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A COMPARATIVE STUDY ON PAUSE AND CLUTCH SIZE TRAITS IN RELATION TO EGG PRODUCTION TRAITS IN THREE LOCAL BREEDS OF CHICKENS.

By

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Abstract: - *The records of 305 Dandarawi (Dand), 303 Fayoumi (Fay) and 452 Golden Montazah (GM) hens from Fayoum Poultry Research Station were used in this study. Four measurements for clutch and pausing traits were calculated for each hen within the studied breeds. These traits were: the average clutch size (number of eggs per clutch of each hen,* CS_{90}*), the number of clutches (*CN_{90}*), the average length of pause duration (*PD_{90}*) and the occurrence number of pauses (*PN_{90}*). GM had significantly (*$P\leq0.01$*) higher* CS_{90} *mean and standard error (3.69 and 0.22) than other breeds whereas Fay showed significantly (*$P\leq0.01$*) higher* CN_{90}*,* PD_{90} *and* PN_{90} *(22.63, 2.24 and 22.9, respectively). Egg number, egg mass in the first 90 days of production and* PD_{90} *for all breeds showed considerable maternal effects. However, higher estimates for* h^2_S *than those calculated from the dam components indicated existence of sex-linked effects on* CS_{90} *for the three breeds studied and* CN_{90} *and* PN_{90} *for Dandarawi and Golden Montazah breeds.*

Phenotypic and genetic correlations between pause and clutch size traits and with some egg production traits for the breeds studied were also calculated.

Individual selection for improving CS_{90}*, CN90,* PN_{90} *and* PD_{90} *traits would be more useful for Golden Montazah. It can be concluded that, GM had a good merit of the egg production performance than other breeds. Expected genetic response for GM to individual selection was estimated to be 3.76, 9.65, 10.27 and –1.21 for the four traits, respectively. For selecting both Dand and Fay females for either* CS_{90} *or* CN_{90}*, family selection based on full sib showed better efficiency compared to individual selection when family size was six hens. Family selection based on full sib showed better efficiency than on half sib. However, for selecting males, sib selection based on full sib showed better efficiency when family size was at least eight hens.*

It can be seen that the bigger the family size, the better the efficiency was. The expected reduction in PD_{90} after one generation of individual selection for either GM or Dand had a considerable reduction in pause length. Moreover, the lower value for CS_{90} recorded for Fay (1.84 egg) and a relative longer PD_{90} (2.24 days) and a lower h^2 than both GM and Dand suggested the need for selection to increase its CS_{90}. Family selection reduced PD_{90} and increased clutch traits for Fay and it would be useful for improving egg production in the first 90 days. However, individual selection for improving these traits would be more useful for GM and Dand. A selection index including clutch, pausing traits and a full record of egg production is suggested.

INTRODUCTION

Since egg production in laying hens strongly exhibits cyclic process in which eggs are laid at the interval of about 24 to 27 hours or more, depending mainly on their laying performance and age. Egg production is treated as clutches in which clutch consists of the eggs laid in consecutive days and is terminated by a pause of one or more non-productive days (**Minh *et al*., 1996**). Production of multiple clutches may be energetically demanding as reported by **Ricklefs (1974 and 1977)**, thus selection is expected to favor reduction of costs associated with the production of individual clutches. **Ross (1979)** revealed that females may reduce costs of multiple clutch production through three mutually non exclusive ways. First, females may lay small eggs. Second, females may evolve larger body size, thereby reducing the relative costs of egg production. Third, females may adopt a variable mating behavior that allows them to take advantage of abundant of food that can be allocated to egg production**.** Moreover, chicks originated from larger clutches had better viability than those from smaller clutches if raised under identical conditions as reported by **Both *et al*. (1998)**. High heritability of clutch size (CS) along with genetic correlations with egg number and egg mass were reported by **Shebl** (**1998**), indicating that selection of hens based on for CS to improve egg production may be more advantageous than selection for egg number. Therefore, CS constitutes a reasonably good indicator of rate of laying and represented an effective tool in selection for egg production than selection for egg number itself (**Van Albada and Timmermans, 1973**). The strong correlations between hen-day egg production and clutch size observed in flocks of laying hens (**Robinson *et al.,* 1992**) may have implications in selection for increasing egg production. In addition, the information of CS in the early laying periods from the onset of lying was used to predict total egg produced for periods of 270 and 360 days of production as reported by (**Minh *et al*.,**

1995). **Sabri *et al.* (1994)** showed that improving egg production for Fayoumi could be realized through selection to reduce pause duration (PD) and increase CS, therefore, a selection index including both traits and yearly egg number would be suggested. **Thangaraju *et al.* (1978) and Shebl (1998**) reported that genetic and phenotypic correlations between CS and egg number tended to be positive and high, however, **Sabri *et al.* (1994)** found negative and high genetic and phenotypic correlations, suggesting that correlated responses of egg production when selecting for CS or against longer pauses would be high in magnitude.

Accurate estimates of genetic parameters with pause and CS traits as a criteria of selection are needed to accurately predict responses to direct and indirect selection. This study aimed to evaluate the inheritance of pause and clutch traits and their relationships with egg production traits for three studied Egyptian breeds: Dandarawi, Fayoumi and Golden Montazah.

