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EFFECTS OF SUPPLEMENTING LAYING HENS DIETS WITH ORGANIC SELENIUM ON EGG PRODUCTION, EGG QUALITY, FERTILITY AND HATCHABILITY

By

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Abstract : *This study was carried out at El Takamoly Poultry Project, Fayoum, Egypt,. A total number of 498 (450 breeder hens and 48 cocks) birds of Golden Montazah (GM) and Fayoumi (F) strains at 42 wks of age were used to evaluate the effects of two dietary levels of Se as Sel-Plex (0.1 or 0.2 mg/Kg diet) on breeder hens performance. Birds were divided randomly into 3 equal treatment groups of 83 birds each (75 breeder hen and 8 cock each). Birds were placed in 6 floor brooder pens, the 1st group was fed the basal diet, while the 2nd and 3rd groups were fed on the same diet but supplemented with one of the two levels (0.1 or 0.2 mg/Kg diet) of selenium (Se) as Sel-Plex. The experimental period was lasted for 23 weeks (from 42 to 65 wks of age).*

Results obtained could be summarized in the following:

1- *The eggs from GM hens were higher EN, EM and EP% as will as heavier EW than those from F hens, Golden Montazah hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher EM value. Laying hens fed diet containing 100 mg Se/ton diet as Sel-Plex had lower FI while, those fed control diet had higher FI value. Fayoumi hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher LBWG.*

2- *The eggs from GM hens were heavier than those from F hens with more albumen% but less shell thickness, shell%, yolk index (YI%) and shape index%. As the layer age increased, yolk color, shell thickness and yolk% increased significantly, however, the YI% and Haugh unit score decreased.*

3- *Fayoumi hens had higher fertility and hatchability%, as the age of hen increased, fertility and hatchability% decreased significantly. F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher fertility and F hens fed diet containing 100 mg Se/ton diet as Sel-Plex had higher*

hatchability%, while, hens (F and GM) fed control diet had lower fertility and hatchability%.

4- *Fayoumi hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher WBCs, MCV and MCH.*

5- *Eggs F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher moisture, fat and Se concentration in the yolk, and gave the best economical and relative efficiency. Fayoumi hens fed control diet had lower moisture, ash and Se concentration in the yolk.*

In conclusion:

Feeding GM and F laying hens on diets containing Se as Sel-Plex (100 mg/ton) improved the productive, reproductive performance and relative economic efficiency values of laying hens at reflected by fertility and hatchability.

INTRODUCTION

Intensive poultry production in Egypt depend not only on commercial hybrid but also on local strains of chickens. During the recent decades, the extensive importation of high producer exotic commercial layers has tended to reduce the amount of research on local chicken strains undertaken in Egypt, and hence the amount of information available on native fowl stocks including **Fayoumi (A)** and **Golden Montazah (B)**. Although, they still contribute to a great extent in meat and egg supply **(El-Hossari, 1970 and Sharaby 1998).**

A. Fayoumi strain (F):

Originally an ancient native breed from the Egyptian city of Fayoumi bred for egg production. The birds are small in size, and their skin is bluish **(Ghany *et al.,* 1962)**. Fairly small, light and active chickens.

B. Golden Montazah strain (GM):

As early as 1950 many attempts were made to produce Egyptian local strains of chicks. All of them used a cross breeding between native strains and foreign strains, followed by selection for different traits on some crosses. In 1966 cross breeding was made between Fayoumi x Barred Plymouth Rock to give Doki-4 strain **(El-Itriby and Sayed, 1966)**. In 1974 Daki-4 x Rhode Island Red was crossed to produce Golden Montazah **(Mahmoud *et al.,* 1974**).

Selenium (Se) is a dietary essential trace mineral for poultry **(NRC, 1994),** Se was reported to prevent liver necrosis in rats **(Schwarz and Foltz,**

1957), which established Se as a dietary essential nutrient**.** Se is essential for proper function of the antioxidant enzyme glutathione peroxidase (GSH-Px), which protects the cell by destroying free radicals **(Rotruck *et al.*,1973).**

The laying hen's requirement for Se ranges from 0.05 to 0.08 ppm depending on daily feed intake **(NRC, 1994).** In humans, Se deficiency is associated with a compromised immune system and increased susceptibility to various diseases **(Surai, 2006 and Papp *et al.*, 2007).** The results of clinical studies suggest that an increase in the intake of Se is associated with health benefits. When considering ways to improve human Se intake, there are several potential options, including the production of Se-enriched eggs, meat and milk **(Surai, 2006).** The egg is a traditional and affordable food in most countries and is consumed by people of all ages more or less regularly and in moderation. It is also a very safe vehicle for supplementation given that a toxic dose of Se from eggs would require consumption of at least 30 eggs per day over time, an unlikely situation **(Surai, 2002 and Fisinin *et al*., 2008).** Before the advent of commercially available organic Se for animal diets, the main problem as regards the enrichment of eggs with Se was the low efficiency of transfer of inorganic Se (the selenite or selenate forms) to the egg. In fact, even high doses of selenite in the diet of laying hens were not able to substantially enrich eggs with this trace element **(Surai, 2002 and Fisinin *et al*., 2008).** Since the main form of Se in the egg is seleno-methionine and chickens cannot synthesise this amino acid, inclusion of sodium selenite into the chicken diet has limited ability to produce enriched eggs. However, seleno-methionine from Se-yeast is effectively transferred to egg yolks and albumin, providing the opportunity to produce Se-eggs **(Fisinin *et al*., 2008)**. It is interesting to note that practically all of the aforementioned Se-eggs are produced using Se-yeast in the commercial from of Sel-Plex (Alltech Inc, USA) as a major source of Se for laying hens at the level of 0.3-0.5 ppm in feed **(Fisinin *et al*., 2008).**

The present study was conducted to evaluate the effects of two dietary levels of Se as Sel-Plex (0.1 or 0.2 mg/Kg diet) on egg performance, egg quality, fertility, hatchability, some blood plasma constituents of GM and F laying hens and the concentration of Se in the eggs.

