Genetic and phenotypic parameters of egg production and some constituents of blood serum in *Fayoumi* layers

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**Summary**

Out of 9 hatches, a total of 439 *Fayoumi* layers, ranging in age between 12 and 19 months, was used to study (i) egg production beside the following blood serum constituents: (2) inorganic phosphorus, (3) calcium, (4) glucose, (5) urea, (6) uric acid, (7) total proteins, (8) albumen, (9) cholesterol, (10) bilirubin, (11) alkaline phosphatase, (12) lactic dehydrogenase and (13) transaminase. These layers were the daughters of 40 sires and 241 dams. Blood serum analyses were done using the Sequential Multiple Auto-Analyser, SMA-i2 /60. The least squares mean of the number of eggs produced per layer till 70 weeks of age was 78. The least squares means of the forementioned blood serum traits were in respective order: (2) 5.55 mg p. 100, (3) 21.62 mg p. 100, (4) 196 mg p. 100, (5) 3.96 mg p. 100, (6) 5.66 mg p. 100, (7) 5.93 mg p. 100, (8) 0.71 mg p. 100, (9) 167.4 mg p. 100, (10) 0.36 mg p. 100, (11) 1.023 mu/ml, (12) 667 mu/ml, (13) 169.7 mu/ml.

Hatch showed statistically significant effects on all the characters studied except inorganic phosphorus, uric acid, total proteins and cholesterol. Age of the layer significantly affected all the blood serum traits except inorganic phosphorus, uric acid and total proteins.

Data were corrected for hatch effects, and, in case of the plasma traits, for age effect, before performing the hierarchical analyses of variances and covariances to evaluate heritabilities, genetic and phenotypic correlations. The combined heritability estimates of the characters studied were in respective order: (1) 0.224 ± 0.136, (2) 0.057 ± 0.124, (3) 0.656 ± 0.226, (4) 0.639 ± 0.224, (5) 0.401 ± 0.195, (6) 0.752 ± 0.236, (7) 0.114 ± 0.154, (8) 0.501 ± 0.215, (9) 0.197 ± 0.168, (10) 0.187 ± 0.166, (11) 0.732 ± 0.234, (12) 0.625 ± 0.223, (13) 0.622 ± 0.222.

Significant genetic correlations (of at least ± 0.7) were found between egg production and all the blood serum traits except inorganic phosphorus and total proteins.

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**Introduction**

Information on the genetics of the blood serum constituents in chicken may be valuable in breeding for high productivity. Some of the results reported indicate positive relationship between egg production and serum alkaline phosphatase.
GUTOWSKA, PARKHURST, PARROT and VERBERG, 1943; and WILCOX, VANVLECK and SHAFFNER, 1962). WILCOX (1966) selected for high level of alkaline phosphatase and found the egg production of the high line to be higher than the control in four generations out of five. Genetic relationship between serum alkaline phosphatase and body weight in chicken was studied by MATSUMOTO, TONOE and OKADA (1960), OKADA and TSUTSUMI (1963) and WILCOX, VANVLECK and HARVEY (1963).

This experiment was undertaken to obtain information on blood serum constituents of the Fayoumi layers: their means, heritabilities and the genetic and phenotypic correlations between them, together with their relationships with egg production.

Material and methods

This work was carried out in the Poultry Breeding Farm, Faculty of Agriculture, Cairo University. A total of 439 Fayoumi layers produced in nine biweekly hatches starting 1st February and ending 31st May 1974, was used for this study. These layers represent 40 sire families and 241 dam families. Samples of blood were collected from the birds for chemical analysis during June, July and August 1975. The age of layers when blood samples were taken averaged about 70 weeks (488 days). About 7 cm³ of blood from each bird were taken from the wing vein in the morning (between 8 and 10 o'clock) before feeding. Blood was kept at 37 °C for 30 minutes and the serum was separated by centrifuging at 3,000 rpm for 20 minutes. Sera were analysed within two weeks of blood collection using the Sequential Auto-Analyser, SMA-12/60, of the Sahil Hospital, Cairo. Traits determined in the blood serum shall be treated in three groups:

Group 1: includes the following chemical and non-protein-nitrogen traits: inorganic phosphorus, calcium, glucose, urea and uric acid.

