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PHYSIOLOGICAL RESPONSES OF INCLUSION OF EGG-PLUS IN DIETS OF LAYING HENS AND ITS EFFECT ON PRODUCTIVE PERFORMANCE

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SUMMARY

An experiment was conducted to estimate the effect of Egg-plus (EP) on some physiological responses and productive performance of laying hens. A total of 240 Hy-Line pullets aged 22 wks were selected randomly, equally divided into four groups and fed layer diets supplemented with 0, 1.0, 1.5 and 2.0 kg EP/ton ration. Results obtained can be summarized as follows. Egg production was 1.87%/hen/day higher / in hens fed 2.0 kg EP/ton diet than control group. However, egg weight and egg mass were 2.46 g and 2.5 g/hen/day higher in hens fed diet with 1.5 kg EP/ton, respectively. Analysis of variance showed highly significant ($P<0.001$) differences in egg weight only due to treatments applied. Hens fed 1.5 kg EP/ton diet had significantly higher ($P<0.001$) absolute and proportional albumen weight, while hens received 2.0 kg EP/ton diet had the highest absolute and proportional yolk weight. The inclusion of 1.0, 1.5 and 2.0 kg EP/ton diet increased shell weight per unit surface area (SWUSA) than control. Diet supplemented with 1.5 EP/ton significantly improved f($P<0.001$) feed conversion when compared with other treatments applied and control group. Plasma calcium and inorganic phosphorus increased as EP supplementation increased. Hens fed 1.5 kg/ton diet had significantly higher ($P<0.001$) plasma total lipids and cholesterol, while the lowest values were observed in control. Analysis of variance revealed significant differences in plasma calcium, total lipids and cholesterol due to experimental intervals. Supplementing ration with EP significantly reduced ($P<0.01$) yolk total lipids and cholesterol. Plasma and yolk total lipids and cholesterol differed according to experimental intervals, reaching their maximum values at the end of the experimental period.

Significant positive correlation was noted between yolk weight and each of yolk cholesterol and plasma calcium. Inverse relationships were found between yolk cholesterol and each of plasma total lipids and cholesterol. Significant positive correlations ($P<0.01$) were observed between plasma calcium and either of plasma total lipids or cholesterol. Highly significant regression coefficient for egg weight, egg production, shell and yolk weights and SWUSA on plasma calcium was noted.

Egg-Plus at a level of 1.5 and 1.0 kg/ton diet, respectively seemed to be adequate to achieve the favourable results and may be recommended from the economic standpoint of view.

INTRODUCTION

It is almost impossible to prepare efficient diet for layers without using either chemical or biological nutritive or non-nutritive additives because they become vital to modern feeds. Antibiotics (Younis, 1987), probiotics (Mohan et al. 1995), enzymes (Makled, 1993 and Hattaba et al., 1994) and herbal extracts, probiotic and enzymes (Radwan et al., 1995). Recently intensive studies (Radwan et al., 1995; Soliman et al., 1995; El-Gendi, 1996 and Khodary et al., 1996) were carried out to investigate the efficiency of herb, edible plants and some plant seeds as natural tonic, restoratives, antibacterial, and – anti parasitic drugs on improving the productive performance in fowl. However, few reports are available concerning laying hens. Therefore the present study was undertaken to asses the effect of Egg Plus as feed additive on some physiological responses and productive performance in pullets.

MATERIALS AND METHODS

The present study was carried out at the Poultry Research Farm, Department of Animal Production, Faculty of Agriculture, Zagazig University, Benha Branch.

A total number of 240 pullets of Hy-Line aged 22 weeks were randomly selected and kept in the floor laying houses. Pullets were randomly divided into four equal groups each of 60 pullets. Layer diet (Table, 1) was offered either alone (control group) or supplemented with 3 Egg Plus (a product from herbal and edible plants fermented and dried extraction) as level of 1.0, 1.5 and 2.0 kg/ton diet to birds of the 1st, 2nd and 3rd experimental groups of birds. The trial was continued after sexual maturity (20% egg production) for seven 15-days periods. Fatty acids, amino acids and mineral contents of Egg-Plus (EP)were carried out at Arid Land Agricultural research unit, Faculty of Agriculture Ain-Shams University.