MATERIALS AND METHODS

This study was carried out at El Takamoly Poultry Project, Fayoum, Egypt, from December, 2007 to February, 2008 (age 1) and from March to May, 2008 (age 2) . A total number of 498 (450 breeder hens and 48 cocks) birds of Golden Montazah (GM) and Fayoumi (F) strains at forty-two weeks of age were used in this experiment to evaluate the effects of two dietary levels of Se as Sel-Plex (0.1 or 0.2 mg/Kg diet) on egg performance, egg quality, fertility, hatchability, some blood plasma constituents of GM and F laying hens and the concentration of Se in the eggs. Birds (each strain) were wing banded and divided randomly into 3 equal treatment groups of 83 birds (having nearly similar body weight) each (75 breeder hen and 8 cock each). Birds were placed in 6 floor brooder pens (open system), which contain wood shaving litter. The 1st group was fed the basal diet (Table 1) and served as control group (unsupplemented with Se) while the 2nd and 3rd groups were fed on the same diet supplemented with two levels of Se (0.1 or 0.2 mg/Kg diet) as Sel-Plex in the form of Se yeast. Se yeast as Sel-Plex (Alltech Inc.) contains 1000 mg Se/Kg Sel-Plex and produced by the fermentation of yeast (*Saccharomyces cerevisiae*) in a high Se medium. The experimental period was lasted for 23 weeks from 42 to 65 weeks of age. Water and feed were offered ad libitum, the lighting schedule was 16 h light : 8 h dark.

Egg production (weight and number) was recorded daily and feed intake for each group was calculated weekly. Feed conversion calculated as the amount of feed required for producing a unit of egg mass. Birds were individually weighed at the beginning and at the end of the experimental period. Two batches of eggs (No=100 egg/treatment) were collected from the 6 treatments pens at the 51th and 65th weeks of age to study the hatchability and incubated at Chick Master hatchery. Fertility was determined by candling at 7 days of incubated period. The averages of the fertility and hatchability of the two batches were calculated. At sampling, eggs were weighed and interior quality was determined (albumen and yolk).

At the end of the experiment, blood samples were collected from 5 hens/pens and taken randomly from the brachial vein and then transferred to heparinized tubes and placed on ice. Hemoglobin concentration (Hb), red blood cells (RBC`s) count and white blood cells (WBC`s) count were determined. Economical efficiency of egg production was calculated from the input-output analysis which was calculated according to the price of the experimental diets and eggs produced. The values of economical efficiency were calculated as the net revenue per unit of total cost. Chemical analyses of representative samples of the experimental eggs were carried out to determine percentages of DM, CP (N x 6.25), EE, ash and concentration of Se in the yolk contents according to the methods of **A.O.A.C (1990).** Nitrogen-free extract (NFE) was calculated by difference.

An ANOVA with the General Linear Models (GLM) procedure of SPSS software **(SPSS, 1999)** included the main effects of strain, level of addition of Se as Sel-Plex and age of hen and the two-and three way interactions between these factors. Treatment means indicating significant differences ($P \leq 0.01$ and $P \leq 0.05$) were tested using Duncan's multiple range test **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Laying hens productive performance:

Effect of supplementing laying hens diets with organic Se on egg number (EN), average egg weight (EW), total egg mass (EM), egg production (EP%), total feed intake (FI), feed conversion (FC) and live body weight gain (LBWG) are shown in Table 2.

The strain effect was significant for EN, EW, EM and FI (Table 2), the EN for GM hens were higher than those from F hens, the EW, EM from GM hens were heavier than those from F hens. The F hens had lower FI value than GM hens. There were insignificant differences among strains in EP%, FC and LBWG values (Table 2).

Level of addition effect was significant for EN, EM and FI (Table 2), it is clear that laying hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher EN value, laying hens fed control diet or 200 mg Se/ton diet as Sel-Plex had higher EM value. The laying hens fed diet containing 100 mg Se/ton diet as Sel-Plex had lower EN, EM and FI values. No significant effect were observed for EW, EP%, FC and LBWG during the over all experimental period.

Significant interactions between strain and levels of addition (Table 2) were observed for EN, EM, FI and LBWG values. It is clear that F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher EN value, while, the GM breeder hens fed diet containing 100 mg Se/ton diet as Sel-Plex had lower EN value. Golden Montazah breeder hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher EM, however, GM hens fed diet containing 0 mg Se/ton diet as Sel-Plex had highest FI value during the over all experimental period (from 42 to 65 wk of age). The F laying hens fed diet containing 100 mg Se/ton diet as Sel-Plex had lower EM and FI values. No significant effect were observed for EW, EP% and FC during the over all experimental period (Table 2).

In this respect, **Renema (2004); Simon (2004) and Sara *et al.* (2008)** showed that addition of organic Se as Sel-Plex to laying hens diets significantly increased EP% and EW during the period ranged from 48–62 wk of age, respectively. Also, **Hanafy *et al.* (2009**) indicated that addition of organic Se as Sel-Plex™ in Bandarah laying hen diets during the period from 40–60 wk of age improved EP% and EW. Our results disagree with those of **Utterback *et al.* (2005); Richter *et al.* (2006) and Hanafy *et al.* (2009)** who noted that the organic Se supplementation had no significant effect on FI values in laying hens.

Concerning the effect of strain by level (Table 2), addition of Sel-Plex of the diet significantly ($P\leq0.01$) influenced the breeder hens LBWG, F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher LBWG value, while, GM hens fed diet containing 200 mg Se/ton diet as Sel-Plex had lower LBWG value. In this respect, **Arpasova *et al.* (2009) and Hanafy *et al.* (2009)** reported that the supplementation of Se into the diet significantly ($P\leq0.05$) influenced the laying hens body weight for a breeding period.

