# EFFECTIVENESS OF INDIRECT SELECTION FOR EGG CHARACTERISTICS USING CERTAIN PLASMA CONSTITUENTS IN THREE LOCAL BREEDS OF CHICKENS

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**ABSTRACT:**

This work aimed to evaluate the effectiveness of the indirect selection by using certain plasma constituents at 8 and 12 weeks of age to achieve an advantageous change of the target productive traits in three local breeds of chickens: Dandarawi (Dand), Fayoumi (Fay) and Golden Montazah (GM). Breed significantly ($P \leq 0.01$) affected plasma constituents regardless of age of measurements. Fay had significantly higher PG and PTC than other breeds (200.65 and 108.20 mg/100ml) whereas GM had the lowest PTC of 88.91mg/100ml. Dand had the highest PTP being 6.38mg/100ml. Age of measurements significantly affected either PTP or PTC while, its effect on PG was insignificant. Higher PTP at 12 than 8 weeks of age was shown whereas the PTC was significantly higher at 8 weeks of age than 12 weeks of age (6.46 vs 5.69 and 109.79 vs 96.94 mg/100ml, Table 1). Significant breed by age of measurement interaction ($P \leq 0.01$) effects on PG, PTP and PTC were found. There were inconsistent breed differences either in magnitude or direction in the expected correlated responses in egg production-related traits and each of clutch size and pause traits to future selection. Therefore, plasma constituents at 8 and 12 weeks in Dand, GM and Fay can be used as selection criteria to improve their productive performance. So, the more than unity efficiencies indicated indirect selection for target productive traits through selection for plasma constituents at certain studied ages which was more efficient than the direct selection for improving these traits. However, direct selection for productive traits will be the most efficient method for improving these traits if their efficiencies were lower than unity.

**Key words: Effectiveness, indirect selection, plasma constituents, egg characteristics, local chickens.**

## INTRODUCTION

Selection for improving certain traits sometimes resulted in a correlated response for other unselected traits (secondary characters) which may result from genetic effects which referred mainly to linkage, environmental influences and a combination of both **(Falconer, 1989**). The indirect selection cannot be expected to be better than direct selection unless the secondary character has a substantially higher heritability and the genetic correlation is high**.** He illustrated that there are three practical considerations make indirect selection preferable: 1. If the desired character is difficult to measure with precision, the errors of measurement may so reduce the heritability that indirect selection becomes advantageous. 2. If the desired character is measurable in one sex only, but the secondary character is measurable in both, then a higher intensity of selection will be possible by indirect selection. 3. The desired character may be costly or a very time consuming to measure.

Blood biochemical traits could be important as indicator traits in breeding for high productivity (**Obeidah *et al*., 1978**, **Abdel Latif, 2001 and Abdel Magid, 2006**). Metabolic differences among animals with potential or ongoing production may be useful predictors of genetic merit for economic productive traits (**Peterson *et al*., 1982)**. The purpose of this study is to evaluate the effectiveness of the indirect selection (through selection for plasma constituents at certain ages) in improving the egg production-related traits and both clutch size and pause traits in three local breeds of chickens after one generation of future selection.

## MATERIALS AND METHODS

This work was carried out at El Azab Poultry Research Center, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. A total of 450 females of Dandarawi (Dand), 592 females of Fayoumi (Fay) and 402 females of Golden Montazah (GM) belonging to ten sires and 100 dams were produced in five to seven successive pedigreed hatches, seven days apart, respectively. Management practices were kept uniform as possible throughout the experimental period**.** Blood samples were collected at 8 and 12 weeks of age. About 3 $cm^3$ of blood from each female were taken from the wing vein in the morning (between 8 and 10 o'clock) before feeding. Blood samples were immediately centrifuged at 3000 rpm for 15 minutes to separate plasma. The prepared plasma samples were stored at $-20^oC$ till the time of chemical analyses. Plasma samples were analyzed at the laboratories of Poultry Production Department, Faculty of Agriculture, Fayoum University. Kits of STANBIO Laboratory INC., Texas, USA, were used.

Age at sexual maturity (SM) individually recorded in days for each hen in each breed. Egg number, egg weight and egg mass from sexual maturity up to 90 days of egg production were recorded on each hen ($EN_{90}$, $EW_{90}$ and $EM_{90}$). Two measurements for either clutch or pause traits were considered during the first 90 day of production**:** the number of eggs per clutch of each hen ($CS_{90}$), the number of clutches ($CN_{90}$) and the average length of pause duration ($PD_{90}$, days) were estimated. The following egg quality characteristics were recorded for each hen: Yolk index (YI) Haugh unit (HU), egg shape index (SI) and shell thickness (ST) on the membraneless shells by using Ames shell thickness Gauge to the nearest µm.