MATERIALS AND METHODS

This work was carried out during the period from June 1998 to February, 1999 on Dandarawi (Dand), Fayoumi (Fay) and Golden Montazah (GM) pullets maintained by El Azab Poultry Research Center, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

The structure of the breeds used is shown in Table 1. Twelve sires were used for each breed where each was mated to 10 hens to produce the females used in this study. A total of 305 Dand, 303 Fay and 452 GM offspring females that produced in about four to seven successive pedigreed hatches, seven days apart, were used in this study. Therefore, at 20 weeks of age, the pullets were moved and kept into individual battery cages to record their first 90 days of egg production. The feeding and management practices were kept uniform as possible throughout the experimental period.

Table 1: The structure of the breeds used.

Breed	Number of hatches	Number of			Family size	
		Sire	Dam	Offspring	Sire	Dam
Dand	7	11	100	305	27.72	3.05
Fay	4	10	79	303	29.99	5.11
GM	7	10	89	452	45.2	5.08

The following traits were recorded for each hen: Age at sexual maturity (SM) individually recorded in days. Egg mass (EM_{90}) in grams was obtained by multiplying egg weight and egg number laid during the first 90 days of age and were recorded foreach hen for each breed. Two measurements for either clutch or pausing traits were considered during the first 90 days of production. They were the average clutch size (number of eggs per clutch of each hen, CS_{90}) was calculated by dividing egg number by number of clutches, the number of clutches (CN_{90}), the average length of pause duration (PD_{90}, the non-productive days) and the occurrence number of pauses (PN_{90}).

Statistical Analyses

Before estimating genetic parameters, data were corrected for hatch effects within each breed. The hierarchical analyses of variance and covariance were done to compute the heritabilities (h^2) according to **Kempthorne (1957)** for egg production traits clutch and pause traits, genetic and phenotypic (rg and rp) correlations among the studied characters using **SAS (2000)**.

The following model was fitted, for each breed, to each of the studied traits to calculate the genetic parameters:

$$\mathbf{Y_{ijk} = \mu + S_i + D_{ij} + e_{ijk}}$$

Where:

$\mathbf{Y_{ijk}}$: expresses the observation of the ijkth hen, μ: is the overall mean, S_i: is the effect of ith sire, $\mathbf{D_{ij}}$**:** is the effect of the jth dam mated to ith sire, $\mathbf{e_{ijk}}$: is the error term accounted for the kth hen of the jth dam and ith sire. The standard errors of heritabilites were obtained according to **Swiger *et al* (1964)**. The standard errors of genetic correlations were computed according to the approximation methods of **Robertson (1959).** Standard errors for phenotypic correlations were calculated according to **Becker (1985)**.The expected genetic response after one generation of individual, family and sib selection were estimated according to **Lush (1947)** and **Falconer (1989)** as the following:

Method of selection	Expected response (R)
Individual	$\mathbf{R= i\delta_P h^2}$
Family selection	$\mathbf{R= i\delta_P h^2 *(1+(n-1)r)/ \sqrt{n}[1+(n-1)t]}$
Sib selection	$\mathbf{R= i\delta_P h^2*(nr)/ \sqrt{n}[1+(n-1)t]}$

i: intensity of selection (selection differential in standard measure): assumed to be equal for all methods, $\boldsymbol{\delta_P}$: standard deviation of phenotypic values of individuals, $\mathbf{h^2}$: heritability of individual values, **r**: intra-class correlation with full-sib families **r =1/2** and with half-sib families **r =1/4, t**: correlation of phenotypic values of members of the families and **n**: number of individuals in the families**.**

The intensity **of** selection was determined according to **Becker (1985)** by assuming a flock contained not less than 400 individuals of each sex and that 20% of each sex to be selected. The effect of family size on family and sib selection was studied. For full sib families the range of family size used was from 2 to 8 individuals per family, for half sib families the range was from 4 to 16 individuals per family. The efficiencies for both family and sib selections compared to individual selection were calculated according to **Falconer (1989).**

RESULTS AND DISCUSSION

As shown in Table 2, Dand reached sexual maturity 5.29 or 16.83 days earlier than GM and Fay breeds, respectively. Similar results were observed by **Saleh *et al.* (1994)** and **El Full *et al.* (2005).** Earlier age at sexual maturity was reported by several authors for native or foreign breeds ranging from 129 to 170.7 days (**Sharaby, 1998 and Shebl, 1998**) . Dand hens had significantly ($P \leq 0.01$) higher EN_{90} than GM or Fay (64.16 vs 61.44 and 40.9 eggs, respectively). GM had the heaviest **EW_{90}** or **EM_{90}** (48.28 and 2966.32g, $P \leq 0.01$) whereas Fay had the lowest EM_{90} being 1969.2g as shown in Table 2. Lower EN_{90} ranging between 23.1 to 57.04 eggs for most native or White Leghorn breeds was cited by **El Hossari *et al.* (1995), Shebl (1998) and Sharma *et al.*, 1999)**. **Ragab (1996)** reported heavier EW for Dand (42.39) whereas, lower estimates of EW (36.19) was reported by **Abdel Galil (1993)**. Similar trend for EM was reported by **Kader and El Sayed (1986)**. However, lower EM estimates were cited by Sharaby **(1998)**. GM had significantly ($P \leq 0.01$) higher CS mean and standard error (3.69 ± 0.22) than other breeds whereas Fay showed significantly ($P \leq 0.01$) higher CN, PD and PN (22.63, 2.24 and 22.9, respectively). **Sabri *et al.* (1994)** reported higher CS and PD (2.16 egg and 4.18days) for Fay selected for high egg number for five generations and lower PN of 20.57 during 365 days of production than estimates of the present study. However, **Shebl (1991)** reported lower CS of 1.82 in Alexandria strain.