Egg quality:

Effect of supplementing laying hens diets with organic Se on egg quality are shown in Table 3. Concerning the strain effect (Table 3), the eggs from GM hens were heavier than those from F hens, with more albumen% but less shell thickness, shell%, YI and shape index%. In this respect, **Silversides and Scott (2001)** found that major influences on albumen quality are the strain and age of a laying hen, eggshell quality and storage time and conditions**.** Albumen height differs between strains **(Toussant *et al.*, 1995 and Scott and Silversides, 2000).**

Concerning the effect of level of Sel-Plex (Table 3), no significant effect were observed on egg quality except, YC, albumen%, yolk%, and shell%. It is clear that laying hens fed diet containing 100 mg Se/ton diet as Sel-Plex had higher YC and albumen%, while, eggs from hens fed control diet had lower YC. However, insignificant differences were detected among other level was found as compared to the control diet. Laying hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher yolk%, while, those fed the control diet had higher shell%. Numerically, as the level of addition increased, egg weight decreased and YI% and HU increased (the difference is not significant). The present results are in accordance with those reported by several investigators who indicated that Se yeast reduced deterioration of the albumen, which results in slower carbon dioxide loss and thus maintains albumen quality after the egg is laid **(Wakebe, 1998)**. Also, **Rutz *et al.* (2003)** found that the addition of organic Se in laying hen diets led to the improvement of the egg shell, yolk and white. An improvement in albumen height with organic Se by indirect mode of action of organic Se which enhanced function of the Se-dependent GSH-Px antioxidant system **(Rutz *et al.*, 2005** and **Hanafy *et al.*, 2009)**. **Renema (2006)** indicated that shell thickness was higher in the Sel-Plex group than in the control group after 9 weeks of treatment. **Klecker *et al.* (2001) and Sara *et al.* (2008)** indicated that the administration of organic Se in laying hen diets increased egg shell thickness and reduced the number of eggs with shell abnormalities, consequently improved eggshell quality. **Spring (2006)** showed that organic Se supplementation in broiler breeders and layers improve egg quality. **Kenyon *et al.* (2003)** reported that supplementation with Sel-Plex led to a significant increase in Se concentrations of both the yolk and the albumen compared to the Na-selenite treatment. Additions of Se as Sel-Plex in Bandarah laying hen diets improve egg shape index%, Haugh unit, yolk index, shell thickness and Se content of yolk and albumen through all studied ages **(Hanafy *et al.*, 2009)**

Regarding to the age of hen, as the layer age increased, YC, shell thickness and yolk% increased significantly, however, the YI% and HU score decreased significantly with increasing age of the hen (Table 3). On the other hand, the YI% and HU score of the egg from 51-wk was higher than that found in the YI% and HU of 65-wk-old birds (47.65 and 71.66 vs. 41.19 and 57.92, respectively). Similar results were observed by **Hill and Hall (1980) and Silversides (1994),** who found that as the age of the hen increases, the albumen height decreases even as the egg weight and total amount of albumen increase. Interaction between strain and level of Sel-Plex and between strain and age of hen presented in (Table 3) indicated no significant differences in egg quality among all dietary treatments.

Fertility and hatchability%:

Effect of supplementing laying hens diets with organic Se on fertility, hatchability, embryonic mortality at 7 d and abnormal chicks% are shown in Table 4.

Regarding to the strain effect (Table 4), strain significantly influenced ($P \leq 0.01$) fertility and hatchability%, F hens had higher fertility and hatchability% (consequently lower embryonic mortality at 7 d and abnormal chicks%), this may be due to F hens had higher Se concentration in the yolk and this breed is clamed to have a wide range of adaptability and sustained productivity under tropical and village conditions in many developing countries. Many workers demonstrated the superiority of Egyptian strains of chickens over the imported breeds regarding disease resistance **(El-Ibiary, 1954, Ragab *et al.*, 1956 and Amer *et al.*, 1957). Agate *et al.*, (2000)** showed that Se as Sel-Plex supplementation in laying hen diets improved the environment of the sperm storage tubules in the hen's oviduct, allowing sperm to live longer, increasing the length of time sperm can be stored and increasing the average number of sperm holes in the yolk layer.

Concerning level of Sel-Plex effect (Table 4), level of Sel-Plex significantly influenced (P≤0.01) fertility and hatchability%, hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher fertility and hatchability% (consequently lower abnormal chicks%), while, hens fed control diet had lower fertility and hatchability% (lower embryonic mortality at 7 d %). These results agree with the findings of **Cantor and Scott (1974); Davtyan *et al.* (2006); Petrosyan *et al.* (2006) and Hanafy *et al.* (2009)** who reported that Se as Sel-Plex™ supplementation increased the hatchability of fertile eggs and number of hatched for laying hen**.**

Regarding to age of hen, as the age of hen increased, fertility and hatchability% decreased significantly, however, as the layer age increased, abnormal chicks% decreased significantly (Table 4).

Regarding to the strain by level of Sel-Plex interaction effect (Table 4), strain by level of Sel-Plex significantly influenced (P≤0.01) fertility and hatchability%, F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher fertility (consequently lower abnormal chicks%) and F hens fed diet containing 100 mg Se/ton diet as Sel-Plex had higher hatchability% (consequently lower embryonic mortality at 7 d%), while, hens (F and GM) fed control diet had lower fertility and hatchability%, respectively, increased hatchability in treated groups may be due to improved anti-oxidant status. In this respect, **Davtyan *et al.* (2006) and Petrosyan *et al*. (2006)**, reported that a primary effect is on the breeder performance by a higher number of viable chicks produced and lower mortality of embryos during incubation, while the second effect on the males by effecting of Se on maintaining sperm quality long time when stored in sperm storage tubules after mating and quantity is of major interest.

The protective effects of organic Se are especially apparent during the highly oxidative state of late incubation and the first few days after hatch**. (Surai, 1999 and Surai, 2000)**. Hatched chicks produced from hens fed high level of Se were significantly (P≤0.05) heavier than those of the group fed low level of Se or the group fed the basal diet. Similar results were reported by **Sefton and Edens (2004) and Pappas *et al.* (2006)** who found that the chick weights from parents fed diets high in Se were heavier at hatch than those hatched from parents fed diets low in Se.

Blood constituents:

Some blood constituents analyses are summarized in Table 5. Concerning the strain effect, strain significantly influenced (P≤0.05) monocyts and MCHC, F hens had higher monocyts and MCHC, while, GM hens had lower monocyts and MCHC.