Group 2: includes the plasma proteins (total proteins and albumen), cholesterol and bilirubin.

Group 3: includes three of the blood serum enzymes, namely, alkaline phosphatase, lactic dehydrogenase and transaminase.

Egg production of the layers was taken as the number of eggs produced till the age of 70 weeks.

For statistical analysis, the model for each of the blood serum traits was taken as:

\[ x_{ij} = \mu + a_i + b(y_{ij} - \bar{Y}) + e_{ij}, \]  
where:

- \( x_{ij} \) = the observation on the \( j^{th} \) individual of the \( i^{th} \) hatch group,
- \( \mu \) = overall mean of \( x_{ij} \) when equal subclass numbers exist,
- \( a_i \) = the effect of the \( i^{th} \) hatch group,
- \( b \) = partial regression coefficient of \( x \) on age of layer,
- \( y_{ij} \) = age of the \( j^{th} \) layer of the \( i^{th} \) hatch group,
- \( \bar{Y} \) = the mean of the \( y_{ij} \) and
- \( e_{ij} \) = random error.

The same model, after dropping the regression term, was used for egg production. The overall means and the hatch means beside the partial regression coefficients were fitted by the least-squares analysis (HARVEY, 1960).
It may be of interest to note that the cycle of egg formation was thought first to be one of the factors affecting the blood serum traits. This cycle was measured by the time the hen lays its egg within the 24 hours following blood sampling. However, this factor proved to be statistically insignificant and explained almost nothing of the variance in all the serum traits without exception, and thus was dropped from the model.

Data were corrected for hatch effects and, in case of the plasma traits, for age effect. The hierarchical analyses of variances and covariances were then done on the corrected data to compute the heritabilities of the characters and the genetic and phenotypic correlations between them. The coefficient of the dam component of variance was 1.760 in the M.S. between dams within sires and 2.128 in the M.S. between sires. The coefficient of the sire component of variance in the M.S. between sires was 10.943. Heritabilities and genetic correlations were estimated using combined sire plus dam components.

Results and discussion

I. — The means

The overall means (± S.E.) and the means of the nine hatches (± S.E.) for egg production and the three groups of blood serum characters studied, beside the partial regression coefficients (± S.E.) on age at blood sampling are given in Tables 1, 3 and 5. The analyses of variances of these characters are shown in Tables 2, 4 and 6.

Estimates of the means of the blood serum traits studied have been reported by Shimer (1937), Sturkie and Newman (1951), Tapper and Kare (1960), McDaniel and Chute (1961), Wilcox (1966), Weiss, Johnson and Naber (1967), Estep, Fanguy and Ferguson (1969), Bell and Freeman (1971), Sturkie (1976) and others. Whenever estimates are comparable, it can be seen that the Fayoumi means are not much different from those reported in different breeds.

Highly significant effects of hatch are clear in all characters except inorganic phosphorus, uric acid, total proteins and Cholesterol. Late hatches showed in general lower means than earlier hatches. This was clear in all the characters significantly affected by hatch except calcium and lactic dehydrogenase, in which the means increased in the late hatches.

The regression on age at blood sampling showed significant effects on nine of the blood serum traits and had no effect only on inorganic phosphorus, uric acid and total proteins (hatch had no effect also on these three traits). Examining the sign of the regression coefficients, it can be seen that the level of calcium and lactic dehydrogenase in the blood serum increased by the advancement of age, while the levels of the other seven serum traits affected significantly by age, decreased. The amount of variance explained by regression in each of the nine traits affected by age is tremendous indeed. This would suggest that, for genetic studies of these blood serum characters, age must be corrected for, even within the range of layer ages of this study (ca 12-19 months).
### TABLE I