Pullets were kept under similar and standard hygienic and environmental conditions. Feed and water were offered ad-libitum and maintained on 16 hours light per day. Egg production, egg weight, egg mass, feed consumption and conversion (recorded for six days biweekly) were estimated as parameters of productive performance. Whereas, absolute and relative weights of albumen, yolk and shell and shell weight per unit surface area (SWUSA)was considered as parameters of detecting egg and shell quality.

Eggs laid during two days each two consecutive weeks were weighed, broken and yolk was completely separated from albumen. Yolks were then frozen at −10°C until the chemical analysis of cholesterol according to Zlatkis et al., (1953) and total lipids was carried out according to the Official Methods of A.O.A.C. (1990).

Heparinized blood samples were withdrawn from the wing vein of [illegible] hens selected randomly per each group at sexual maturity, at the peak of egg production and at the end of the experimental period. Plasma was separated and stored at −20°C till the time of chemical analysis. Plasma total lipids, cholesterol, calcium and inorganic phosphorus were colorimetricaly determined using commercial kits purchased from Bio-Merieux (Morcyl Etiols Charbon [illegible] Rains/ France).

The calculations of analysis of variance using ANOVA Procedure were carried out using SAS Procedure Guide 1996 (SAS, 1996) using the following linear moder:

$$Y_{ijk} = \mu + \alpha_i + B_j + (\alpha B)_{ij} + e_{ijk}$$

where:

Y_{ijk} = The observation on k^{th} hen or egg.

μ = The common mean.

α_i =The fixed effect of the i^{th} treatment.

B_j = The fixed effect of the j^{th} interval.

$(\alpha B)_{ij}$ = The fixed effect of treatment × interval interaction.

e_{ijk} = The random error assumed to be independently randomly distributed (0, $\delta^2 e$) .

Means were compared by the "Duncan" multiple comparisons (SAS, 1996).

RESULTS AND DISCUSSION

1- Composition and chemical analysis of Egg – Plus:

Egg-Plus which is recommended as feed additive contains a high concentrated extracts of edible plants special parts choice (palm pollen grains, sessame indicum, trigonella foenum graceum, foeniculum vulgarae and nigella sativa) mixed with dried extraction by - products (Massoud, 1997). Analysis of EP (Table, 2) showed that it contains adequate amounts of unsaturated essential fatty acids (Murray et al., 1991) which are necessary for increasing egg production and egg weight (Leo and Jensen, 1963) , Witehood, 1980 and Massoud, 1992).

Mineral content of the EP (Table, 2) is considered to be of good balanced amounts needed for biosynthesis of the shell matrix and for well built pallicade columns which resulted in good egg shell and internal egg qualities that minimize microbial penteration (Witehood, 1980, Solomon, 1985 and Massoud, 1992).

The higher lysine and methionine+cystine amino acids contents of EP (Table, 2) which are known to be essential and limiting amino acids for protein biosynthesis (El-Gendi, 1996) give EP its good potential effect on productive performance. Therefore, it could be of great use to recommend EP as feed additive supplemented to layer diets to improve their productive performance.

2. Rate of egg production, egg weight and mass:

Results obtained (Table, 3) showed that, the inclusion of EP in different levels increased egg production, egg weight and egg mass. Hens fed 2.0 kg/ton diet had 1.87% higher egg production per hen / day than control. On the other hand, hens fed 1.5 kg/ton diet had 2.46 g egg weight and 2.51 g egg mass per hen per day than the control. The present results agree with those reported by Oser (1979); Witehood (1980); Anis (1985); Peter (1988); Massoud (1992) and Radwan et al., (1995) who stated that, supplementing layer feeds with EP stimulate LH surge to an optimum level for better ovulation. They added that, egg weight increased by 2-3% due to the availability of linoleic acid in EP feed additive. Analysis of variance showed highly significant ($P<0.001$) differences in egg weight among the experimental groups.