Inclusion of Sel-Plex in the laying diets at different levels caused a significant ($P \leq 0.01$) differences in white blood cells (WBCs) count, neutrophils and lymphocyte (LYMP), while, insignificant ($P \geq 0.05$) effects were observed in the other blood constituents being hemoglobin (HGB), red blood cells (RBCs) count, total leucocytes (TLC), monocyts, eosinophil (ESINO), haematocrit (HCT), MCV, MCH and MCHC. Hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher WBCs and neutrophils (consequently lower LYMP) and hens fed diet containing 100 mg Se/ton diet as Sel-Plex had higher LYMP (consequently lower WBCs and neutrophils).

Interaction due to strain by level Sel-Plex supplementation had significantly ($P \leq 0.05$) affected some blood constituents (WBCs, TLC, MCV and MCH), however, insignificant ($P \geq 0.05$) affected were observed in other blood constituents (Table 5). F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher WBCs, MCV and MCH, however, F hens fed control diet had higher TLC.

Similarly, **Blood *et al.* (1995)** noted that organic Se supplementation in the diets is important for increase number of lymphocytes and for proper development and function of immune system **(Hussain *et al.*, 2004 and Fisinin *et al*., 2008)**. **Hanafy *et al.* (2009),** reported that Se supplementation significantly ($P \leq 0.05$) increases of Hb, RBC`s and WBC`s in Se treated groups compared with those in the control group.

Chemical composition of eggs and Se concentration in the yolk:

Effect of supplementing laying hens diets with organic Se on chemical composition of eggs are shown in Table 6. Concerning the strain effect, strain significantly influenced ($P \leq 0.01$ and $P \leq 0.05$) chemical composition of eggs, except, moisture and NFE%, GM hens had higher protein and ash% (consequently lower fat%) and F hens had higher fat% (consequently lower protein and ash%). Strain significantly influenced ($P \leq 0.01$) Se concentration in the yolk, F hens had higher Se concentration in the yolk than GM (Table 6).

Regarding to level of Sel-Plex (Table 6), level of Sel-Plex significantly influenced ($P \leq 0.01$) chemical composition of eggs, hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher eggs moisture and fat (consequently lower protein%) and hens fed diet containing 100 mg Se/ton diet as Sel-Plex had higher eggs ash and NFE (consequently lower fat%), while, hens fed control diet had lower eggs moisture (consequently higher protein%). Level of Sel-Plex significantly influenced ($P \leq 0.01$) Se concentration in the yolk, hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher Se concentration in the yolk. On the other hand, Se concentration in the yolk increased significantly with increasing level of Sel-Plex addition (Table 6). Similarly, **Fisinin *et al.* (2008) ; Sara *et al.* (2008) and Hanafy *et al.*(2009)** reported that the supplementation of hens' diet with organic Se not only improves their health and productivity but can also be a natural way to produce functional food, respectively the production of eggs enriched with Se.

Regarding to the strain by level of Sel-Plex interaction effect, strain by level of Sel-Plex significantly influenced ($P \leq 0.01$) chemical composition of eggs, F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher eggs moisture and fat, GM hens fed control diet had higher eggs protein, while, GM hens fed diet containing 200 mg Se/ton diet as Sel-Plex had lower eggs protein (higher NFE%), and F hens fed control diet had lower eggs moisture and ash. Strain by level of Sel-Plex significantly influenced ($P \leq 0.01$) Se concentration in the yolk, F hens fed diet containing 200 mg Se/ton diet as Sel-Plex had higher Se concentration in the yolk, while, F hens fed control diet had lower Se concentration in the yolk.

Economical efficiency(EEf):

Table 7 show the economical efficiency (EEf) and the relative economical efficiency (relative EEf) values. F hens fed diet containing 200 mg Se/ton diet as Sel-Plex gave the best economical and relative efficiency values being 0.678 and 106.85%, respectively followed by GM hens fed diet containing 100 mg Se/ton diet as Sel-Plex being 0.431 and 103.76%, respectively, all of which are superior compared to the control diet without supplementation, except, GM hens fed diet containing 200 mg Se/ton diet as Sel-Plex which had the worst corresponding values, being 0.395 and 95.09%, respectively. The relative efficiency varied between –4.91 to +6.85% which is of minor importance relative to the other factors of production.

Mortality rate%:

The calculated cumulative mortality% during the period from 42 to 65 wks of age are presented in Table 7. It appears that mortality% was not related to treatments studied.

In conclusion, the results of this study indicated that feeding GM or F laying hens on diets containing Se as Sel-Plex improved the productive, reproductive performance and relative economic efficiency values of laying hen at reflected by fertility and hatchability. Further research is needed to get better understanding of the effect of Se as Sel-Plex in poultry production and their beneficial impact on human health.

Table 1: Composition and analyses of the control or basal diets.

Item, %	Fayoumi	Golden Montazah
Yellow corn, ground	67.00	66.00
Soybean meal (44%CP)	19.50	22.00
Corn glutein meal	1.00	1.50
Wheat bran	3.22	1.22
Calcium carbonate	7.20	7.20
Sodium chloride	0.30	0.30
Vit. and Min. premix [1]	0.30	0.30
Monocalcium phosphate	1.40	1.40
DL–Methionine	0.08	0.08
Total	100.0	100.0
Calculated analysis % [2]:		
Crude protein	15.45	16.46
Ether extract	2.82	2.76
Crude fiber	3.21	3.15
Calcium	3.04	3.05
Available phosphorus	0.41	0.41
Methionine	0.34	0.36
Methionine+Cystine	0.61	0.64
Lysine	0.73	0.79
ME, kcal./Kg	2761	2776
Cost (£.E./ton) [3]	1504.0	1575.0

[1] Each 3.0 Kg of the Vit. and Min. premix manufactured by Vetgreen Company and contains : Vit. A, 10000000 IU ; Vit. D_3 2000000 IU ; Vit. E, 1000 mg; Vit. K_3, 1000 mg; Vit. B1, 1000 mg; Vit. B2, 500 mg ; Vit. B6, 1500 mg; Vit. B12, 10 mg ; biotin, 50 mg ; folic acid, 1 mg; niacin , 3000 mg; Ca pantothenate, 1000 mg ; Zn, 50 g ; Cu,4 g ; Fe, 30 g ; Co, 0.1 g ; Se, 0.1 g ; I, 0.3 g ; Mn, 60 g and anti-oxidant, 10 g, and complete to 3.0 Kg by calcium carbonate.