**Least-squares means (± S.E.) of egg production, blood serum chemical traits and plasma non-protein-nitrogen traits**

*Moyennes estimées par les moindres carrés, pour la production d'œufs, les paramètres chimiques du sérum sanguin et l'azote non protéIQUE du plasma*

| Classification     | N   | Egg production | Inorganic phosphorus (mg %) | Calcium (mg %) | Glucose (mg %) | Urea (mg %) | Uric acid (mg %) |
|-------------------|-----|----------------|----------------------------|----------------|---------------|-------------|------------------|
| Overall mean      | 439 | 77.88 ± 2.047  | 5.55 ± 0.087               | 21.62 ± 0.276  | 196.03 ± 2.287| 3.96 ± 0.229 | 5.66 ± 0.133     |
| Hatches:          |     |                |                            |                |               |             |                  |
| 1.                 | 86  | 100.72 ± 33.781| 5.71 ± 0.266               | 12.94 ± 0.771  | 250.53 ± 5.892| 8.42 ± 0.590 | 5.89 ± 0.344     |
| 2.                 | 58  | 86.22 ± 4.605  | 5.46 ± 0.199               | 16.71 ± 0.628  | 232.05 ± 5.202| 5.78 ± 0.521 | 5.25 ± 0.303     |
| 3.                 | 62  | 92.66 ± 4.453  | 5.60 ± 0.179               | 17.81 ± 0.564  | 215.93 ± 4.675| 5.58 ± 0.468 | 5.61 ± 0.272     |
| 4.                 | 38  | 89.21 ± 5.068  | 5.50 ± 0.229               | 19.20 ± 0.724  | 203.80 ± 5.097| 4.40 ± 0.601 | 5.15 ± 0.349     |
| 5.                 | 58  | 75.50 ± 4.605  | 5.59 ± 0.194               | 20.46 ± 0.611  | 188.55 ± 5.068| 3.12 ± 0.508 | 5.60 ± 0.296     |
| 6.                 | 67  | 80.31 ± 4.284  | 5.88 ± 0.107               | 23.71 ± 0.621  | 179.53 ± 5.143| 1.96 ± 0.515 | 5.49 ± 0.299     |
| 7.                 | 41  | 71.71 ± 5.477  | 5.80 ± 0.249               | 25.42 ± 0.785  | 170.36 ± 6.519| 1.25 ± 0.652 | 5.49 ± 0.379     |
| 8.                 | 12  | 47.33 ± 10.123 | 5.45 ± 0.418               | 29.32 ± 1.319  | 160.16 ± 10.029| 2.84 ± 1.005 | 5.53 ± 0.437     |
| 9.                 | 17  | 57.24 ± 8.505  | 4.92 ± 0.372               | 28.95 ± 1.710  | 163.34 ± 9.799| 2.37 ± 0.973 | 6.93 ± 0.566     |
| Regression on age/day (*) | 439 | 0.0078 ± 0.0056| 0.2943 ± 0.0178            | 1.8295 ± 0.1472| 0.1067 ± 0.0148| 0.0100 ± 0.0008 |

(*) Keeping the other variable (hatch) constant.
TABLE 2

The analyses of variances of egg production, blood serum chemical traits and plasma non-protein-nitrogen traits
Analyses de variance pour la production d'œufs, les caractéristiques chimiques du sérum et l'azote non protéique du plasma

| Source of variance       | M.S. values | Mean square values |
|--------------------------|-------------|--------------------|
|                          | D.F.        | Egg                | D.F. | Inorganic phosphorus | Calcium | Glucose | Urea | Uric acid |
|                          |             | production         |      |                     |         |         |      |           |
| Between hatches          | 8           | 8,695.21 (**)      | 8    | 2.1407 NS            | 437.65 (**) | 15,212.3 (**) | 105.06 (**) | 6.7514 NS |
| Regression               | 1           | 3.7995 NS          | 1    | 3.7995 NS            | 5,382.68 (**) | 208,035.5 (**) | 708.78 (**) | 0.0671 NS |
| Residual                 | 430         | 1,229.76           | 429  | 1.9735               | 19.61   | 1,347.3 | 13.53 | 4.5797    |