Rate of egg production and egg weight increased as the time passed reaching its maximum values at the 12^{th} and 10^{th} wks after sexual maturity for egg production and egg weight, respectively. Experimental intervals had highly significant ($P<0.001$) effects on egg production, egg weight and egg mass. Results obtained agree with those of Nagarajan et al., (1991) and Mady and Ahmed (1998).

3. Absolute and proportional albumen and yolk weights:

Inspection of data (Table, 4) shows that, hens fed 1.5 kg EP/ton diet significantly ($P<0.001$) had higher absolute (32.42 g) and proportional (62.08%) albumen weight. However, hens supplied with 2.0 kg/ton diet had higher absolute (13.86 g) and proportional (27.62%) yolk weight when compared with the control or the other treatments applied.

These results agree with those reported by Radwan et al., (1995). Analysis of variance revealed significant ($P<0.001$) variation due to treatments applied in absolute and proportional albumen weight and proportional yolk weight only.

Significant variation found in albumen and yolk weights due to treatments applied and experimental intervals may be attributed to the significant variation existed in average egg weight. It is well know that there is positive correlation between albumen weight and egg size (El-Aggoury, 1974).

4. Absolute and proportional shell weight and shell weight per unit surface area (SWUSA):

It is clear from (Table, 5) that the inclusion of 1.0 kg EP/ton diet increased absolute and proportional egg shell weight by values mounted 0.19 g and 0.05%, respectively over the control. Also, applying EP at levels of 1.0, 1.5 and 2.0 kg EP/ton ration increased SWUSA by 0.11; 4.34 and 1.68 mg/cm^2, respectively over the control. Similar results were observed by Solomon (1985) and (1988), Massoud (1992) and Radwan et al., (1995) who reported that the trace elements present in EP mainly organic (Ca, Mn, I and P) are easily and quickly absorbed. They added that, calcium contents in EP can be easily bound with amino acids in alimentary tract, which facilitate its absorption to be percipitated in pure form on the fiberous layer to form shell mammellery layer and a good shell formation. Analysis of variance revealed highly significant (P<0.001) variation in absolute and proportional shell weight and SWUSA due to treatments applied, experimental period and the interaction between them.

5. Feed consumption and conversion:

Data in (Table, 6) showed that, hens fed 1.0 or 2.0 kg EP/ton diet consumed more food 112.43 and 112.23 g/hen/day, respectively allover the experimental period than those fed 1.5 kg EP and control (106.68 and 110.83 g/hen/day, respectively). The corresponding values for feed conversion were 3.24; 3.27, 2.99 and 3.34 kg feed/kg eggs for 1.0, 2.0, 1.5 kg EP/ton diet and control, respectively. Analysis of variance and Duncan multiple range test revealed highly significant (P<0.001) variation in either feed consumption or conversion at all periods of estimation due to treatments applied, experimental intervals and the interaction between them.

The effectiveness of EP dietary supplementation in improving feed conversion may be attributed to its effect on improving the digestibility of the various dietary ingredients as a result of increasing the surge of the gastrointestinal hormones and correspondingly to the stimulation of various digestive juces, containing greater amount of digestive enzymes resulting to an efficient digestibility and higher feed conversion (Alishekhov et al., 1986; Sabra and Mehta, 1990; Hashish et al., 1992; Radwan et al., 1995; El-Gendi, 1996 and Massoud, 1997).