[2] According to **NRC, 1994**.

[3] According to the local market price at the experimental time.

Table 2: Effects of supplementing laying hens diets with organic selenium on egg number, average egg weight, total egg mass, hen house egg production, total feed intake, feed conversion and live body weight gain during period from 42 to 65 week of age.

Items		Egg number (EN)	Average egg weight (EW,g)	Total egg mass (EM, Kg)	Hen house egg production (EP)%	Total feed intake (FI, Kg)	Feed conversion (FC, g feed/ g egg)	Live body weight gain (LBWG,g)
Strain								
Fayoumi		**6041.7±0.33^{1B}**	**48.61±0.33^{B}**	**293.33±0.33^{B}**	**52.90±0.33**	**1191.5±0.33^{B}**	**4.06±0.03**	**56.60±4.96**
Golden Montazah		**6069.3±0.33^{A}**	**54.52±0.33^{A}**	**331.06±0.33^{A}**	**53.01±0.33**	**1337.6±0.33^{A}**	**4.04±0.03**	**47.94±4.67**
Level of addition Se as Sel-Plex (mg/ton diet)								
0.00		**6058.5±0.41^{B}**	**52.16±0.41**	**316.77±0.41^{A}**	**53.06±0.41**	**1296.2±0.41^{A}**	**4.09±0.04**	**52.94±5.73**
100.00		**5898.5±0.41^{C}**	**51.62±0.41**	**304.06±0.41^{B}**	**52.39±0.41**	**1225.8±0.41^{C}**	**4.03±0.04**	**51.62±5.81**
200.00		**6209.5±0.41^{A}**	**50.91±0.41**	**315.76±0.41^{A}**	**53.41±0.41**	**1271.7±0.41^{B}**	**4.03±0.04**	**52.26±5.67**
Strain * Level of addition Se as Sel-Plex (mg/ton diet)								
Fayoumi	**0.00**	**5984.0±0.58^{D}**	**49.62±0.58**	**297.24±0.58^{C}**	**53.32±0.58**	**1217.1±0.58^{D}**	**4.10±0.06**	**42.86±8.18^{AB}**
	100.00	**5911.0±0.58^{E}**	**48.93±0.58**	**288.40±0.58^{E}**	**51.63±0.58**	**1170.4±0.58^{F}**	**4.06±0.06**	**59.86±8.12^{AB}**
	200.00	**6230.0±0.58^{A}**	**47.27±0.58**	**294.35±0.58^{D}**	**53.73±0.58**	**1186.9±0.58^{E}**	**4.03±0.06**	**67.08±8.07^{A}**
Golden Montazah	**0.00**	**6133.0±0.58^{C}**	**54.70±0.58**	**336.31±0.58^{A}**	**52.80±0.58**	**1375.3±0.58^{A}**	**4.09±0.06**	**63.01±8.01^{A}**
	100.00	**5886.0±0.58^{F}**	**54.32±0.58**	**319.71±0.58^{B}**	**53.15±0.58**	**1281.1±0.58^{C}**	**4.01±0.06**	**43.38±8.30^{AB}**
	200.00	**6189.0±0.58^{B}**	**54.55±0.58**	**337.16±0.58^{A}**	**53.08±0.58**	**1356.4±0.58^{B}**	**4.02±0.06**	**37.43±7.96^{B}**
Over all mean		**6055.5±0.24**	**51.56±0.24**	**312.20±0.24**	**52.95±0.24**	**1264.6±0.24**	**4.05±0.02**	**52.27±3.31**

[1] Mean ± Standard error of the mean.

A,… F, values in the same column within the same item followed by different superscripts are significantly different (at P ≤0.01 for A to F).

Table 3: Effects of supplementing laying hens diets with organic selenium on egg quality.

Items		Egg weight (EW), g	Yolk color (YC)	Shell thickness, mm	Albumen%	Yolk%	Shell%	Yolk index (YI)%	Shape index%	Haugh unit (HU)
Strain										
Fayoumi		48.60±0.39^{1B}	6.86±0.12	0.388±0.003^{A}	56.65±0.32^{b}	32.48±0.29	10.86±0.10^{A}	45.12±0.43^{a}	77.55±0.34^{A}	64.69±1.20
Golden Montazah		54.52±0.39^{A}	6.77±0.12	0.358±0.003^{B}	57.69±0.31^{a}	32.65±0.28	9.664±0.10^{B}	43.72±0.41^{b}	76.00±0.34^{B}	64.90±1.20
Level of addition Se as Sel-Plex (mg/ton diet)										
0.00		52.16±0.48	6.45±0.15^{B}	0.376±0.004	57.45±0.38^{ab}	32.04±0.35^{b}	10.50±0.12^{a}	43.49±0.51	76.73±0.41	63.32±1.46
100.00		51.62±0.48	7.18±0.15^{A}	0.368±0.004	57.66±0.38^{a}	32.27±0.34^{b}	10.06±0.12^{b}	44.56±0.51	77.10±0.42	65.52±1.46
200.00		50.91±0.48	6.81±0.15^{AB}	0.374±0.004	56.39±0.39^{b}	33.38±0.35^{a}	10.22±0.12^{ab}	45.21±0.52	76.48±0.41	65.53±1.49
Age of hens (wk)										
at 51		51.55±0.35	5.73±0.11^{B}	0.367±0.003^{b}	57.60±0.28	32.06±0.25^{b}	10.35±0.09	47.65±0.37^{A}	76.39±0.30	71.66±1.08^{A}
at 65		51.58±0.43	7.90±0.13^{A}	0.379±0.004^{a}	56.74±0.34	33.07±0.31^{a}	10.17±0.11	41.19±0.46^{B}	77.16±0.37	57.92±1.31^{B}
Strain * Level of addition Se as Sel-Plex (mg/ton diet)										
Fayoumi	0.00	49.62±0.67	6.63±0.21	0.392±0.01	56.95±0.55	31.99±0.50	11.02±0.17	44.31±0.73	77.28±0.59	60.71±2.05
	100.00	48.93±0.67	7.35±0.21	0.384±0.01	56.86±0.54	32.36±0.49	10.78±0.18	45.41±0.72	78.17±0.59	66.89±2.08
	200.00	47.26±0.67	6.58±0.21	0.387±0.01	56.15±0.57	33.08±0.52	10.76±0.17	45.64±0.76	77.19±0.59	66.45±2.12
Golden Montazah	0.00	54.70±0.67	6.26±0.21	0.360±0.01	57.96±0.54	32.09±0.49	9.968±0.17	42.67±0.72	76.19±0.59	65.93±2.08
	100.00	54.31±0.67	7.02±0.21	0.352±0.01	58.48±0.53	32.19±0.48	9.335±0.17	43.71±0.71	76.03±0.59	64.15±2.05
	200.00	54.55±0.67	7.03±0.21	0.361±0.01	56.63±0.53	33.68±0.48	9.688±0.17	44.78±0.72	75.78±0.59	64.61±2.08
Over all mean		51.56±0.28	6.81±0.08	0.373±0.002	57.17±0.22	32.56±0.20	10.26±0.07	44.42±0.30	76.77±0.24	64.79±0.85