NS: Not significant.
(**) Significant at the 1 p. 100 level.
II. Genetic and phenotypic parameters

a) Egg production and group 1 of the serum traits:

The heritability values of egg production and group 1 of the serum traits beside the genetic and phenotypic correlations between them are given in Table 7. The genetic variance of inorganic phosphorus was negative and thus all the genetic
correlations involving this trait are imaginary. The heritability values of calcium, glucose and uric acid are very high, uric acid showing the highest estimate of 0.75.

The genetic correlations among the five traits of Table 7 (that is; excluding inorganic phosphorus) are all positive except those involving calcium. Uric acid showed the highest genetic correlation with egg production (−0.9), explaining more than 80 p. 100 of its variance. Calcium, glucose and urea, the almost completely genetically correlated characters, showed genetic correlation values of more than 0.7 with egg production.

| Overall mean | N | Alkaline phosphatase (µ/ml) | Lactic dehydrogenase (µ/ml) | Transaminase (µ/ml) |
|--------------|---|-----------------------------|-----------------------------|---------------------|
|              | 439| 1,023.32 ± 15.43            | 666.87 ± 10.41              | 168.72 ± 2.52       |
| Hatches:     |    |                             |                             |                     |
| 1            | 86 | 1,464.55 ± 39.94            | 386.03 ± 26.82              | 243.03 ± 6.49       |
| 2            | 58 | 1,297.80 ± 35.09            | 446.92 ± 23.67              | 204.89 ± 5.73       |
| 3            | 62 | 1,242.15 ± 31.53            | 557.14 ± 21.28              | 196.73 ± 5.15       |
| 4            | 38 | 1,001.35 ± 40.45            | 627.21 ± 27.29              | 180.97 ± 6.61       |
| 5            | 58 | 1,033.81 ± 34.19            | 703.68 ± 23.07              | 176.75 ± 5.58       |
| 6            | 67 | 943.84 ± 34.69              | 765.57 ± 23.66              | 147.97 ± 5.67       |
| 7            | 41 | 879.85 ± 43.90              | 820.22 ± 29.61              | 133.73 ± 7.18       |
| 8            | 12 | 722.23 ± 73.71              | 857.02 ± 49.75              | 109.74 ± 12.05      |
| 9            | 17 | 623.29 ± 85.48              | 833.01 ± 44.19              | 124.57 ± 10.70      |
| Regression on age/ day (*) |    | −12.6190 ± 0.9930           | −10.0577 ± 0.6701           | −1.9302 ± 0.1623    |

(*) Keeping the other variable (hatch) constant.

| Source of variance | D.F. | Alkaline phosphatase | Lactic dehydrogenase | Transaminase |
|--------------------|------|----------------------|----------------------|--------------|
| Between hatches    | 8    | 10,624.42 (***)      | 4,700.27 (***)       | 278.22 (***) |
| Regression         | 1    | 98,992.82 (***)      | 62,877.30 (***)      | 2,315.87 (***)|
| Residual           | 429  | 612.95               | 279.12               | 16.37        |

(**) Significant at the 1 p. 100 level.
|                          | Egg production | Inorganic phosphorus | Calcium       | Glucose       | Urea        | Uric acid   |
|--------------------------|----------------|----------------------|---------------|---------------|-------------|-------------|
| Egg production           | 0.224 ± 0.136  | -0.009 ± 0.048       | -0.096 ± 0.048| 0.067 ± 0.048 | 0.145 ± 0.047| 0.178 ± 0.046|
| Inorganic phosphorus     |                | 0.057 ± 0.124        | 0.301 ± 0.043 | -0.099 ± 0.047| -0.161 ± 0.046| -0.107 ± 0.047|
| Calcium                  | -0.712 ± 0.117 |                      | 0.656 ± 0.226 | -0.840 ± 0.014| -0.760 ± 0.020| -0.059 ± 0.048|
| Glucose                  | 0.791 ± 0.125  |                      |               | 0.639 ± 0.224 | 0.739 ± 0.022 | 0.105 ± 0.047|
| Urea                     | 0.750 ± 0.044  |                      |               | 1.029 ± 0.176 | 0.401 ± 0.195 | 0.015 ± 0.048|
| Uric acid                | 0.901 ± 0.152  |                      |               | 0.524 ± 0.170 | 0.582 ± 0.183 | 0.752 ± 0.236|