6- Plasma calcium and inorganic phosphorus:

Plasma calcium and inorganic phosphorus increased with the increase in EP supplementation rate (Table, 7). Plasma calcium content was [illegible]; [illegible] and 2.51 mg/100 ml higher in birds fed 1.0, 1.5 and 2.0 kg EP/ton ration than control. The corresponding values of plasma phosphorus were 0.26; 0.36 and 0.61 mg/100 ml, respectively. However, plasma calcium only was significantly (P<0.001) affected by dietary treatments applied.

The higher average of plasma calcium (18.74) and phosphorus ([illegible] mg/100 ml) were attained at the end of the experimental period and at the peak of egg production, respectively. Experimental intervals had highly significant (P<0.001) effect on plasma calcium only.

This may lead to attribute the significant increase in the plasma calcium level to the increase of renal biosynthesis of vit. D derivatives like 1,25 (OH_2) vit. D_3 or 1,24 (OH_2) vit. D_3 which are considered the hormonal forms of vit. D_3 facilitating the rate of calcium absorption through the intestinal wall and correspondingly increase its level in blood plasma (Norman, 1979). The increasing amount of calcium may be quickly utilized into shell formation and thus did not affect the phosphorus homeostasis. This may be a good reason for the insignificant variation found in the plasma phosphorus content.

7- Plasma total lipids and cholesterol:

Data in (Table, 7) showed that, hens fed 1.5 kg EP/ ton ration had significantly ($P<0.001$) higher plasma total lipids (16.97 g/100 ml) and cholesterol (221.1 mg/100 ml). While the lowest values were observed in control (14.09 g/100 ml and 179.4 mg/100 ml for plasma total lipids and cholesterol, respectively). Theses results agree with those of El-Gendi (1996) who reported that serum total lipids and cholesterol increased with increased level of EP in the diet. This may be due to the increase occured in the rate of total lipids and cholesterol absorption through the intestinal villi which reflected as an increased level of them in serum (Massoud, 1994).

Plasma total lipids as well as plasma cholesterol significantly increased as the time elapsed, reaching its maximum values at the end of the experimental period (16.19 g/100 ml and 198.7 mg/100 ml for plasma total lipids and cholesterol, respectively).

8- Yolk total lipids and cholesterol:

Supplementing ration with EP significantly reduced yolk total lipids and cholesterol with an increasing level as the level of dietary EP increased (Table 8). This may lead to conclude that there is no relation between the plasma content of cholesterol and total lipids and their levels in egg yolk. It is well known that yolk content of either cholesterol and total lipids physiologically depend on an enzymatic system resulting the biological process of their active transmission through the growing ovum cell membrane and the hormonal status during the egg formation. Ovarian hormones (oestrogen and progesterone) may have a role in combination with the glucocorticoids (mainly cortisol) in the process of total lipids and cholesterol mobilization rate from plasma to the growing ovum.

Yolk total lipids and cholesterol significantly differed according to experimental intervals, reaching its maximum values at the end of the experiment (38.65 g/100 g and 43.30 mg/g for yolk total lipids and cholesterol, respectively).

9- Economic efficiency:

Results of economical efficiency from hen fed the experimental diets are summarized in table (9). The results indicate that all diets supplemented with EP had higher economic efficiency than the basal diet. This may be due to the higher egg production rate of treated birds compared to control. From economic side of view it could be reported that, ration containing 1.5 and 1.0 kg EP/ton diet, respectively seemed to be adequate to achieve favorable results and would be more economic than other treatments.

10- Correlation coefficient values between some traits of egg and some plasma parameters.

Weights of different egg component (albumen, yolk and shell) were positively correlated with yolk cholesterol content. Correlation coefficient values ranged between 0.225 to 0.355 that are mostly low, but lead to an important conclusion. Yolk weight is mostly related to the amount of deutoplasm accompanied the female ovum. It is logic to expect the increase of all yolk materials and specially yolk cholesterol as its weight increases. Correspondingly, egg albumen and shell weights are positively corelated with yolk weight. These results disagree with those reported by (Hall and Mckay,

1992) who found negative phenotypic relationships between yolk cholesterol concentration and both rate of egg production and yolk weight.