Heritability estimates for different traits studied based on sire (h^2_S), dam (h^2_D) and sire+dam (h^2_{S+D}) component of variance are presented in Table 3. Higher h^2_D estimates than h^2_S for SM in Dand, EN_{90}, EM_{90}, PD_{90} for all breeds studied and PN_{90} for Fay indicated maternal effects on these traits. Combined estimates showed moderate magnitude for these traits. Similar trend was reported by **Sabri *et al.* (1994)** that CS showed considerable maternal effects. However, higher estimates for h^2_S than those calculated from the dam components indicated existence of sex-linked effects on SM (**Becker, 1985**) for Fay, EW_{90} for Dand and Fay, CS_{90} for the three breeds studied, CN_{90} for Dand and PN for Dand and GM. This was in agreement with **Hossari (1976)** and **Sabri *et al.* (1994)** who found evidence of sex-linkage in the inheritance of these traits in Fay. Estimates of h^2_{S+D} for EM_{90} ranged from 0.23 to 0.45 for different breeds in the present study which were within the range of those published by **Arboleda *et al.* (1976)**, **Thangaraju *et al*. (1978), Barua *et al*. (1986), Kalita and Das (1987)** , **Zanella *et al*. (1988)** and **Shebl (1991)**. The h^2_{S+D} estimates for CS_{90} were 0.26, 0.09 and 0.57, respectively for Dand, Fay and GM. **Shebl (1991)** reported h^2_{S+D} for CS in Alexandria strain of 0.19 while those reported by **Thangaraju *et al*. (1978), Dixit *et al.* (1986)** and **Singh *et al*. (1990)** were 0.88, 1.07, 0.06 and 0.47 . The high values of heritability may be due to correction of hatch effect which may have trimmed the phenotypic variability to some extent (**Ayyagari *et al*., 1985**). Moreover**, King and Henderson (1954)** reported that the adjustment of hatch effects decreased the environmental component by 30 to 40% thereby increasing the estimates of heritability for production traits. Since the heritability estimates of different traits were high in magnitude, individual selection for these traits would be an effective criterion to make progress for all studied traits except SM in Dand and for EW_{90} and PD_{90} of GM flocks. However, Fay had very low h^2 estimates for both CN and PN ranging from 0.03 tom 0.09 (Table 3). **Abdel Gawad and El Ibiary (1971)** reported averages of 0.11 and 0.14 for heritabilities of PD and PN. However, **Kruger *et al.* (1952)** reported that heritability of PD ranged from 0.16 to 0.20.

Phenotypic Correlations

Phenotypic correlations among pause and clutch size traits for the breeds studied are presented in Table 4. In all breeds**,** CS_{90} was negatively correlated with CN_{90}, PN_{90} and PD_{90}. Similar trends of negative correlations were found between PD_{90} and each of CN_{90}, PN_{90} but lower in magnitude. However, CN_{90} was positively correlated with PN_{90}.

Although Fay's PN_{90} had high r_P's with other traits of clutch or pausing, it was not a good indicator for egg production compared to PD, since some hens recorded few numbers of pauses. However, the pauses were too long and in some cases lasted to the end of production year (**Sabri *et al.*, 1994**). This was decided because of the low h^2 of Fay's PN, indicating small additive variance for this trait. However, Dand and GM had higher h^2_S for this trait being 0.38 and 0.67 (Table 3).

As shown in Table 5, all breeds showed low rP among SM and either clutch or pause traits. In both Dand and GM, as CS_{90} or PD_{90} increased EW_{90} decreased, however, in GM EW_{90} positively correlated with

CN_{90} and PN_{90}. This is inagreement with the findings of **Sabri *et al.* (1994)** for Fay that PD was positively correlated with SM. However, Fay in the present study showed lower correlations but opposite in direction than those found in Dand and GM for EW. As CS_{90} increased both EN_{90} and EM_{90} increased in Dand and Fay. This is in agreement with the finding of **Sabri *et al.* (1994).** There were negative associations between EN_{90} and each of CN_{90} and PN_{90} in Dand and GM, whereas, EN_{90} positively correlated with these traits in Fay. Estimates of positive phenotypic correlation moderate in magnitude were found between EM_{90} and each of CS_{90}, CN_{90} and PN_{90} in Dand and Fay. However, lower and negative phenotypic correlations were found between EM_{90} and these traits in GM as shown in Table 5. This is expected since GM had negative relationships between EN_{90} and these traits.