Plasma glucose (PG, mg/100ml), and total cholesterol (PTC, mg/100ml) were quantitatively determined based on an enzymatic-colorimetric technique described by **Trinder (1959, 1969)**, **Richmond (1973)** and **Weissman & Pileggi (1974).** Plasma total protein (PTP, mg/100ml) was calorimetrically determined according to the methods described by **Weichselbaum (1946).**

**Statistical analysis:**

Before estimating genetic parameters, data were corrected for hatch effects within each breed. Then data for productive performance traits were analyzed for breed effect as the following model:

$$\mathbf{Y_{ij} = \mu + B_i + e_{ij}}$$

**where:**

$\mathbf{Y_{ij}}$ : expresses the observation of the ij$^{th}$ hen, $\mathbf{\mu}$ : is the overall mean, $B_i$: is the effect of i$^{th}$ breed ( i =1 and 3) and $\mathbf{e_{ij}}$: is the residual error term accounted for the j$^{th}$ hen of the i$^{th}$ breed. The following model was used for plasma constituent concentrations where breed and age of measurements used as main effects:

$$Y_{ijk}=\mu+ B_i +A_j+BA_{ij}+e_{ijk}$$

**where:**

$\mathbf{\mu}$**:** Overall mean, $\mathbf{B_i}$: Breed effect (**i**: 1 and 3), $\mathbf{A_j}$: Age of measurement effect (**j**: 1 and 2), $\mathbf{BA_{ij}}$: Interaction of breed by age of measurement and $\mathbf{e_{ijk}}$: Random error term. Means were compared for breed effect and their interactions with age by Duncan's multiple range test **(Duncan, 1955)** when significant F value were obtained ($P\leq0.05$).

The hierarchical analyses of variance and covariance were done to compute the heritabilities ($h^2$) according to **Kempthorne (1957)** for studied traits using **SAS (2000)**. The following model was fitted, by breed, to each of the traits to calculate the genetic parameters:

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

**where:**

$\mathbf{Y_{ijk}}$ : expresses the observation of the ijk$^{th}$ hen, $\mathbf{\mu}$ : is the overall mean, $S_i$: is the effect of i$^{th}$ sire, $\mathbf{D_{ij}}$ : is the effect of the j$^{th}$ dam mated to i$^{th}$ sire, $\mathbf{e_{ijk}}$ : is the error term accounted for the k$^{th}$ hen of the j$^{th}$ dam and i$^{th}$ sire. The standard errors of heritabilites were obtained according to **Swiger *et al* (1964)**. 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 expected genetic direct response (R) after one generation of individual and family selection were estimated according to **Falconer (1989)** as follows:

| Method of selection | Expected direct response (R) |
|---|---|
| **Individual selection** | $R= i\ \delta p\ h^2$ |
| **Family selection** | $R= i\ \delta p\ h^2 * \{1+(n-1)r\}/(n)^{1/2}\{1+(n-1)t\}^{1/2}$ |

**where:**

**i:** Intensity of selection (selection differential in standard measure): assumed to be equal for all methods, **δp:** 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 (n=6).

Expected correlated response in the secondary (unselected) trait which called correlated response ($\mathbf{CR_Y}$) was determined according to **Falconer (1989)** as the following:

$$CR_Y = i\ h_X\ h_Y\ r_g\ \delta p_{(Y)}$$

**where:**

**$h_X$, $h_Y$** are the square root of heritability of X and Y traits, $r_g$ is the genetic correlation between x and y traits, **$\delta p_{(Y)}$** is the phenotypic standard deviation of trait Y, and i is the selection intensity for trait X.

The expected efficiencies (E) for family selection or individual selection were calculated as follows:

$$E = CR_Y/DR_Y$$

**where:**

**E**: is the efficiency of selection, **$CR_Y$**: is the correlated response for Y trait and **$DR_Y$**: is the direct response for Y trait.

## RESULTS AND DISCUSSION

Information presented in Table 1, indicated that breed significantly ($P\leq 0.01$) affected plasma constituents regardless of age of measurements. Fay had significantly higher PG and PTC than other breeds (200.65 and 108.20 mg/100ml) whereas GM had the lowest PTC of 88.91mg/100ml. Dand had the highest PTP being 6.38mg/100ml. Similar results for GM and Dand plasma constituents concentrations were reported by **Abdel Latif (2001)**, **Moawad (2002)** and **Abdel Magid (2006).** Age of measurements significantly affected either PTP or PTC however insignificantly affected PG. Higher PTP at 12 than 8 weeks of age was shown whereas the PTC was significantly higher at 8 weeks of age than 12 weeks of age (6.46 vs 5.69 and 109.79 vs 96.94 mg/100ml, Table 1). Significant breed by age of measurement interaction ($P\leq 0.01$) effects on PG, PTP and PTC were found. The highest PG was 210.22 mg/100ml for Fay at eight weeks whereas the lowest PG was shown by Dand at eight weeks. Significantly higher estimate of $PTP_{12}$ was shown by Dand whereas Fay had the lowest PTP at 8 weeks of age (6.98 and 5.59 mg/100ml, respectively). Fay showed significantly higher $PTC_8$, however the lowest PTC of 83.41mg/100ml was shown for GM at 12 weeks of age.