On the other hand, plasma calcium content was found to be positively ($P<0.001$) correlated with yolk weight, shell weight and SWUSA. This could be attributed to the fact stated that serum calcium is the main source of egg shell calcium.

Negative but low correlation coefficient value (-0.254) was found between egg yolk total lipids and cholesterol. On the other hand, yolk cholesterol content was negatively correlated with total lipids in blood plasma which is also highly correlated with plasma cholesterol content. Plasma calcium was found to be positive ($P<0.01$) correlated with plasma cholesterol (0.306) and total lipids (0.274). These results agree with those of Abdel-Hakim et al., (1982) and Hall and Mckay (1992) who found that plasma cholesterol and plasma total lipids were highly significant correlated. They added that a positive correlation were noted between serum calcium and serum cholesterol.

11- Multivariate regression coefficient among plasma calcium, phosphorus, total lipids and cholesterol and each of egg traits and yolk total lipids and cholesterol:

Data in (Table, 11) indicate that the regression coefficients of egg weight, egg production, shell weight, yolk weight and SWUSA on plasma calcium were positive with highly significant ($P<0.01$) values. The rate of egg production increased by 4.23 egg and the weights of these traits increased by 0.97, 0.29, 0.40 g and 1.94 mg/cm^2 for egg weight, shell weight, yolk weight and SWUCA, respectively per unit change of plasma calcium.

Yolk total lipids are significantly regressed on plasma cholesterol ($P<0.05$) by –0.01 and on plasma total lipids ($P<0.05$), by 0.21. Also, yolk cholesterol is significantly regression on plasma phosphorus ($P<0.05$) and total lipids ($P<0.05$) by –0.73, 0.60, respectively.

Y-Intercept for most of studied traits were positive and highly significant ($P<0.01$).

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Table 1. Formula and calculated nutritive value of the experimental laying ration.

Ingredients	%
Yellow corn	64.00
Soya bean meal (44% CP)	20.00
Fish meal (72%)	3.00
Wheat bran	3.00
Limestone	6.90
Bone meal	2.50
Permix	0.30
Salt	0.30
Calculated nutritive value:	
ME Kcal/kg	2775
Crude protein %	17.04
Calcium %	3.50
Available phosphorus	0.48

Table 2. Fatty acid%, amino acid(%) and mineral (PPM) contents of Egg-Plus.

Fatty acids		Amino acids		Minerals	
Palmitic	8.25	Methionine + Cystine	1.00	Ca	3151
Linoleic	3.19	Methionine	0.44	Mn	14.65
Linolenic	2.90	Lysine	1.30	Zn	28.78
Arachidic	3.20	Arginine	0.91	Fe	168.95
Arachidonic	1.00	Histidine	0.52	Mg	2443

Table 3. Least square means, standard errors and tests of significance for the applying Egg Plus on egg production, weight and egg mass.

Item	Egg production (% /hen/day)	Egg weight (g)	Egg mass (g/hen/day)
Egg plus (kg/ton)			
0	64.25±0.61 A	49.88±0.52 B	33.17±0.57 A
1.0	65.62±0.61 A	51.15±0.52 AB	34.68±0.57 A
1.5	66.03±0.61 A	52.34±0.52 A	35.68±0.57 A
2.0	66.12±0.61 A	50.22±0.52 B	34.33±0.57 A
Intervals (wks)			
At sexual maturity (0 wk)	21.22±0.86 F	41.84±0.73 E	08.88±0.80 F
2	38.65±0.86 E	44.72±0.73 D	17.28±0.80 E
4	57.74±0.86 D	47.68±0.73 C	27.53±0.80 D
6	77.88±0.86 B	48.49±0.73 C	37.76±0.80 C
8	80.02±0.86 B	55.23±0.73 B	44.20±0.80 B
10	86.53±0.86 A	58.07±0.73 A	50.25±0.80 A
12	88.07±0.86 A	54.72±0.73 B	48.19±0.80 A
14	73.89±0.86 C	56.45±0.73 AB	41.71±0.80 B
Grand mean	65.51±3.83	50.90±3.29	34.47±3.58
<u>ANOVA</u>[1]			
Treatment (T)	2.03 ns	4.50***	1.95ns
Interval (I)	1088.85***	66.72***	442.79***
T × I	3.58***	3.35***	2.03**