Genetic Correlations

In all breeds, the genetic correlations (r_g) between CS_{90} and each of CN_{90} and pausing traits were mostly negative higher than their corresponding r_p's as shown in Tables 4 and 6, indicating the big influence of environmental factors on these relationships. A wide range of genetic correlations between CN_{90} and pausing traits was found and ranged from 0.09 to 1.00 in Dand and GM. Positive r_g estimates were found between $PN_{90}$and CN_{90} in Dand and GM, whereas a low negative r_g of -0.19 was found between these traits. A wide range of positive genetic correlations between PN_{90} and CN_{90} and pausing traits was found and ranged from 0.07 to 1.17 in Dand and GM. Although, no phenotypic correlations were found between SM and either clutch or pausing traits in all breeds. There were low to moderate positive genetic correlations between SM and each of CS for all breeds ranging from 0.15 to 0.41. Conversely, SM was negatively correlated with CN_{90} and PN_{90} in Dand and GM. However, it was positively associated with these traits in Fay (Table 7). Very low negative rg estimates were shown in Dand between EW_{90} and CS_{90}, CN_{90} and PN_{90}, however EW_{90} was positively correlated with PD_{90} (0.16). Similar trends of negative rg's were found in Fay between EW_{90} and each of CN_{90} whereas, GM indicated positive rg of 0.31 between EW_{90} and both CN_{90} and PN_{90}. Either Dand or Fay had low positive rg ranging between 0.16 and 0.18 between EW_{90} and PD_{90}, indicating that egg weight increased as pause duration increased. However, GM had negative low rg between the same two traits as shown in Table 7.

Regarding rg's based on S+D components of variance and covariance, both Dand and GM had positive rg between EN_{90} and CS_{90} being 0.19 and 1.00, however, Fay showed negative associations between these traits (-0.16). Similar trends of negative genetic correlations ranging from -0.16 to -0.98 were found between EN_{90} and each of CN_{90}, PN_{90} and PD_{90} for all breeds, except the rg between EN_{90} and PD_{90} in Fay being 0.86. This is expected, because long and multiple pauses led to decrease egg production as shown in Table 7. No genetic correlations were found between EM_{90} and each of CS_{90} in Fay, CN_{90} and PN_{90} of GM. EM_{90} had similar trends with CS and pause traits as those obtained with $EN_{90,}$ except the moderate positive rg between EM_{90} and CN_{90} as shown in Table 7.

Expected Genetic Response to Selection

The breeds used in the present study weren't subjected to selection for any traits. The expected genetic responses as gain in $CS_{90,}$ CN_{90} or loss in PN_{90} and PD_{90} after selection for one generation are presented in Tables 8 and 9. The genetic response for individual selection was calculated according to **Falconer (1989)**. GM had the highest expected gain in either CS_{90} or CN_{90} due to individual selection, whereas Fay showed the lowest expected gain for these traits. Similar trend was observed for pausing traits. This is expected since GM had higher heritability estimates for these traits than other breeds. Selection intensity used was based on the assumption that 20% of each sex to be selected. However, selecting only 10% of the males would increase the intensity of selection for males from 1.4 to 1.755 (**Backer, 1987**).

For selecting both Dand and Fay females for either CS_{90} or CN_{90}, family selection based on full sib showed better efficiency compared to individual selection when family size was six hens. Family selection based on full sib showed better efficiency compared to family selection based on half sib (Table 8). However, for selecting males, sib selection based on full sib showed better efficiency when family size was at least eight hens. The average genetic response can be estimated as the average of the genetic response of both sexes. It is clear that the bigger the family size, the better the efficiency was.

The expected reduction in PD_{90} after one generation of individual selection for either GM or Dand would be a considerable reduction in pause length. Moreover, the lower value for CS_{90} recorded for Fay (1.84 egg) and a relatively longer PD_{90} (2.24 days) and a lower h^2 than both GM and Dand suggested the need for selection to increase its CS_{90}.

It was clear that, GM had heavier EM_{90}, longer CS_{90}, lower and a relatively short PD_{90} followed by Dand than the Fay which means a good merit of the egg production performance of the former breeds than the latter. Results of the present study suggested that family selection to reduce PD_{90} and increase clutch traits for Fay would be useful for improving egg production in the first 90 days (Table 9). However, individual selection for improving these traits would be more useful for GM and Dand

The tested breeds could be followed different production curves. Therefore, it is recommended in future to test the productivity for longer period than 12 weeks. In conclusion, in spite of the reproductive merit of either GM or Dand than Fay, their productive efficiency still need improvement through applying a consistant and sustainable breeding program. These future studies must test and improve their full record of egg production to clarify the persistency of production. On the other hand, we need to compare among one or more than commercial hybrids with these native breeds under same traditional conditions taking into consideration their relative economic efficiency, cost and total yield . A selection index including clutch, pausing traits and a full record of egg production is suggested.

Table 2: Means ± SE for different traits of the studied breeds.

Trait	Dand	Fay	GM
SM	170.17±0.33 ^{c}	187.00±1.77^{a}	175.46±0.80 ^{b}
EW_{90}	40.00±0.30 ^{b}	40.80±0.21 ^{a}	48.28±0.75 ^{a}
EN_{90}	64.16±0.66 ^{a}	40.90±0.36 ^{c}	61.44±1.06 ^{b}
EM_{90}	2566.40±29.04 ^{b}	1669.20±17.50 ^{c}	2966.32±1.08 ^{a}
CS_{90}, egg	3.32±0.08 ^{b}	1.84±0.03 ^{c}	3.69±0.22 ^{a}
CN_{90}	19.22±0.33 ^{b}	22.63±0.25 ^{a}	18.09±0.69 ^{b}
PD_{90}, days	1.58±0.03 ^{c}	2.24±0.03 ^{a}	1.69±0.05 ^{b}
PN_{90}	18.78±0.33 ^{b}	22.9±0.25 ^{a}	17.56±0.69 ^{c}

Means within the same row had different superscripts are significantly different at P≤ 0.01.