Underlined figures (on diagonal) are combined heritabilities, figures above diagonal are phenotypic correlations and below diagonal are genetic correlations.

⊕ ⊕ Imaginary values.
The phenotypic correlations among the six traits of Table 7 are less in size than the corresponding genetic correlations, though of the same signs. It can be observed that egg production had significant phenotypic correlations only with urea and uric acid. Calcium, glucose and urea showed again very high and significant phenotypic correlations among themselves.

b) Egg production and group 2 of the serum traits:

The heritabilities of the plasma proteins, cholesterol and bilirubin together with the genetic and phenotypic correlations among themselves and with egg production are given in Table 8. Among this group of serum traits, albumen showed the highest and significant heritability value (of 0.56 ± 0.21). Total proteins had the lowest value of heritability (0.114 ± 0.154) and showed no significant genetic correlations with any of the characters studied, except bilirubin, with which the genetic correlation was complete (see also Tables 9 and 11).

Bilirubin showed complete genetic correlations also with all the other characters of Table 8, including egg production. Egg production had also very high genetic correlations with albumen (0.9) and cholesterol (0.8).

Phenotypic correlations of group 2 of the serum traits with egg production are all significant and have the highest value of 0.23 with albumen.

c) Correlations between serum traits of group 1 and group 2:

The genetic and phenotypic correlations between the serum traits of group 1 and those of group 2 are presented in Table 9. Total proteins, as discussed above, are not significantly correlated genetically with any of the serum traits of group 1. So is also uric acid, except for its high genetic correlation with cholesterol (0.84 ± 0.11). Calcium showed significant negative correlations with all the serum traits of group 2, except total proteins. Albumen and bilirubin showed complete, or almost complete genetic correlations with calcium, glucose and urea. Cholesterol had complete genetic correlation with urea and was very highly genetically correlated with calcium and glucose.

The phenotypic correlations of calcium, glucose and urea with albumen, cholesterol and bilirubin are all significant; those involving albumen showed the highest values followed by those involving bilirubin. Inorganic phosphorus showed significant phenotypic correlations only with total proteins and cholesterol.

d) Egg production and group 3 of the serum traits:

The heritability estimates of the three blood serum enzymes studied are presented in Table 10, together with their genetic and phenotypic correlations, among themselves and with egg production. The blood serum enzymes had very high and significant estimates of heritability, alkaline phosphatase showing the highest heritability value of 0.73 ± 0.23. The estimate reported by Wilcox, Vanvleck and Shafrner (1962) for the heritability of alkaline phosphatase in the blood serum of 6-weeks old pullets (0.36) is just half the value estimated here.

Alkaline phosphatase, lactic dehydrogenase and transaminase are completely or almost completely genetically correlated, lactic dehydrogenase being negatively
### Table 8

Heritabilities (± S.E.) of, and genetic and phenotypic correlations (± S.E.) between egg production, plasma proteins, cholesterol and bilirubin