The earliest breed attained SM was Dand whereas Fay was the latest breed attaining maturity (170.17 vs 208.55 days, $P\leq 0.01$)as shown in Table 2. Earlier SM was reported by **Shebl (1998) and El Full *et al.* (2005a)** for native breeds**.** Similarly, Dand produced the highest $EN_{90}$ followed by GM whereas Fay had the lowest estimate ($P\leq 0.01$,64.16 and 61.46 vs 23.51 eggs). GM hens laid significantly heavier $EW_{90}$ and $EM_{90}$ than other breeds, however, Fay had the lowest $EW_{90}$ and $EM_{90}$ (48.22 and 2963g vs 39.87 and 937g). The cited estimates of $EN_{90}$ ranged from 23.1 to 57.04 eggs for most native breeds (**El Hossari *et al.***, **1995** and **El Full *et al.*(2005a).** However, heavier $EW_{90}$ and $EM_{90}$ for Dand was reported by **El Hammady *et al.* (1992)** and **Ragab (1996).**Whereas **Abdel Galil (1993)** cited lower EW of 36.2 for same breed. GM had significantly longer followed by Dand $CS_{90}$ whereas Fay had shorter $CS_{90}$ than other breeds (3.70 and 3.32 vs 1.53 eggs, $P\leq 0.01$). Higher $CN_{90}$ was shown for Dand whereas Fay had the lowest $CN_{90}$ ($P\leq 0.01$, 19.22 and 14.89). The longest $PD_{90}$ was 9.77 days for Fay, however, Dand had the shortest $PD_{90}$ than other breeds, this is expected since the former had higher egg number and clutch size than the later. Similar trend for clutch and pause traits was reported by **El Full *et al.*(2005b) and Abdel Magid (2006)**. Concerning egg quality traits, Fay had significantly higher SI, YI, HU and thicker shells than other breeds. Either Dand or GM had higher variability than Fay for HU and ST traits, since they had larger standard phenotypic deviations for their means (Table 2). These results are in agreement with the findings reported by **Abdel Latif (2001)** and **Abdel Magid (2006)**.

**Table 1. Means± $\delta_P$ for plasma constituents as affected by breed, age and breed x age of measurements interaction.**

| Effect | Age | PG,mg/100ml | PTP, mg/100ml | PTC, mg/100ml |
|---|---|---|---|---|
| **Breed effect:** | | | | |
| Dandarawi (Dand) | | 107.35±32.97[b] | 6.38±1.13[a] | 99.06±21.98[b] |
| Fayoumi (Fay) | | 200.65±50.50[a] | 5.93± 1.71[b] | 108.20±31.27[a] |
| Golden Montazah (GM) | | 112.63±24.93[b] | 6.07±1.15[ab] | 88.91±14.64[c] |
| **Age of measurement effect:** | | | | |
| 8 | | 163.71±69.52[a] | 5.69±1.38[b] | 109.79±29.46[a] |
| 12 | | 162.71±55.38[a] | 6.46±1.54[a] | 96.94±25.05[b] |
| **Breed x Age interaction effect:** | | | | |
| Dand | 8 | 92.12±22.47[e] | 5.78±1.00[bc] | 98.06±26.13[b] |
| | 12 | 122.59±34.83[c] | 6.98±0.92[a] | 100.06±16.95[b] |
| Fay | 8 | 210.22±48.92[a] | 5.59±1.58[c] | 118.59±30.28[a] |
| | 12 | 191.09±50.39[b] | 6.26±1.76[b] | 97.87±28.80[b] |
| GM | 8 | 106.89±30.01[de] | 6.00±1.06[bc] | 94.40±10.18[b] |
| | 12 | 118.37±17.16[cd] | 6.13±1.25[bc] | 83.41±16.43[c] |

PG : Plasma glucose concentration, PTP: Plasma total protein concentration, PTC: Plasma total cholesterol concentration. Means having different superscripts per each effect within each column are significantly different at P≤0.01.

**Table 2. Means ± $\delta_P$ of unselected productive traits in different genetic groups.**

| Trait | Dandarawi | Golden Montazah | Fayoumi |
|---|---|---|---|
| Egg production-related traits in the first 90 days of production | | | |
| Sexual maturity, day | 170.17±4.39[c] | 175.35±9.32[b] | 208.55±22.30[a] |
| Egg number, egg | 64.16±8.21[a] | 61.46±8.33[b] | 23.41±10.82[c] |
| Egg weight, g | 39.89±2.80[b] | 48.22±3.36[a] | 39.87±3.77[b] |
| Egg mass, g | 2553 ±343[b] | 2963±406[a] | 937±454[c] |
| Clutch and Pause traits in the first 90 days of production | | | |
| Clutch size, egg | 3.32±0.91[b] | 3.70±1.24[a] | 1.53±0.41[c] |
| Clutch number | 19.22±3.97[a] | 18.08±4.14[b] | 14.89±6.48[c] |
| Pause duration, day | 1.58±0.70[b] | 1.70±1.62[b] | 9.77±15.77[a] |
| Egg quality traits | | | |
| Shape index, % | 76.57±3.09[b] | 75.92±2.73[b] | 78.18±4.31[a] |
| Yolk index, % | 41.99±2.46[b] | 42.13±1.94[b] | 50.37±3.19[a] |
| Haugh unit, % | 70.69±7.60[b] | 72.43±8.20[b] | 91.20±5.61[a] |
| Shell thickness, mm | 37.40±3.41[b] | 36.45±1.73[c] | 39.88±1.09[a] |

a,b and c: Means having different superscripts within the same raw are significantly different at P ≤0.05.

