (%)	AEW (g)	TEM (g)
Generation effect					
G1		171.52±0.48[a]	35.32 ±0.29[b]	47.70±0.10[b]	3932.95±53.60[b]
G2		154.26±0.09[b]	37.09 ±0.24[a]	48.20±0.14[a]	4029.78 ±51.74[a]
Line effect					
Control		161.47±1.14	37.88±0.26[a]	47.48±0.13[b]	4021±52.12[a]
Selected		165.44±1.44	34.07±0.27[b]	48.30±0.11[a]	3927±53.12[b]
Interaction between (generation x line)					
G1	**Control**	170.78±0.38	37.46±0.45	47.61±0.15	3661±78.53
	Selected	172.15±0.82	33.51±0.36	47.79±0.14	4189±72.08
G2	**Control**	154.33±0.13	38.21±0.30	47.27±0.26	4320±67.93
	Selected	154.13±0.09	35.00±0.40	48.70±0.16	3484±70.02
Significances					
Generation		**	**	**	*
Line		NS	**	**	*
Generation*line		NS	NS	NS	NS

G1= First generation, G2= Second generation, ASM (d) = Age at sexual maturity, AEW (g) = Average egg weight, ALR (%) = Average laying rate, TEM (g) = Total egg mass (7 laying periods).
* Any two least square means with different superscript within each trait within each classification are significantly different (P≤0.05). *:P≤0.05, **:P≤0.01, NS: not significant.

Egg quality traits

Least square means of egg quality traits in both control and selected line over generations are presented in Table (3). No significant were found among generations for egg weight, egg shape index, albumen percent, yolk percent, yolk index, shell percent and eggshell thickness, in contrast, significant differences (P≤0.05) were found for Haugh units as shown in Table (3). Egg weight at 48 weeks of age was 48.93 and 50.97 g for control and selected line over generations, respectively. There were highly and significant differences between lines in egg weight, albumen percent, yolk index and eggshell thickness (P≤0.01 and P≤0.05) as shown in Table (3). No significant interactions among generations and lines for egg weight, egg shape index, albumen percent, yolk percent, and shell percent. In general, the selection for high body weight at 8 weeks of age in Dandarawi chicken had a slight effect on egg quality traits because these traits depend on different environmental factors such as temperature, feeding, and storage conditions.

Table 3. Least squares means* ± S.E of egg quality traits as affected by generation, line, and their interaction

		Egg weight (g)	Egg S. I. (%)	Albumen (%)	Haugh Units	Yolk (%)	Y. I. (%)	Shell (%)	S. Th. (mm.)
Generation effect									
G1		50.01±0.54	77.95±0.51	56.66±0.40	85.60±1.00[b]	32.84±0.37	50.49±0.89	10.50±0.1	0.38±0.0
G2		49.90±0.56	77.34±0.41	56.55±0.40	87.93±0.70[a]	33.16±0.36	50.37±0.47	10.29±0.1	0.38±0.0
Line effect									
Control		48.93±0.58[b]	77.77±0.47	56.13±0.44[b]	86.21±1.04	33.40±0.40	48.25±0.72[b]	10.47±0.1	0.37±0.0[b]
Selected		50.97±0.48[a]	77.51±0.46	57.08±0.35[a]	87.32±0.67	32.60±0.32	52.62±0.56[a]	10.32±0.1	0.38±0.0[a]
Interaction between (generation x line)									
G1	**Control**	49.44±0.79	78.00±0.78	56.29±0.62	82.74±1.60[c]	33.06±0.58	47.28±1.22[c]	10.65±0.1	0.38±0.0[a]
	Selected	50.58±0.75	77.90±0.66	57.03±0.50	88.46±0.89[ab]	32.62±0.48	53.70±0.95[a]	10.35±0.1	0.37±0.0[a]
G2	**Control**	48.42±0.86	77.55±0.54	55.97±0.63	89.68±0.92[a]	33.75±0.57	49.22±0.73[bc]	10.28±0.1	0.36±0.0[b]
	Selected	51.37±0.60	77.12±0.64	57.13±0.49	86.17±0.95[b]	32.57±0.43	51.53±0.53[ab]	10.30±0.1	0.39±0.0[a]
Significances									
Generation		NS	NS	NS	*	NS	NS	NS	NS
Line		**	NS	*	NS	NS	**	NS	*
Generation* line		NS	NS	NS	**	NS	*	NS	*

G1= First generation, G2= Second generation, Egg S. I. = Egg Shape Index, Y. I. = Yolk Index, S. Th. = Shell Thickness.

* Any two least square means with different superscript within each trait within each classification are significantly different (P≤0.05). *:P≤0.05, **:P≤0.01, N.S: not significant.

Conclusion

In conclusion, the current study showed that selection for high body weight at 8 weeks of age in Dandarawi chicken tend to delay the age at sexual maturity, decrease laying rate, increased egg weight and decreased total egg mass in the selected line, also egg quality was slightly affected as an indirect response to selection.

Finally, this program of selection should be on-going to improve the productive performance in Dandarawi chicken by selection for high body weight at eight weeks of age.

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الاستجابة غير المباشرة في صفات إنتاج البيض وجودة البيض نتيجة الانتخاب لوزن الجسم عند عمر ٨ أسابيع في دجاج الدندراوى

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الملخص

تهدف صناعة الدواجن أساسا الي إنتاج طيور متفوقة وراثيا وذات إنتاجية عالية من اللحم والبيض. أجريت التجربة الحالية على دجاج الدندراوى المنتخب لوزن الجسم العالي عند عمر ٨ أسابيع خلال جيلين متتاليين لتحديد الاستجابة غير المباشرة في صفات إنتاج البيض وجودة البيض. وتم دراسة الصفات التالية العمر عند النضج الجنسي، معدل الوضع، وزن البيضة، كتلة البيض الكلية وجودة البيض.

أوضحت النتائج وجود فروق معنوية جدا في العمر عند النضج الجنسي ومعدل الوضع ووزن البيضة متأثرة بالأجيال وايضا كان تأثير الجيل معنوي فقط على كتلة البيض الكلية. نضجت دجاجات الخط المنتخب متأخرة (165.44 يوم) عن مثيلتها في خط الكنترول (161.47 يوم). وعلاوة على ذلك، وضعت الطيور في الخط المنتخب بيض ذات وزن عالي مقارنة بخط الكنترول. أيضا لا توجد أي تداخلات معنوية بين الأجيال والخطوط في كل صفات إنتاج البيض. فيما يتعلق بصفات جودة البيض، كان وزن البيض معنوي جدا متأثرة بالخطوط، وكانت نسبة البياض وسمك قشرة البيض معنوية فقط متأثرة بالخط.

نستنتج أن الانتخاب لوزن الجسم عند عمر **8** أسابيع أدي الي تأخير العمر عند النضج الجنسي وانخفاض معدل الوضع وزيادة وزن البيضة وانخفاض كتلة البيض الكلية في طيور الخط المنتخب كاستجابة غير مباشرة للانتخاب. تأثرت صفات جودة البيض بشكل طفيف عن طريق الانتخاب لوزن الجسم العالي عند عمر **8** أسابيع.