Héritalités, corrélations génétiques et phénotypiques concernant la production d’œufs, les protéines du plasma, le cholestérol et la bilirubine

|                  | Egg production | Total proteins | Albumen   | Cholesterol | Bilirubin   |
|------------------|----------------|---------------|-----------|-------------|-------------|
| Egg production   | 0.224 ± 0.136  | 0.186 ± 0.046 | 0.231 ± 0.045 | 0.168 ± 0.046 | 0.177 ± 0.046 |
| Total proteins   | -0.393 ± 0.626 | -0.114 ± 0.154 | -0.031 ± 0.048 | -0.017 ± 0.048 | -0.115 ± 0.047 |
| Albumen          | 0.004 ± 0.054  | -0.581 ± 0.338 | 0.561 ± 0.215 | 0.416 ± 0.039 | 0.779 ± 0.019 |
| Cholesterol      | 0.820 ± 0.147  | -0.505 ± 0.566 | 0.805 ± 0.143 | 0.197 ± 0.168 | 0.318 ± 0.043 |
| Bilirubin        | 1.009 ± 0.152  | -1.107 ± 0.176 | 1.050 ± 0.042 | 1.013 ± 0.016 | 0.187 ± 0.166 |

Underlined figures (on diagonal) are combined heritabilities, figures above diagonal are phenotypic correlations and below diagonal are genetic correlations.
TABLE 9

*Genetic and phenotypic correlations (± S.E.) between plasma proteins, cholesterol and bilirubin and each of the serum chemical traits and plasma non-protein-nitrogen traits*

*Corrélations génétiques et phénotypiques entre les protéines du plasma, le cholestérol et la bilirubine et chacune des caractéristiques chimiques du sérum et de l'azote non protéique du plasma*

|                  | Total proteins | Albumen  | Cholesterol | Bilirubin  |
|------------------|----------------|----------|-------------|------------|
| **Genetic correlations** |                |          |             |            |
| Inorganic phosphorus | 0.322 ± 0.490 | 0.996 ± 0.002 | 0.777 ± 0.153 | 1.194 ± 0.170 |
| Calcium           | -0.407 ± 0.463 | -1.002 ± 0.001 | 0.901 ± 0.074 | 1.128 ± 0.111 |
| Glucose           | -0.349 ± 0.567 | 1.012 ± 0.007 | 1.095 ± 0.091 | 1.100 ± 0.099 |
| Urea              | -0.478 ± 0.414 | 0.442 ± 0.201 | 0.839 ± 0.112 | 0.449 ± 0.313 |
| **Phenotypic correlations** |        |          |              |            |
| Inorganic phosphorus | 0.269 ± 0.044 | -0.043 ± 0.048 | 0.188 ± 0.046 | -0.062 ± 0.048 |
| Calcium           | 0.363 ± 0.041  | -0.825 ± 0.015 | -0.325 ± 0.042 | -0.635 ± 0.028 |
| Glucose           | -0.168 ± 0.046 | 0.830 ± 0.014  | 0.353 ± 0.041  | 0.609 ± 0.030  |
| Urea              | -0.136 ± 0.046 | 0.774 ± 0.019  | 0.285 ± 0.044  | 0.664 ± 0.027  |
| Uric acid         | 0.211 ± 0.046  | 0.073 ± 0.047  | -0.014 ± 0.048 | 0.041 ± 0.048  |

⊕ ⊕ Imaginary values.

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TABLE 10

*Heritabilities (± S.E.) of, and genetic and phenotypic correlations (± S.E.) between egg production and the three plasma enzymes studied*

*Hérabilités, corrélations génétiques et phénotypiques concernant la production d'œufs et les trois enzymes plasmatiques étudiés*

|                  | Egg production | Alkaline phosphatase | Lactic dehydrogenase | Transaminase |
|------------------|----------------|----------------------|----------------------|-------------|
| Egg production   | 0.224 ± 0.136  | 0.137 ± 0.047        | -0.089 ± 0.047       | 0.179 ± 0.046 |
| Alkaline phosphatase | 0.847 ± 0.101  | 0.732 ± 0.234        | -0.807 ± 0.017       | 0.893 ± 0.010 |
| Lactic dehydrogenase | -0.858 ± 0.107 | -0.985 ± 0.007       | 0.625 ± 0.223        | -0.786 ± 0.018 |
| Transaminase     | 0.799 ± 0.137  | 1.023 ± 0.011        | -0.988 ± 0.006       | 0.622 ± 0.222 |