Table 3: Heritability estimates ± SE for different traits of the studied breeds.

Breed		SM	EW_{90}	EN_{90}	EM_{90}	CS_{90}	CN_{90}	PD_{90}	PN_{90}
Dand	**S**	0.11±0.26	0.99±0.38	0.15±0.28	0.28±0.29	0.43±0.26	0.30±0.28	0.55±0.24	0.38±0.27
	D	0.22±0.37	0.14±0.28	0.37±0.39	0.29±0.37	0.10±0.31	0.18±0.35	0.71±0.52	0.01±0.32
	S+D	0.16±0.23	0.57±0.23	0.26±0.24	0.28±0.23	0.26±0.20	0.24±0.22	0.62±0.25	0.19±0.21
Fay	**S**	0.20±0.15	0.15±0.13	0.05±0.05	0.08±0.06	0.10±0.11	0.04±0.07	0.01±0.04	0.04±0.07
	D	0.18±0.22	0.11±0.21	0.39±0.15	0.37±0.16	0.08±0.21	0.03±0.20	0.33±0.17	0.09±0.19
	S+D	0.19±0.12	0.13±0.12	0.23±0.08	0.23±0.08	0.0±0.11	0.04±0.0	0.16±0.08/	0.07±0.09
GM	**S**	0.12±0.09	***	0.25±0.27	0.12±0.24	0.76±0.45	0.66±0.41	0.39±0.44	0.67±0.42
	D	0.12±0.15	0.24±0.25	0.51±0.39	0.77±0.43	0.39±0.33	0.28±0.33	1.22±0.51	0.33±0.34
	S+D	0.12±0.08	0.87±0.38	0.38±0.20	0.45±0.21	0.57±0.26	0.47±0.24	0.81±0.21	0.50±0.25

Table 4: Phenotypic correlations ± SE among pause and clutch size traits for the studied breeds.

Breed	Trait	CS_{90}	CN_{90}	PN_{90}	PD_{90}
Dand	CN_{90}	-0.69±0.03		0.97±0.01	-0.27±0.06
	PN_{90}	-0.71±0.03	0.97±0.01		-0.20±0.06
	PD_{90}	-0.16±0.07	-0.27±0.06	-0.20±0.06	
Fay	CN_{90}	-0.84±0.02		0.99±0.01	-0.32±0.07
	PN_{90}	-0.85±0.02	0.99±0.01		-0.31±0.08
	PD_{90}	-0.09±0.08	-0.32±0.07	-0.31±0.08	
GM	CN_{90}	-0.84±0.02		0.99±0.01	-0.32±0.07
	PN_{90}	-0.85±0.02	0.99±0.01		-0.31±0.08
	PD_{90}	-0.09±0.08	-0.32±0.07	-0.31±0.08	

***: Imaginary values.**

Table 5: Phenotypic correlations ± SE among egg production traits and both pause and clutch size traits for the studied breeds.

Breed	Trait	CS_{90}	CN_{90}	PN_{90}	PD_{90}
Dand	SM	0.03±0.06	0.03±0.06	0.03±0.06	-0.05±0.43
	EW_{90}	-0.12±0.06	0.17±0.06	0.18±0.06	-0.20±0.37
	EN_{90}	0.53±0.02	-0.42±0.05	-0.45±0.05	-0.16±0.31
	EM_{90}	0.44±0.02	0.31±0.05	0.33±0.05	-0.18±0.29
Fay	SM	0.04±0.06	-0.08±0.06	-0.07±0.06	0.09±0.06
	EW_{90}	0.04±0.04	-0.02±0.06	-0.01±0.06	-0.01±0.06
	EN_{90}	0.33±0.05	0.51±0.04	0.4±0.04	-0.73±0.03
	EM_{90}	0.31±0.05	0.47±0.04	0.46±0.0	-0.68±0.03
GM	SM	***	0.06±0.08	0.05±0.08	-0.02±0.08
	EW_{90}	***	0.44±0.07	0.43±0.06	-0.14±0.08
	EN_{90}	***	-0.30±0.07	-0.32±0.07	-0.60±0.05
	EM_{90}	***	-0.09±0.08	-0.11±0.08	-0.28±0.08

***: Imaginary values.**

Table 6: Genetic correlations (r_g) ± SE among pause and clutchsize traits for the studied breeds.