Dand had the highest heritability estimates for $PG_8$, $PG_{12}$, $PTP_8$, $PTP_{12}$ and $PTC_8$ than other breeds (0.73, 0.42, 0.29, 0.57 and 0.52, respectively). However, GM had the highest heritability estimate for $PTC_{12}$ of 0.43 than other breeds (Table 3). The cited ranges for plasma constituents in these studied breeds were 0.13 to 0.37, 0.12 to 0.43 and 0.24 to 0.45, respectively by **Abdel Latif (2001**), **El Full (2001)**, **Moawad (2002)** and **Abdel Magid (2006)**. Similar trends for PTC and PTP were reported by **Obeidah *et al.* (1978), Rai *et al.* (1987)** and **Naryana *et al.*(1991)**. Fay had higher heritability estimate for

SM than other breeds. However, GM had the highest heritability estimates than other breeds for $EN_{90}$, $EW_{90}$, $EM_{90}$, $CS_{90}$, $CN_{90}$ and $PD_{90}$ (0.50, 0.77, 0.54, 0.57, 0.47, and 0.81). Higher heritability estimates of SI and YI for Fay were found (0.78 and 0.87). Dand had larger heritability estimates than other breeds for both HU and ST (0.99 and 0.59).

**Table 3. Heritability estimates ± SE of target productive traits and plasma constituents studied in different breeds based on full-sib correlations.**

| Item | Dandarawi | Golden Montazah | Fayoumi |
|---|---|---|---|
| Plasma constituents traits | | | |
| $PG_8$,mg/100ml | 0.73±0.21 | 0.13±0.19 | 0.54±0.21 |
| $PG_{12}$,mg/100ml | 0.42±0.19 | 0.20±0.18 | 0.23±0.17 |
| $PTP_8$, mg/100ml | 0.29±0.23 | 0.20±0.19 | 0.21±0.10 |
| $PTP_{12}$, mg/100ml | 0.57±0.21 | 0.11±0.19 | 0.12±0.15 |
| $PTC_8$, mg/100ml | 0.52±0.22 | 0.23±0.39 | 0.11±0.05 |
| $PTC_{12}$, mg/100ml | 0.10±0.25 | 0.43±0.17 | 0.09±0.14 |
| Egg production-related traits | | | |
| SM, day | 0.24±0.10 | 0.12±0.08 | 0.27±0.18 |
| $EN_{90}$, EGG | 0.11±0.15 | 0.50±0.21 | 0.45±0.26 |
| $EW_{90}$, g | 0.66±0.19 | 0.77±0.29 | 0.61±0.37 |
| $EM_{90}$, g | 0.14±0.16 | 0.54±0.21 | 0.43±0.34 |
| Clutch and Pause traits | | | |
| $CS_{90}$, egg | 0.26±0.20 | 0.57±0.26 | 0.31±0.17 |
| $CN_{90}$ | 0.24±0.22 | 0.47±0.24 | 0.37±0.26 |
| $PD_{90}$, day | 0.62±0.25 | 0.81±0.21 | 0.45±0.22 |
| Egg quality traits | | | |
| Shape index, % | 0.37±0.12 | 0.67±0.19 | 0.78±0.41 |
| Yolk index, % | 0.82±0.16 | 0.29±0.13 | 0.87±0.34 |
| Haugh unit, % | 0.99±0.17 | 0.46±0.16 | 0.75±0.54 |
| Shell thickness, µm | 0.59±0.16 | 0.20±0.11 | 0.32±0.17 |

SM: sexual maturity, EN: Egg number, EW: Egg weight, EM: Egg mass , PG : Plasma glucose concentration, PTP: Plasma total protein concentration, PTC: Plasma total cholesterol concentration, CS: Clutch size, CN:Clutch number and PD: Pause duration.

There were inconsistent breed differences either in magnitude or direction in the expected correlated responses in the target productive performance traits to future selection (Table 4). The direct selection responses to same target traits after only one generation were presented in Table 5. Dividing these correlated responses by the direct responses resulted in the relative efficiency estimation based on individual and full-sib families due to selection for plasma constituent as shown in Tables from 6 to 8. Results of the present study indicated that full-sib family selection had higher direct responses than the individual selection in all studied breeds. The highest responses for selection for sexual maturity, egg number, clutch number, pause duration and yolk index % were shown in Fay (Table 5). Whereas, GM had the highest response due to full-sib family selection, since Fay had lower heritability for most traits, than other breeds for each of egg weight, egg mass, clutch size and Haugh unit. However, Dand had higher response for shell thickness.

**Table 4. Correlated responses (CR) in the target traits of different genetic groups due to selection for plasma constituents.**