Underlined figures (on diagonal) are combined heritabilities, figures above diagonal are phenotypic correlations and below diagonal are genetic correlations.
correlated with the other two serum enzymes. The three enzymes are highly
correlated genetically with egg production. The genetic correlations with egg
production of alkaline phosphatase and transaminase were positive (0.85 and 0.80
resp.) and of lactic dehydrogenase was negative (— 0.86). WILCOX et al. (1962)
reported a genetic correlation estimate of ± 0.5 between serum alkaline phospha-
tase level of 6-week old pullets and their egg production. It may be noted that
egg production in the present study showed significant negative genetic correla-
tions only with calcium and lactic dehydrogenase. As described above, the means
of these last two characters, unlike egg production, increased in the late hatches
and with the advancement of age.

The phenotypic correlations between the three blood enzymes showed also
high significant values of the same signs as the corresponding genetic correlations.
Alkaline phosphatase and transaminase had very low but significant positive
phenotypic correlation values with egg production. The correlation of lactic-

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**TABLE II**

*Genetic and phenotypic correlations (± S.E.) between the three plasma enzymes and each of the serum chemical traits, plasma non-protein-nitrogen traits, proteins, cholesterol and bilirubin*

Corrélations génétiques et phénométiques entre les trois enzymes plasmatiques et chacune
des caractéristiques chimiques du sérum, de l'azote non protéique du plasma, les protéines, le
cholestérol et la bilirubine.

|                     | Alkaline phosphatase | Lactic dehydrogenase | Transaminase |
|---------------------|----------------------|----------------------|--------------|
| **Inorganic phosphorus** | || |
| Calcium             | —1.001 ± 0.001       | 0.994 ± 0.003        | —0.966 ± 0.002 |
| Glucose             | 0.998 ± 0.001        | —0.988 ± 0.006       | 1.023 ± 0.012  |
| Urea                | 0.973 ± 0.015        | —1.045 ± 0.027       | 1.012 ± 0.007  |
| Uric acid           | 0.402 ± 0.192        | —0.543 ± 0.193       | 0.433 ± 0.169  |
| Total proteins      | —0.397 ± 0.443       | 0.095 ± 0.550        | —0.494 ± 0.418 |
| Albumen             | 1.025 ± 0.013        | —1.019 ± 0.010       | 0.987 ± 0.007  |
| Cholesterol         | 0.779 ± 0.147        | —0.807 ± 0.137       | 0.728 ± 0.184  |
| Bilirubin           | 1.010 ± 0.155        | —1.101 ± 0.098       | 1.009 ± 0.146  |

**Genetic correlations**

**Phenotypic correlations**

| Inorganic phosphorus | —0.131 ± 0.047       | 0.117 ± 0.047        | —0.106 ± 0.047  |
| Calcium             | —0.876 ± 0.011       | 0.884 ± 0.010        | —0.859 ± 0.012  |
| Glucose             | 0.839 ± 0.014        | —0.870 ± 0.011       | 0.823 ± 0.015  |
| Urea                | 0.708 ± 0.024        | —0.726 ± 0.020       | 0.707 ± 0.024  |
| Uric acid           | 0.070 ± 0.047        | 0.037 ± 0.048        | 0.049 ± 0.048  |
| Total proteins      | —0.245 ± 0.045       | 0.246 ± 0.045        | —0.188 ± 0.046 |
| Albumen             | 0.798 ± 0.017        | —0.865 ± 0.012       | 0.808 ± 0.017  |
| Cholesterol         | 0.314 ± 0.043        | —0.410 ± 0.040       | 0.347 ± 0.042  |
| Bilirubin           | 0.549 ± 0.033        | —0.653 ± 0.027       | 0.608 ± 0.031  |

⊕ ⊕ Imaginary values.
dehydrogenase with egg production was negative and insignificant (— 0.089 ± 0.047). WILCOX et al. (1962) reported a phenotypic correlation estimate of 0.01 between egg production and serum alkaline phosphatase level.