Breed		r_g	CS_{90}	CN_{90}	PN_{90}	PD_{90}
Dand	**CN_{90}**	**S**	1.00±0.00		1.05±0.05	0.48±0.35
		D	-0.83±0.56		2.19±3.30	-0.29±0.73
		S+D	-0.93±0.05		0.98±0.23	0.12±0.26
	PN_{90}	**S**	-0.91±0.09	1.05±0.05		0.29±0.49
		D	-3.44±20.11	2.19±3.30		-0.18±1.79
		S+D	-0.98±0.01	0.98±0.23		0.17±0.42
	PD_{90}	**S**	-0.09±0.58	0.48±0.35	0.29±0.49	
		D	0.09±0.81	-0.29±0.73	-0.18±1.79	
		S+D	-0.02±0.73	0.12±0.26	0.17±0.42	
Fay	**CN_{90}**	**S**	-0.42±0.79		0.98±0.06	-0.67±1.82
		D	-4.50±53.42		-1.08±0.47	1.14±0.22
		S+D	-2.24±5.02		-0.19±1.89	0.90±0.11
	PN_{90}	**S**	-0.46±0.74	0.98±0.06		-0.43±2.79
		D	-1.84±3.96	-1.08±0.47		1.81±2.80
		S+D	-1.22±0.44	-0.19±1.89		1.17±0.29
	PD_{90}	**S**	-1.70±4.95	-0.67±1.82	-0.43±2.79	
		D	0.79±0.30	1.14±0.22	1.81±2.80	
		S+D	0.41±0.66	0.90±0.11	1.17±0.29	
GM	**CN_{90}**	**S**	-1.03±0.03		1.00±0.00	0.59±0.19
		D	-0.86±0.18		1.00±0.00	-0.33±0.44
		S+D	-0.98±0.01		1.00±0.15	0.09±0.25
	PN_{90}	**S**	-1.04±0.04	1.00±0.00		0.58±0.29
		D	-0.83±0.23	1.00±0.00		0.32±0.64
		S+D	-0.97±0.02	1.00±0.15		0.07±0.34
	PD_{90}	**S**	-0.27±0.41	0.59±0.19	0.58±0.29	
		D	-0.28±0.71	-0.33±0.44	0.32±0.64	
		S+D	-0.25±0.49	0.09±0.25	0.07±0.34	

Table 7: L Genetic correlations (r_g) ± SE among egg production traits and both pause and clutch size traits and for the studied breeds.

Breed		Base of estimate	SM	EW_{90}	EN_{90}	EM_{90}
Dand	CS_{90}	S	0.17±0.83	0.11±0.33	0.81±0.26	0.61±0.35
		D	0.94±0.18	-0.89±0.36	***	***
		S+D	0.41±0.60	-0.04±0.39	1.00±0.02	0.84±0.13
	CN_{90}	S	-0.29±0.97	0.06±0.41	-0.58±0.62	-0.29±0.63
		D	-0.72±0.64	-0.34±1.24	***	***
		S+D	-0.48±0.62	-0.03±0.43	-0.80±0.24	0.40±0.52
	PN_{90}	S	-0.40±0.79	-0.01±0.36	-0.52±0.60	-0.31±0.55
		D	***	***	***	***
		S+D	-0.62±0.54	-0.09±0.47	-0.85±0.20	-0.81±0.23
	PD_{90}	S	***	-0.30±0.26	0.47±0.50	0.09±0.47
		D	0.85±0.21	***	-0.87±0.14	-0.57±0.45
		S+D	0.08±0.53	0.16±0.28	-0.39±0.37	-0.26±0.38
Fay	CS_{90}	S	0.54±0.44	0.22±0.63	1.15±0.22	0.93±0.09
		D	-0.18±1.19	0.71±0.78	-0.72±0.33	-0.52±0.53
		S+D	0.21±0.84	0.43±0.87	-0.16±0.62	-0.02±0.64
	CN_{90}	S	0.35±0.72	0.13±0.85	-0.28±0.86	-0.12±0.83
		D	1.59±2.96	-1.79±5.34	-2.32±4.75	-2.58±6.32
		S+D	0.92±0.13	-0.70±0.53	-1.53±0.88	1.60±1.05
	PN_{90}	S	0.44±0.65	0.40±0.71	-0.33±0.81	-0.02±0.83
		D	1.06±0.14	-0.97±0.09	-1.17±0.25	-1.33±0.52
		S+D	0.78±0.26	-0.35±0.69	-0.98±0.02	-1.00±0.01
	PD_{90}	S	-2.44±11.06	-1.44±2.55	-1.00±0.03	-1.50±2.85
		D	-0.67±0.30	0.43±0.57	0.95±0.03	0.99±0.01
		S+D	-0.63±0.24	0.18±0.44	0.86±0.07	0.84±0.08
GM	CS_{90}	S	0.23±0.45	-0.12±0.38	0.14±0.55	0.08±0.76
		D	0.66±0.34	-0.06±0.64	0.73±0.27	0.82±0.16
		S+D	0.15±0.38	-0.11±0.31	0.19±0.34	0.13±0.46
	CN_{90}	S	***	***	***	-0.74±0.37
		D	-0.16±0.08	0.11±0.81	-0.01±0.66	0.03±0.57
		S+D	-0.04±0.57	0.31±0.46	-0.20±0.40	-0.07±0.39
	PN_{90}	S	***	***	***	-0.68±0.43
		D	-0.17±1.00	0.12±0.75	-0.02±0.61	0.02±0.52
		S+D	-0.04±0.56	0.31±0.45	-0.21±0.38	-0.08±0.38
	PD_{90}	S	-0.21±0.40	0.39±0.22	0.20±0.37	-0.88±0.21
		D	0.07±0.65	-0.33±0.44	-0.26±0.37	0.06±0.34
		S+D	0.04±0.47	-0.20±0.37	-0.16±0.31	-0.18±0.29

***: Imaginary values.**

Table 8: Expected genetic gain for clutch traits from different methods of selection and efficiency for family and sib selection in relation to individual selection.