| Target trait | $CR_Y = i\ h_X\ h_Y\ r_g\ \delta p_{(Y)}$ | | | | | |
|---|---|---|---|---|---|---|
| | **$PG_8$ (X)** | | | **$PG_{12}$(X)** | | |
| Y | Fay | Dand | GM | Fay | Dand | GM |
| SM,day | -7.868 | -22.140 | 1.316 | 13.771 | 3.304 | -5.432 |
| $EN_{90}$,egg | 7.989 | -2.124 | 2.806 | -6.920 | -0.464 | -3.573 |
| $EW_{90}$,g | -5.259 | 2.634 | -0.482 | -3.717 | 0.029 | 0.121 |
| $EM_{90}$,g | 82.695 | -0.723 | 1.181 | -205.882 | -0.229 | -1.505 |
| $CS_{90}$, egg | 0.199 | -0.008 | -0.136 | -0.297 | 0.104 | -0.021 |
| $CN_{90}$ | -2.839 | 0.168 | 0.483 | -2.170 | -0.334 | 0.119 |
| $PD_{90}$,day | | 0.009 | -0.005 | | -0.029 | 0.029 |
| SI, % | -0.469 | -0.412 | 0.230 | 0.946 | 0.365 | 0.342 |
| YI, % | 0.582 | -0.304 | 0.055 | 0.002 | 0.296 | 0.019 |
| HU, % | -0.499 | -2.609 | -0.553 | 1.011 | -0.694 | 0.691 |
| ST, mm | 0.311 | -0.858 | 0.055 | -0.489 | 0.0219 | 0.059 |
| | $PTP_8$ (X) | | | $PTP_{12}$(X) | | |
| | Fay | Dand | GM | Fay | Dand | GM |
| SM,day | -7.508 | -1.029 | -2.791 | -0.506 | 2.253 | -1.644 |
| $EN_{90}$,egg | -14.063 | -1.405 | 0.319 | 7.463 | -0.620 | -2.299 |
| $EW_{90}$,g | -1.379 | 1.406 | 2.412 | -3.170 | -0.205 | -0.796 |
| $EM_{90}$,g | -296.046 | -0.649 | 1.533 | -115.505 | -0.357 | -1.652 |
| $CS_{90}$, egg | -0.119 | 0.367 | 0.021 | -0.068 | 0.114 | 0.202 |
| $CN_{90}$ | -1.264 | -1.302 | 0.060 | -1.070 | 1.201 | -0.576 |
| $PD_{90}$,day | 11.836 | -0.009 | -0.017 | 2.615 | -0.079 | 0.013 |
| SI, % | 1.0257 | -0.073 | -0.324 | 0.239 | 0.088 | 0.105 |
| YI, % | -0.038 | 0.474 | 0.424 | -1.602 | 0.025 | 0.253 |
| HU, % | -0.810 | 1.297 | 1.256 | -2.238 | 0.079 | 0.276 |
| ST, mm | 0.055 | 0.109 | -0.385 | 0.386 | 0.792 | 0.362 |
| | $PTC_8$ (X) | | | $PTC_{12}$ (X) | | |
| | Fay | Dand | GM | Fay | Dand | GM |
| SM,day | 6.241 | 7.166 | -0.850 | -9.782 | -5.828 | -7.016 |
| $EN_{90}$,egg | -10.178 | 0.073 | -2.211 | -5.883 | 0.718 | 4.053 |
| $EW_{90}$,g | -1.723 | 2.069 | -2.315 | -1.904 | 1.106 | 1.945 |
| $EM_{90}$,g | -181.086 | 0.654 | -2.241 | -152.545 | 0.582 | 3.373 |
| $CS_{90}$, egg | 0.106 | 0.179 | 0.339 | -0.146 | -0.093 | 0.404 |
| $CN_{90}$ | 0.604 | -1.337 | -0.837 | -1.324 | 0.594 | -1.151 |
| $PD_{90}$,day | -0.841 | -0.029 | -0.037 | 6.088 | -0.026 | -0.034 |
| SI, % | -0.884 | -0.195 | 0.134 | 2.382 | 0.192 | -0.026 |
| YI, % | 0.262 | 0.444 | -0.316 | 1.087 | -0.042 | 0.072 |
| HU, % | -1.421 | 0.577 | -0.335 | -1.918 | 0.039 | 0.368 |
| ST, mm | 0.349 | -0.024 | -0.221 | -0.233 | 0.279 | 0.014 |

$h_X$ , $h_Y$ are the square root of heritability of X and Y traits, $r_g$ is the genetic correlation between x and y traits, $\delta p_{(Y)}$ is the phenotypic standard deviation of trait, and i is the selection intensity for trait X, PG: Plasma glucose concentration, Fay: Fayoumi, Dand: Dandarawi, GM: Golden Montazah, SM: Sexual maturity, EN: Egg number, EW: Egg weight, EM: Egg mass, SI: Shape index, YI: Yolk index, HU: Haugh unit, ST: Shell thickness, CS: Clutch size, CN: Clutch number and PD: Pause duration.

**Table 5. Direct responses (R) in the target productive traits (Y) of different genetic groups due to direct selection for these traits.**

| Trait | R= iδp h² | | | | | |
|---|---|---|---|---|---|---|
| | Dandarawi | | Golden Montazah | | Fayoumi | |
| | RIS | RFS | RIS | RFS | RIS | RFS |
| Egg production-related traits in the first 90 days of production | | | | | | |
| Sexual maturity, day | 1.475 | 1.979 | 1.566 | 1.791 | 8.429 | 11.734 |
| Egg number, egg | 1.264 | 1.426 | 5.831 | 10.335 | 6.817 | 11.518 |
| Egg weight, g | 2.587 | 5.271 | 3.622 | 8.038 | 3.219 | 6.294 |
| Egg mass, g | 67.228 | 79.122 | 306.936 | 564.34 | 333.508 | 371.05 |
| Clutch and Pause traits in the first 90 days of production | | | | | | |
| Clutch size, egg | 0.331 | 0.456 | 0.989 | 1.869 | 0.178 | 0.259 |
| Clutch number | 1.334 | 1.791 | 2.724 | 4.693 | 3.357 | 5.227 |
| Pause duration, day | 0.608 | 1.197 | 1.837 | 4.198 | 9.935 | 16.788 |
| Egg quality traits | | | | | | |
| Shape index, % | 1.601 | 2.436 | 2.561 | 5.528 | 4.707 | 10.522 |
| Yolk index, % | 2.824 | 6.501 | 0.788 | 1.122 | 3.885 | 9.265 |
| Haugh unit, % | 10.534 | 27.209 | 5.281 | 257.81 | 5.851 | 12.964 |
| Shell thickness, mm | 2.817 | 5.411 | 0.484 | 0.619 | 0.488 | 0.720 |