[1] Mean ± Standard error of the mean.

a,….b, and A,… B, values in the same column within the same item followed by different superscripts are significantly different (at P ≤0.05 for a to b ; P ≤0.01 for A to B).

Table 4: Effects of supplementing laying hens diets with organic selenium on fertility, hatchability, embryonic mortality at 7 d and abnormal chicks%.

Items		Fertility%	Hatchability%	Embryonic mortality at 7 d%	Abnormal chicks%
Strain					
Fayoumi		**94.42±0.02^{1A}**	**81.09±0.02^{A}**	**1.78±0.02^{B}**	**0.000±0.02^{B}**
Golden Montazah		**93.10±0.02^{B}**	**75.24±0.02^{B}**	**3.57±0.02^{A}**	**0.714±0.02^{A}**
Level of addition Se as Sel-Plex (mg/ton diet)					
0.00		**92.20±0.03^{C}**	**75.83±0.03^{B}**	**1.85±0.03^{C}**	**0.357±0.03^{B}**
100.00		**93.93±0.03^{B}**	**79.29±0.03^{A}**	**2.50±0.03^{B}**	**0.714±0.03^{A}**
200.00		**95.14±0.03^{A}**	**79.37±0.03^{A}**	**3.68±0.03^{A}**	**0.000±0.03^{C}**
Age of hens (wk)					
at 51		**94.18±0.02^{A}**	**82.28±0.02^{A}**	**2.25±0.02^{B}**	**0.476±0.02^{A}**
at 65		**93.33±0.02^{B}**	**74.05±0.02^{B}**	**3.10±0.02^{A}**	**0.238±0.02^{B}**
Strain * Level of addition Se as Sel-Plex (mg/ton diet)					
Fayoumi	**0.00**	**91.55±0.04^{C}**	**77.38±0.04^{BC}**	**1.55±0.04^{CD}**	**0.000±0.04^{C}**
	100.00	**95.00±0.04^{AB}**	**83.57±0.04^{A}**	**0.71±0.04^{D}**	**0.000±0.04^{C}**
	200.00	**96.72±0.04^{A}**	**82.30±0.04^{AB}**	**3.07±0.04^{B}**	**0.000±0.04^{C}**
Golden Montazah	**0.00**	**92.86±0.04^{BC}**	**74.29±0.04^{C}**	**2.14±0.04^{C}**	**0.714±0.04^{B}**
	100.00	**92.86±0.04^{BC}**	**75.00±0.04^{C}**	**4.29±0.04^{A}**	**1.429±0.04^{A}**
	200.00	**93.57±0.04^{BC}**	**76.43±0.04^{BC}**	**4.29±0.04^{A}**	**0.000±0.04^{C}**
Over all mean		**93.76±0.02**	**78.16±0.02**	**2.67±0.02**	**0.357±0.02**

[1] Mean ± Standard error of the mean.
A,… D, values in the same column within the same item followed by different superscripts are significantly different (at P ≤0.01 for A to D).

Table 5: Effects of supplementing laying hens diets with organic selenium on some blood constituents.

Items		Strain: Fayoumi	Strain: Golden Montazah	Level of addition Se as Sel-Plex (mg/ton diet): 0.00	100.00	200.00	Overall Mean
Hemoglobin (g/dL)		10.58±0.20[1]	9.97±0.23	10.45±0.27	10.23±0.27	10.15±0.24	10.27±0.15
Red blood cells*		2.92±0.09	2.87±0.11	3.07±0.13	2.71±0.13	2.90±0.11	2.89±0.07
White blood cells*		12.65±0.31	13.47±0.36	13.15±0.42[B]	11.26±0.42[C]	14.77±0.38[A]	13.06±0.24
Total leucocytes/cmm		50.67±2.56	45.06±2.96	52.75±3.51	43.67±3.51	47.17±3.14	47.86±1.96
Differential count%	Neutrophils	27.56±1.34	31.72±1.55	27.58±1.84[B]	25.00±1.84[B]	36.33±1.64[A]	29.64±1.02
	Lymphocyte	65.89±1.32	62.61±1.52	66.00±1.81[A]	68.92±1.81[A]	57.83±1.62[B]	64.25±1.01
	Monocytes	4.22±0.26[a]	3.28±0.29[b]	4.00±0.35	3.75±0.35	3.50±0.31	3.75±0.19
	Eosinophils	2.33±0.22	2.39±0.26	2.42±0.31	2.33±0.31	2.33±0.27	2.36±0.17
Blood index	HCT%	39.44±0.56	39.00±0.65	40.08±0.77	38.75±0.77	38.83±0.69	39.22±0.43
	MCV μ^3	138.1±2.79	136.8±3.22	130.8±3.82	144.1±3.82	137.5±3.42	137.5±2.13
	MCH μμg	36.97±0.85	34.97±0.98	34.26±1.16	37.67±1.16	35.98±1.04	35.97±0.65
	MCHC%	26.78±0.32[a]	25.54±0.37[b]	26.23±0.44	26.13±0.44	26.12±0.40	26.16±0.25