e) Correlations between serum enzymes and serum traits of group I and group 2:

The genetic and phenotypic correlations between the three blood serum enzymes and each of the serum traits of group I and group 2 are presented in Table II. It can be seen, here also, that the genetic (or phenotypic) correlation of each of the different serum traits of group 1 or 2 with either alkaline phosphatase or transaminase has a different sign from the corresponding correlation with lactic dehydrogenase. All genetic correlations of any of the three enzymes with uric acid and total proteins are insignificant. Otherwise, all genetic correlations are significant. It can be noticed that the three correlations of any of the serum traits with the three enzymes are almost of the same magnitude. Calcium, glucose, urea, albumen and bilirubin have complete, or almost complete genetic correlations with the serum enzymes.

The phenotypic correlations are all of lower magnitudes compared to their corresponding genetic correlations, and are all significant except those involving uric acid. Inorganic phosphorus showed significant phenotypic correlations, though of very low magnitudes, with the three blood serum enzymes.

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Résumé

Paramètres génétiques et phénotypiques de la production d’œufs et de certains constituants du sérum sanguin chez des pondeuses Fayoumi

Un total de 439 pondeuses Fayoumi issues de 9 lots d’éclosion, d’un âge compris entre 12 et 19 mois, ont été utilisées pour étudier (i) la production d’œufs; puis les constituants suivants du sérum sanguin : (2) phosphore inorganique, (3) calcium, (4) glucose, (5) urée, (6) acide unique, (7) protéines totales, (8) albumine, (9) cholestérol, (10) bilirubine, (11) phosphatase alcaline, (12) déshydrogénase lactique, (13) transaminase. Ces pondeuses étaient les filles de 40 pères et 241 mères. Les analyses sur le sérum étaient faites à l’aide de l’auto-analyseur Séquentiel Multiple, SMA-12/60. La moyenne estimée par les moindres carrés pour le nombre d’œufs produit par poule jusqu’à 70 semaines d’âge était 78. Les moyennes des moindres carrés des paramètres du sérum sanguin mentionnés plus haut étaient dans l’ordre : (2) 5,55 mg p. 100, (3) 21,62 mg p. 100, (4) 196 mg p. 100, (5) 3,66 mg p. 100, (6) 5,66 mg p. 100, (7) 5,93 mg p. 100, (8) 0,71 mg p. 100, (9) 167,4 mg p. 100, (10) 0,36 mg p. 100, (11) 1 023 mu/ml, (12) 667 mu/ml, (13) 169,7 mu/ml. Le lot d’éclosion avait des effets statistiquement significatifs sur tous les caractères étudiés excepté le phosphore inorganique, l’acide urique, les protéines totales et le cholestérol. L’âge de la poule affectait de façon significative tous les caractères du sérum sanguin excepté le phosphore inorganique, l’acide urique et les protéines totales.

Les données étaient corrigées pour l’effet du lot d’éclosion, et, dans le cas des caractéristiques du plasma, pour l’effet de l’âge, préalablement aux analyses hiérarchiques de variance et de covariance destinées à évaluer les héritabilités et les corrélations génétiques et phénotypiques. Les estimations combinées de l’héritabilité des caractères étudiés étaient dans l’ordre : (1) 0,224 ± 0,136, (2) 0,057 ± 0,124, (3) 0,056 ± 0,226, (4) 0,039 ± 0,224, (5) 0,401 ± 0,195, (6) 0,752 ± 0,236, (7) 0,114 ± 0,154, (8) 0,561 ± 0,215, (9) 0,107 ± 0,168, (10) 0,187 ± 0,166, (11) 0,732 ± 0,234, (12) 0,625 ± 0,223, (13) 0,622 ± 0,222.

Des corrélations génétiques significatives (d’une valeur supérieure ou égale à ± 0,7) étaient trouvées entre la production d’œufs et tous les caractères du sérum sanguin excepté le phosphore inorganique et les protéines totales.
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