Dand: Dandarawi, GM: Golden Montazah, Fay: Unselected control of Fayoumi, δp is the phenotypic standard deviation of trait, and i is the selection intensity for trait X and $h^2$: heritability of the selected trait, RIS: Response due to individual selection and RFS: Response due to full-sib family selection.

**Table 6. Expected efficiencies (correlated response/direct response)due to individual or family selection for plasma glucose concentration (PG) in the target traits of different genetic.**

| Trait | $E=CR_Y/DR_Y$ | | | | | |
|---|---|---|---|---|---|---|
| | Dandarawi | | Golden Montazah | | Fayoumi | |
| **$PG_8$ (X)** | **EIS** | **EFS** | **EIS** | **EFS** | **EIS** | **EFS** |
| Sexual maturity, day | -10.897 | -8.122 | 0.822 | 0.718 | -0.933 | -0.671 |
| Egg number, egg | -1.664 | -1.475 | 0.437 | 0.247 | 1.172 | 0.694 |
| Egg weight, g | 0.906 | 0.445 | -0.415 | -0.187 | -1.562 | -0.799 |
| Egg mass, g | -0.877 | -0.745 | 0.285 | 0.155 | 0.248 | 0.223 |
| Clutch size, egg | -0.007 | -0.005 | -0.013 | -0.007 | 1.122 | 0.771 |
| Clutch number | 0.142 | 0.106 | 0.082 | 0.048 | -0.846 | -0.543 |
| Pause duration, day | -0.489 | -0.248 | -0.039 | -0.017 | 1.391 | 0.823 |
| Shape index, % | -0.490 | -0.322 | 0.111 | 0.052 | -0.099 | -0.045 |
| Yolk index, % | -0.135 | -0.058 | 0.077 | 0.054 | 0.149 | 0.063 |
| Haugh unit, % | -0.146 | -0.056 | -0.040 | -0.001 | -0.085 | -0.039 |
| Shell thickness, mm | -0.107 | -0.056 | 0.036 | 0.028 | 0.637 | 0.432 |
| $PG_{12}$ (X) | | | | | | |
| Sexual maturity, day | 1.613 | 1.202 | -3.366 | -2.944 | -0.060 | -0.043 |
| Egg number, egg | -0.361 | -0.319 | -0.509 | -0.287 | 0.578 | 0.342 |
| Egg weight, g | 0.827 | 0.406 | 0.315 | 0.142 | -0.541 | -0.277 |
| Egg mass, g | -0.275 | -0.234 | -0.361 | -0.196 | -0.346 | -0.312 |
| Clutch size, egg | 0.092 | 0.067 | -0.002 | -0.001 | -0.379 | -0.261 |
| Clutch number | -0.281 | -0.209 | 0.020 | 0.012 | -0.319 | -0.205 |
| Pause duration, day | -1.482 | -0.753 | 0.242 | 0.106 | -0.754 | -0.446 |
| Shape index, % | 0.431 | 0.283 | 0.164 | 0.076 | 0.051 | 0.023 |
| Yolk index, % | 0.129 | 0.056 | 0.027 | 0.019 | -0.412 | -0.173 |
| Haugh unit, % | -0.038 | -0.015 | 0.049 | 0.001 | -0.383 | -0.173 |
| Shell thickness, mm | 0.003 | 0.001 | 0.038 | 0.029 | 0.791 | 0.536 |

**EIS: Efficiency due to individual selection and EFS: Efficiency due to full-sib family selection.**

Expected efficiencies that presented in Tables 6, 7 and 8 indicated that the more than unity efficiencies indicated that indirect selection for target productive traits through selection for plasma constituents at certain ages studied were more efficient than the direct selection for improving these traits. However, direct selection for productive traits will be the most efficient method for improving these traits if their efficiencies were lower than unity.