Items	Strain / Level of addition Se as Sel-Plex (mg/ton diet)	Fayoumi: 0.00	Fayoumi: 100.00	Fayoumi: 200.00	Golden Montazah: 0.00	Golden Montazah: 100.00	Golden Montazah: 200.00
Hemoglobin (g/dL)		11.23±0.34	10.40±0.34	10.10±0.0.34	9.85±0.41	9.85±0.041	10.20±0.34
Red blood cells*		3.23±0.16	2.88±0.16	2.66±0.16	2.92±0.20	2.55±0.20	3.14±0.16
White blood cells*		11.74±0.54[b]	10.93±0.54[b]	15.28±0.54[a]	14.55±0.66[a]	11.58±0.66[b]	14.27±0.54[a]
Total leucocytes/cmm		61.00±4.44[a]	37.33±4.44[b]	53.67±4.44[ab]	44.50±5.43[b]	50.00±5.43[ab]	40.67±5.43[b]
Differential count%	Neutrophils	26.67±2.32	20.00±2.32	36.00±2.32	28.50±2.85	30.00±2.85	36.67±2.32
	Lymphocyte	66.00±2.28	73.33±2.28	58.33±2.28	66.00±2.80	64.50±2.80	57.33±2.28
	Monocytes	5.00±0.44	4.00±0.44	3.67±0.44	3.00±0.54	3.50±0.54	3.33±0.44
	Eosinophils	2.33±0.39	2.67±0.39	2.00±0.39	2.50±0.47	2.00±0.47	2.67±0.39
Blood index	HCT%	40.67±0.97	40.00±0.97	37.67±0.97	39.50±1.19	37.50±1.19	40.00±0.97
	MCV μ^3	126.1±4.83[b]	140.7±4.83[ab]	147.5±4.83[a]	135.5±5.92[ab]	147.5±5.92[a]	127.5±4.83[b]
	MCH μμg	34.77±1.47[abc]	36.63±1.47[abc]	39.50±1.47[a]	33.75±1.80[bc]	38.70±1.80[ab]	32.47±1.47[c]
	MCHC%	27.57±0.56	26.00±0.56	26.77±0.56	24.90±0.69	26.25±0.69	25.47±0.56

[1] Mean ± Standard error of the mean. * ($10^{\wedge 6}$/ ML)

a,…c, and A,… C, values in the same row within the same item followed by different superscripts are significantly different (at P ≤0.05 for a to c ; P ≤0.01 for A to C).

Table 6: Effects of supplementing laying hens diets with organic selenium on chemical composition of eggs and selenium concentration in the yolk.

Items		Moisture%	Protein%	Fat%	Ash%	Nitrogen-free extract%	Selenium mg/L
Strain							
Fayoumi		**73.93±0.04**[1]	**13.30±0.01^{b}**	**10.03±0.003^{A}**	**0.733±0.01^{B}**	**2.01±0.04**	**1.81±0.03^{A}**
Golden Montazah		**73.86±0.04**	**13.33±0.01^{a}**	**9.906±0.003^{B}**	**0.867±0.01^{A}**	**2.04±0.04**	**1.42±0.03^{B}**
Level of addition Se as Sel-Plex (mg/ton diet)							
0.00		**73.41±0.05^{C}**	**14.07±0.01^{A}**	**10.25±0.004^{B}**	**0.599±0.01^{C}**	**1.67±0.05^{C}**	**1.20±0.04^{C}**
100.00		**74.22±0.05^{B}**	**13.46±0.01^{B}**	**8.803±0.004^{C}**	**0.973±0.01^{A}**	**2.54±0.05^{A}**	**1.75±0.04^{B}**
200.00		**74.06±0.05^{A}**	**12.41±0.01^{C}**	**10.85±0.004^{A}**	**0.827±0.01^{B}**	**1.86±0.05^{B}**	**1.91±0.04^{A}**
Strain * Level of addition Se as Sel-Plex (mg/ton diet)							
Fayoumi	**0.00**	**73.14±0.07^{E}**	**13.75±0.01^{B}**	**9.789±0.01^{D}**	**0.446±0.01^{E}**	**2.87±0.07^{B}**	**1.29±0.06^{C}**
	100.00	**74.04±0.07^{C}**	**13.43±0.01^{D}**	**9.036±0.01^{E}**	**0.955±0.01^{A}**	**2.54±0.07^{C}**	**2.10±0.06^{A}**
	200.00	**74.62±0.07^{A}**	**12.72±0.01^{E}**	**11.26±0.01^{A}**	**0.796±0.01^{C}**	**0.61±0.07^{D}**	**2.04±0.06^{A}**
Golden Montazah	**0.00**	**73.68±0.07^{D}**	**14.38±0.01^{A}**	**10.71±0.01^{B}**	**0.751±0.01^{D}**	**0.47±0.07^{D}**	**1.10±0.06^{D}**
	100.00	**74.40±0.07^{B}**	**13.50±0.01^{C}**	**8.570±0.01^{F}**	**0.991±0.01^{A}**	**2.54±0.07^{C}**	**1.39±0.06^{C}**
	200.00	**73.50±0.07^{D}**	**12.10±0.01^{F}**	**10.44±0.01^{C}**	**0.858±0.01^{B}**	**3.10±0.07^{A}**	**1.78±0.06^{B}**
Over all mean		**73.90±0.03**	**13.31±0.01**	**9.97±0.002**	**0.800±0.01**	**2.02±0.03**	**1.62±0.02**

[1] Mean ± Standard error of the mean.

a,….b, and A,… F, values in the same column within the same item followed by different superscripts are significantly different (at P ≤0.05 for a to b ; P ≤0.01 for A to F).

Table 7: Effects of supplementing laying hens diets with organic selenium on economical efficiency and mortality rate%.