Trait	Breed	IS	NFS	NHS	FAMILY SELECTION FOR FEMALES				SIB SELECTION FOR MALES			
					FS		HS		FS		HS	
					G	E	G	E	G	E	G	E
CS_{90}	Dand	0.509	2	4	0.507	0.998	0.407	0.800	0.423	0.832	0.389	0.766
			4	8	0.539	1.060	0.409	0.806	0.621	1.220	0.580	1.140
			6	12	0.566	1.112	0.420	0.827	0.720	1.415	0.679	1.336
			8	16	0.586	1.151	0.430	0.845	0.771	1.515	0.733	1.441
	Fay	0.066	2	4	0.068	1.038	0.056	0.847	0.062	0.936	0.060	0.907
			4	8	0.077	1.173	0.059	0.904	0.109	1.654	0.106	1.606
			6	12	0.085	1.291	0.064	0.969	0.146	2.213	0.142	2.153
			8	16	0.091	1.387	0.068	1.027	0.175	2.653	0.170	2.586
	GM	3.732	2	4	3.492	0.936	2.733	0.732	2.562	0.687	2.188	0.586
			4	8	3.426	0.918	2.568	0.688	2.955	0.792	2.644	0.708
			6	12	3.425	0.918	2.522	0.676	2.965	0.794	2.722	0.729
			8	16	3.431	0.919	2.502	0.670	2.880	0.772	2.686	0.720
CN_{90}	Dand	1.936	2	4	1.941	1.002	1.560	0.806	1.634	0.844	1.511	0.780
			4	8	2.056	1.071	1.580	0.816	2.442	1.261	2.289	1.182
			6	12	2.187	1.130	1.627	0.840	2.870	1.482	2.716	1.403
			8	16	2.271	1.173	1.668	0.862	3.103	1.603	2.958	1.527
	Fay	0.244	2	4	0.256	1.050	0.210	0.862	0.237	0.971	0.233	0.957
			4	8	0.296	1.214	0.229	0.940	0.447	1.833	0.440	1.807
			6	12	0.332	1.362	0.250	1.027	0.634	2.600	0.625	2.565
			8	16	0.363	1.490	0.270	1.107	0.801	3.286	0.790	3.243
	GM	9.563	2	4	9.213	0.954	7.262	0.752	7.033	0.729	6.137	0.636
			4	8	9.240	0.957	6.952	0.720	8.671	0.898	7.846	0.813
			6	12	9.352	0.969	6.901	0.715	9.028	0.935	8.343	0.864
			8	16	9.442	0.978	6.896	0.715	8.76	0.930	8.409	0.871

IS: Individual selection, NFS: Full- sib family size, NHS: Half- sib family size, G: Gain of selection and E: Efficiency of selection comparing to individual selection.

Table 9: Expected genetic gains for pausing traits from different methods of selection and efficiency for family and sib selection in relation to individual selection.

Trait	Breed	IS	NFS	NHS	FAMILY SELECTION FOR FEMALES				SIB SELECTION FOR MALES			
					FS		HS		FS		HS	
					G	E	G	E	G	E	G	E
PN_{90}	Dand	1.533	2	4	1.554	1.014	1.255	0.819	1.338	0.873	1.255	0.819
			4	8	1.690	1.103	1.291	0.842	2.105	1.373	1.993	1.300
			6	12	1.804	1.177	1.345	0.877	2.567	1.675	2.448	1.597
			8	16	1.890	1.233	1.391	0.907	2.854	1.862	2.736	1.784
	Fay	0.427	2	4	0.445	1.043	0.364	0.853	0.405	0.950	0.395	0.926
			4	8	0.507	1.189	0.391	0.918	0.734	1.722	0.717	1.682
			6	12	0.562	1.318	0.423	0.991	1.005	2.355	0.983	2.304
			8	16	0.608	1.426	0.451	1.057	1.228	2.879	1.203	2.820
	GM	10.269	2	4	9.742	0.949	7.663	0.746	7.348	0.716	6.369	0.520
			4	8	9.703	0.945	7.291	0.710	8.871	0.864	7.999	0.779
			6	12	9.782	0.953	7.213	0.702	9.128	0.889	8.417	0.819
			8	16	9.852	0.959	7.192	0.700	9.007	0.877	8.426	0.821
PD_{90}	Dand	0.455	2	4	0.421	0.927	0.329	0.723	0.303	0.667	0.256	0.564
			4	8	0.409	0.900	0.306	0.673	0.339	0.746	0.302	0.664
			6	12	0.407	0.895	0.299	0.658	0.335	0.737	0.307	0.674
			8	16	0.406	0.894	0.296	0.651	0.322	0.709	0.300	0.660
	Fay	0.117	2	4	0.119	1.021	0.097	0.827	0.104	0.891	0.099	0.844
			4	8	0.131	1.123	0.101	0.859	0.169	1.448	0.161	1.381
			6	12	0.141	1.208	0.106	0.902	0.212	1.811	0.203	1.736
			8	16	0.149	1.274	0.110	0.939	0.240	2.053	0.231	1.976
	GM	1.205	2	4	1.079	0.895	0.832	0.690	0.724	0.601	0.591	0.491
			4	8	1.012	0.840	0.754	0.625	0.731	0.607	0.641	0.532
			6	12	0.990	0.822	0.726	0.603	0.687	0.570	0.624	0.517
			8	16	0.979	0.812	0.712	0.591	0.642	0.533	0.594	0.493

IS: Individual selection, NFS: Full- sib family size, NHS: Half- sib family size, G: Gain of selection and E: Efficiency of selection comparing to individual selection.