**Table 7. Expected efficiencies (correlated response/direct response)due to individual or family selection for plasma total protein concentration (PTP) in the target traits of different genetic.**

| Trait | $E=CR_Y/DR_Y$ | | | | | |
|---|---|---|---|---|---|---|
| | Dandarawi | | Golden Montazah | | Fayoumi | |
| $PTP_8$ (X) | EIS | EFS | EIS | EFS | EIS | EFS |
| Sexual maturity, day | -0.586 | -0.519 | -1.836 | -1.369 | -0.891 | -.640 |
| Egg number, egg | -0.533 | -0.262 | 0.227 | 0.202 | -0.697 | -0.412 |
| Egg weight, g | 0.019 | 0.017 | 0.801 | 0.393 | -0.428 | -0.219 |
| Egg mass, g | -158.636 | -115.151 | 1.678 | 1.426 | -0.888 | -0.798 |
| Clutch size, egg | 0.080 | 0.059 | 0.006 | 0.004 | -0.666 | -0.458 |
| Clutch number | -2.401 | -1.219 | 0.021 | 0.016 | -0.377 | -0.242 |
| Pause duration, day | -0.175 | -0.115 | -0.438 | -0.223 | 0.881 | 0.522 |
| Shape index, % | -0.049 | -0.021 | -0.248 | -0.163 | 0.218 | 0.097 |
| Yolk index, % | 0.056 | 0.022 | 0.164 | 0.071 | -0.009 | -0.004 |
| Haugh unit, % | 0.269 | 0.139 | 0.045 | 0.018 | -0.139 | -0.063 |
| Shell thickness, mm | 0.038 | 0.020 | -0.042 | -0.022 | 0.113 | 0.077 |
| $PTP_{12}$ (X) | | | | | | |
| Sexual maturity, day | 1.096 | 0.817 | -1.031 | -0.901 | 1.634 | 1.174 |
| Egg number, egg | -0.480 | -0.426 | -0.359 | -0.203 | -1.015 | -0.601 |
| Egg weight, g | -0.075 | 0.037 | -0.191 | -0.086 | -1.155 | -0.591 |
| Egg mass, g | -0.481 | -0.408 | -0.378 | -0.206 | -0.617 | -0.555 |
| Clutch size, egg | 0.100 | 0.073 | 0.019 | 0.009 | -1.671 | -1.148 |
| Clutch number | 1.207 | 0.899 | -0.098 | -0.057 | -0.646 | -0.415 |
| Pause duration, day | -3.886 | -1.974 | 0.108 | 0.047 | 0.307 | 0.182 |
| Shape index, % | 0.104 | 0.068 | 0.051 | 0.024 | 0.201 | 0.089 |
| Yolk index, % | 0.011 | 0.005 | 0.354 | 0.249 | 0.010 | 0.004 |
| Haugh unit, % | 0.067 | 0.026 | 0.020 | 0.001 | 0.173 | 0.078 |
| Shell thickness, mm | 0.097 | 0.051 | 0.234 | 0.183 | -1.001 | -0.678 |

**EIS: Efficiency due to individual selection and EFS: Efficiency due to full-sib family selection.**

Sexual maturity could be indirectly selected through selection for high $PG_8$ or lower $PG_{12}$ for Dand or high $PG_{12}$ for GM as shown in Table 6. Egg number in Dand could be improved through selection for lower $PG_8$. Conversely, Fay' egg number could be improved through selection for high $PG_8$. Egg weight of the Fay could be increased through selection for lower $PG_8$. On the other hand, high $PG_8$ could be used as a selection criteria in Fay to increase clutch size and resulted in undesirable longer pause duration, therefore selection for lower $PG_8$ could be helpful in shortening this trait. Pause duration could be shortened in Dand through selection for higher $PG_{12}$ as shown in Table 6.

As shown in Table 7, selection for high $PTP_8$ may result in earliness in sexual maturity and heavier egg mass in the GM. However, selection for lower $PTP_8$ may result in increasing egg mass and clutch number in the Dand. Selection for lower $PTP_{12}$ could be used as a selection criteria to earlier sexual maturity in both Dand and Fay. However, GM had inverse situation of that trait. Selection for lower $PTP_{12}$ could be used to increase egg number, egg weight, clutch size and shell thickness in the Fay breed. Selection for higher $PTP_{12}$ could be increased clutch number and decreased pause duration as shown in Table 7.

**Table 8. Expected efficiencies (correlated response/direct response)due to individual or family selection for plasma total protein concentration (PTP) in the target traits of different genetic.**