Items	Strain	Fayoumi			Golden Montazah		
	Level of addition Se as Sel-Plex (mg/ton diet)	**0.00**	**100.00**	**200.00**	**0.00**	**100.00**	**200.00**
Economical efficiency							
Price/ k feed (L.E.)	**a**	**1.504**	**1.534**	**1.564**	**1.575**	**1.605**	**1.635**
Total feed intake (kg)	**b**	**1217.06**	**1170.4**	**1186.9**	**1375.3**	**1281.1**	**1356.5**
Total feed cost (L.E.)	**a x b = c**	**1830.46**	**1795.39**	**1856.31**	**2166.10**	**2056.17**	**2217.88**
Total number of eggs	**d**	**5984.0**	**5911.0**	**6230.0**	**6133.0**	**5886.0**	**6189.0**
Price/ egg (L.E.)	**e**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Total price of eggs (L.E.)	**d x e = f**	**2992.0**	**2955.5**	**3115.0**	**3066.5**	**2943.0**	**3094.5**
Net revenue (L.E.)	**f – c = g**	**1161.54**	**1160.11**	**1258.69**	**900.40**	**886.83**	**876.62**
Economical efficiency (E.Ef.)	**g / c = h**	**0.6346**	**0.6462**	**0.6781**	**0.4157**	**0.4313**	**0.3953**
Relative E.Ef.	**r**	**100.00**	**101.83**	**106.85**	**100.00**	**103.76**	**95.09**
Mortality rate%							
Strain		**Fayoumi**			**Golden Montazah**		
Level of addition Se as Sel-Plex (mg/ton diet)		**0.00**	**100.00**	**200.00**	**0.00**	**100.00**	**200.00**
Mortality rate%		**6.67**	**5.33**	**4.00**	**2.67**	**9.33**	**1.33**

a……………………….…… (based on average price of diets during the experimental time).

e……………………….……....(according to the local market price at the experimental time).

g /c …………………..……...(net revenue per unit feed cost).

r……………………….…….(assuming that economical efficiency of the control groups equals 100).

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الملخص العربي

"تأثير إضافة السيلنيوم العضوي إلي علائق الدجاج البياض علي إنتاج وجودة البيض ونسبة الخصب والفقس".

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أجريت هذه التجربة لمدة 23 أسبوع من عمر 42 إلي عمر 65 أسبوع في المزرعة التجريبية الخاصة بمشروع الدواجن التكاملي العزب فيوم – مصر. كان العدد المستخدم 498 دجاجة بياضة عمر 42 أسبوع من سلالتي الفيومي والمنتزة الذهبي لتقيم مستويين من السيلنيوم في صورة سلبلكس (0.1 ، 0.2 ملليجرام لكل كجم عليقة) علي أداء الدجاج البياض، قسمت الطيور عشوائياً إلي 3 معاملات بكل معاملة 83 طائر (75 أنثي و 8 ذكر). وزعت الطيور عشوائيا في 6 حظائر أمهات تم تغذية المجموعة الأولي علي العليقة الأساسية (الكنترول) بينما

المجموعة الثانية والثالثة غذيت علي نفس العليقة مضاف إليها مستويين من السيلنيوم في صورة سلبلكس 0.1 ، 0.2 ملليجرام لكل كجم عليقة.

وتتلخص أهم النتائج المتحصل عليها فيما يلي:-

1- كان البيض الناتج من دجاج المنتزة الذهبي أكثر في العدد وكذا اعلي كتلة للبيض و معدل إنتاج%ووزن بيضة عن الفيومي **-** كان لدجاج المنتزة الذهبي المغذي علي عليقة تحتوي علي 200 ملليجرام سيلنيوم للطن في صورة سلبلكس اعلي كتلة للبيض- كان للدجاج المغذي علي عليقة تحتوي علي 100 ملليجرام سيلنيوم للطن في صورة سلبلكس أقل استهلاك للعليقة. كان للدجاج المغذي علي عليقة الكنترول أعلي استهلاك للعليقة،. كان للدجاج الفيومي المغذي علي عليقة تحتوي علي 200 ملليجرام سيلنيوم للطن في صورة سلبلكس أعلي قيمة وزن جسم مكتسب.

2- كان البيض الناتج من دجاج المنتزة الذهبي أعلي من بيض الفيومي في الوزن ونسبة البياض وأقل في سمك القشرة ونسبة القشرة ودليل الصفار ودليل الشكل%. بزيادة عمر الدجاجات يزداد معنوياً لون الصفار وسمك قشرة البيضة ونسبة الصفار بينما يقل دليل الصفار ووحدات هاو.

3-كان دجاج الفيومي أعلي في نسبة الخصب والفقس، بزيادة عمر الدجاجات تقل معنوياً نسبة الخصب والفقس. كان للدجاج الفيومي المغذي علي عليقة تحتوي علي 200 ملليجرام سيلنيوم للطن في صورة سلبلكس اعلي نسبة خصب، كان للدجاج الفيومي المغذي علي عليقة تحتوي علي 100 ملليجرام سيلنيوم للطن في صورة سلبلكس أعلي نسبة فقس ، كان للدجاج المغذي علي عليقة الكنترول (فيومي أو ذهبي) أقل نسبة خصب وفقس.

4- كان للدجاج الفيومي المغذي علي عليقة تحتوي علي 200 ملليجرام سيلنيوم للطن في صورة سلبلكس اعلي عدد لكرات الدم البيضاء، MCH،MCV .

5- كان لبيض الدجاج الفيومي المغذي علي عليقة تحتوي علي200 ملليجرام سيلنيوم للطن في صورة سلبلكس اعلي في نسبة الرطوبة والدهن وأعلي نسبة للسيلنيوم في الصفار وكذا أعطي أحسن كفاءة اقتصادية واعلي كفاءة اقتصادية نسبية. بينما كان لدجاج الفيومي المغذي علي عليقة الكنترول أقل في نسبة الرطوبة والرماد وأقل نسبة للسيلنيوم في الصفار.

ومن ذلك يمكن أستنتاج أن دجاج المنتزة الذهبي أو الفيومي المغذي علي عليقة تحتوي علي السيلنيوم قي صورة سلبلكس(100 ملليجرام للطن) كان أعلي في الأداء الإنتاجي وأعلي نسبة خصب وفقس وأعطي اعلي كفاءة اقتصادية ونسبية.