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الملخص العربي

دراسة مقارنة لصفات التوقف عن وضع البيض وطول السلسلة وعلاقتها بصفات إنتاج البيض في ثلاثة أنواع من الدجاج المحلى

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*قسم إنتاج الدواجن-كلية الزراعة بالفيوم-جامعة القاهرة

استخدمت سجلات 305 دجاجة دندراوي و303 دجاجة فيومي و452 دجاجة منتزه ذهبى من محطة بحوث الدواجن بالفيوم فى هذه الدراسة. تم حساب 4 قياسات لصفات طول السلسلة والتوقف عن وضع البيض. متوسط طول السلسلة (عدد البيض الذى تضعها كل دجاجة فى السلسلة)، عدد سلاسل البيض ومتوسط طول فترة التوقف عن وضع البيض وعدد مرات التوقف عن وضع البيض وذلك فى الـ90 يوم الأولى من الإنتاج. كان متوسط طول السلسلة والخطأ القياسي (3.69 ، 0.22) فى المنتزه الذهبى أعلى معنوياً(P≤0.01) عن باقى الأنواع بينما أظهر الفيومى عدد سلاسل أعلى وطول فترة توقف أطول وعدد مرات توقف عن وضع البيض أكبر (22.63، 2.24، 22.9 على التوالى) معنوياً (P≤0.01). أظهرت صفات عدد البيض وكتلة البيض وطول فترة التوقف فى الـ90 يوم الأولى من الإنتاج تأثيرات أمية جديرة بالأخذ فى الاعتبار. بينما كانت تقديرات العمق الوراثي المحسوبة من مكونات تباين الآباء أكبر من تلك المحسوبة من مكونات الأمهات مما يدل على وجود ارتباطاً بالجنس فى صفات طول السلسلة فى الـ90 يوم الأولى من الإنتاج للأنواع الثلاثة المدروسة وعدد السلاسل وعدد فترات التوقف فى الـ90 يوم الأولى من الإنتاج لنوعى الدندراوى والمنتزه الذهبى. وقد تم أيضاً حساب كل من الارتباط الوراثى والمظهري بين صفات التوقف وطول السلسة وبين بعض صفات إنتاج البيض للأنواع المدروسة.

ويكون الانتخاب الفردي أكثر فائدة لتحسين طول السلسلة وعدد السلاسل وعدد طول فترات التوقف عن وضع البيض في الـ90 يوم الأولى من الإنتاج فى نوع المنتزه الذهبى. ويمكن استنتاج أن للمنتزه الذهبى ميزة جيدة لكفاءة إنتاج البيض عن الأنواع الأخرى. وقد قدرت الاستجابة الوراثية المتوقعة للمنتزه الذهبى من الانتخاب الفردى بـ 3.76، 9.65، 10.27، -1.21 للصفات الأربعة السابق ذكرها على التوالى. ولانتخاب إناث كل من الدندراوى والفيومي لصفتي طول السلسلة وعدد السلاسل فى الـ90 يوم الأولى من الانتاج فإن الانتخاب العائلى بناءاً على مظهر عائلات الأشقة الكاملة أظهر كفاءة أعلى نسبة للانتخاب الفردى وذلك عندما يكون عدد أفراد العائلة ستة دجاجات. كما أن الانتخاب العائلى لعائلات الأشقة الكاملة أظهر كفاءة أعلى منه لعائلات أنصاف الأشقة. بينما عند انتخاب الذكور فقد أظهر الانتخاب بناء على مظهر الأشقة الكاملة كفاءة أعلى عندما يكون عدد الأفراد ثمانية على الأقل. و يمكن من ذلك ملاحظة أنه كلما زاد حجم العائلة كلما زادت كفاءة

الانتخاب. كما أن من المتوقع و بعد جيل واحد من الانتخاب الفردى أن يحدث انخفاض ملموس فى طول فترات التوقف فى الـ90 يوم الأولى من الانتاج لكل من الدندراوى والمنتزه الذهبى. علاوة على أنه قد تم تسجيل طول سلسلة أقصر لنوع الفيومى (1.84بيضة) وطول فترة توقف أطول نسبياً (2.24 يوم) وعمقاً وراثياً منخفضاً عن كل من المنتزه الذهبى والدندراوي لتلك الصفات مما يفرض احتياجاً للانتخاب لزيادة صفة طول السلسلة في الـ90 يوم الأولى من الانتاج. على أن الدراسة قد بينت أن الانتخاب العائلى هو الأفضل لخفض طول فترة التوقف عن وضع البيض لرفع إنتاج البيض في الـ90 يوم الأولى من الإنتاج. بينما الانتخاب الفردى لتحسين تلك الصفات كان الأفضل لكل من المنتزه الذهبى والدندراوى. وكذلك يقترح عمل دليلاً انتخابياً يشمل صفات طول السلسلة والتوقف عن وضع البيض بالاضافة لسجل كامل لإنتاج الدجاجة من البيض.