| Trait | $E=CR_Y/DR_Y$ | | | | | |
|---|---|---|---|---|---|---|
| | Dandarawi | | Golden Montazah | | Fayoumi | |
| **$PTC_8$ (X)** | **EIS** | **EFS** | **EIS** | **EFS** | **EIS** | **EFS** |
| Sexual maturity, day | 3.0709 | 2.619 | -0.563 | -0.419 | 0.740 | 0.532 |
| Egg number, egg | -1.192 | 0.051 | -1.585 | -1.405 | -0.504 | -.298 |
| Egg weight, g | -0.608 | 0.375 | -0.773 | -0.379 | -0.535 | -0.274 |
| Egg mass, g | -14.065 | 0.672 | -2.466 | -2.095 | -0.543 | -0.488 |
| Clutch size, egg | -0.278 | 0.116 | 0.094 | 0.068 | 0.55 | 0.409 |
| Clutch number | -2.840 | -0.841 | -0.291 | -0.217 | 0.179 | 0.116 |
| Pause duration, day | -1.486 | -0.733 | -0.940 | -0.478 | -0.099 | -0.059 |
| Shape index, % | -1.972 | -0.152 | 0.104 | 0.068 | -0.188 | -0.84 |
| Yolk index, % | -2.269 | 0.085 | -0.123 | -0.053 | 0.067 | 0.028 |
| Haugh unit, % | -10.196 | 0.012 | -0.012 | -0.005 | -0.243 | -0.109 |
| Shell thickness, mm | -2.825 | -0.002 | -0.024 | -0.013 | 0.716 | 0.485 |
| $PTC_{12}$ (X) | | | | | | |
| Sexual maturity, day | -2.819 | -2.102 | -4.347 | -3.801 | -0.583 | -0.419 |
| Egg number, egg | 0.553 | 0.490 | .626 | 0.353 | -0.863 | -0.511 |
| Egg weight, g | 0.404 | 0.198 | 0.461 | 0.208 | -0.592 | -0.303 |
| Egg mass, g | 0.694 | 0.589 | 0.808 | 0.439 | -0.457 | -0.411 |
| Clutch size, egg | -0.081 | -0.059 | 0.037 | 0.019 | -0.819 | -0.563 |
| Clutch number | 0.495 | 0.369 | -0.195 | -0.113 | -0.395 | -0.253 |
| Pause duration, day | -1.266 | -0.643 | -0.284 | -0.124 | 0.716 | 0.423 |
| Shape index, % | 0.225 | 0.148 | -0.013 | -0.006 | 0.506 | 0.226 |
| Yolk index, % | -0.018 | -0.008 | 0.100 | 0.070 | 0.279 | 0.117 |
| Haugh unit, % | 0.033 | 0.013 | 0.026 | 0.001 | -0.328 | -0.148 |
| Shell thickness, mm | 0.034 | 0.018 | 0.009 | 0.007 | -0.478 | -0.324 |

**EIS: Efficiency due to individual selection and EFS: Efficiency due to full-sib family selection.**

Selection for lower $PTC_8$ in Dand as shown in Table 8 can be used to improve Dand' sexual maturity through individual or full-sib family selection favoring the former than the later. As shown in Table 8, selection for lower $PTC_8$ can be applied to increase each of egg number, egg mass, clutch number and all studied quality traits in Dand. Similarly, egg number in the GM can be improved via selection for lower $PTC_8$. It can be seen that selection for lower $PTC_{12}$ could be used to decrease sexual maturity in both Dand and GM based on either individual or full-sib family selection. Also, selection for lower $PTC_{12}$ could be used to shorten pause duration for Dand breed.

Therefore, plasma constituents at 8 and 12 weeks in Dand, GM and Fay can be used as selection criteria to improve their productive performance.

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## فعالية الانتخاب غير المباشر لصفات إنتاج البيض باستخدام مكونات بلازما معينة على لثلاثة أنواع من الدجاج المحلى

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الهدف من هذه الدراسة هو تقييم فعالية الانتخاب غير المباشر باستخدام مكونات بلازما معينة عند ٨ و١٢ أسبوع من العمر لتحقيق تغيير موات فى الصفات الانتاجية المستهدفة فى ثلاثة أنواع من الدجاج المحلى: الدندراوى، الفيومي والمنتزه الذهبى مقارنة بالانتخاب المباشر لتلك الصفات. وقد خلصت النتائج إلى أنه النوع أثر معنوياً على مكونات البلازما بغض النظر عن العمر. كان تركيز الجلوكوز والكوليستيرول الكلى أعلى فى الفيومى عن النوعين الآخرين (٢٠٠.٦٥ و١٠٨.٢٠ مجم/١٠٠ مل) بينما كان للمنتزه الذهبى أقل تقدير للكوليستيرول الكلى وكانت قيمته ٨٨.٩ مجم/١٠٠مل. كان للدندراوى أعلى تركيز فى البروتين الكلى بالبلازما والذى كان ٦.٣٨ مجم/١٠٠مل. كما كان تأثير عمر القياس معنوياً على كل من البروتين الكلىو للكوليستيرول الكلى بالبلازما بينما لم يؤثر معنوياً على جلوكوز البلازما. كان تركيز البروتين عند عمر ١٢ أسبوع أعلى منه عند ٨ أسابيع بينما كان تركيز للكوليستيـرول الكلـى أعلى عند عمر ٨ أسابيع عنه عند عمر ١٢ أسبوع (٦.٤٦ مقابل ٥.٦٩ و١٠٩.٧٩ مقابل ٩٦.٩٤ مجم/١٠٠ مل). وجد أن التداخل بين النوع والعمر معنوياً ($P\leq 0.01$) على كل من الجلوكوز والبروتين وللكوليستيرول الكلى بالبلازما. كانت هناك اختلافات غير ثابتة للنوع سواء من حيث القيمة أو الاتجاه بالنسبة للاستجابات المصاحبة المتوقعة فى الصفات الإنتاجية موضع الاهتمام للانتخاب مستقبلا. لذا يمكن استخدام مكونات البلازما عند عمرى ٨ و١٢ أسبوع كصفات انتخابية فى كل من الدندراوى والمنتزه الذهبى والفيومى لتحسين أدائها الانتاجي. إذ يمكن الانتخاب للصفات الإنتاجية التى لها معامل كفاءة متوقع أكبر من الوحدة انتخاباً غير مباشر لبعض مكونات البلازما عند ٨ أو ١٢أسبوع من العمر بينما تكون الأفضلية للانتخاب المباشر لتحسين تلك الصفات إذا كانت قيمة معاملات الكفاءة لها أقل من الوحدة.