1= The F-ratio is shown for all single sources of variation and their interactions.
Means having similar letters in each column are not significantly different.
ns = not significant ** = P<0.01 *** = P<0.001

Table 4. Least square means, standard errors and tests of significance for the applying Egg Plus on absolute and proportional weights of albumen and yolk.

Item	Albumen weight		Yolk weight	
	(g)	(%)	(g)	(%)
Egg plus (kg/ton)				
0	29.96±0.42 B	60.21±0.33 B	13.46±0.13 A	26.90±0.22 B
1.0	30.90±0.42 B	60.41±0.33 B	13.60±0.13 A	26.73±0.22 BC
1.5	32.42±0.42 A	62.08±0.33 A	13.62±0.13 A	26.17±0.22 C
2.0	29.96±0.42 B	59.79±0.33 B	13.86±0.13 A	27.62±0.22 A
Intervals (wks)				
At sexual maturity (0 wk)	26.94±0.59 D	64.51±0.46 A	10.48±0.18 E	24.92±0.32 C
2	27.58±0.59CD	61.57±0.46 B	12.32±0.18 D	27.52±0.32 A
4	29.20±0.59 C	61.20±0.46 B	12.89±0.18 C	27.34±0.32 A
6	28.98±0.59 C	59.75±0.46 C	13.40±0.18 C	27.64±0.32 A
8	34.46±0.59 A	62.34±0.46 B	14.11±0.18 B	25.79±0.32 BC
10	34.58±0.59 A	59.30±0.46 C	15.04±0.18 A	26.13±0.32 B
12	31.34±0.59 B	57.19±0.46 D	15.30±0.18 A	27.94±0.32 A
14	33.42±0.59 A	59.12±0.46 C	15.55±0.18 A	27.59±0.32 A
Grand mean	30.81±0.63	60.62±2.06	13.63±0.82	26.86±1.42
ANOVA[1]				
Treatment (T)	7.76***	9.58***	1.62[ns]	7.07***
Interval (I)	27.26***	24.14***	89.22***	11.88***
T × I	2.71***	2.15***	6.35***	4.88***

1= The F-ratio is shown for all single sources of variation and their interactions.
Means having similar letters in each column are not significantly different.
ns = not significant *** = P<0.001

Table 5. Least square means, standard errors and tests of significance for the applying Egg Plus on shell quality.

Item	Shell weight(g)	Shell weight(%)	SWUSA (mg/Cm²)
Egg plus (kg/ton)			
0	6.33±0.08 A	12.63±0.16 A	73.17±0.97 B
1.0	6.52±0.08 A	12.68±0.16 A	73.28±0.97 B
1.5	6.15±0.08 B	11.72±0.16 B	77.51±0.97 A
2.0	6.27±0.08 A	12.42±0.16 A	74.85±0.97 AB
Intervals (wks)			
At sexual maturity (0 wk)	4.44±0.11 G	10.68±0.23 D	69.97±1.37 CD
2	4.88±0.11 F	10.92±0.23 D	55.74±1.37 E
4	5.62±0.11 E	11.82±0.23 C	66.17±1.37 D
6	6.13±0.11 D	12.66±0.23 B	73.95±1.37 C
8	6.59±0.11 C	11.95±0.23 C	72.60±1.37 C
10	8.06±0.11 A	13.96±0.23 A	88.50±1.37 A
12	7.55±0.11 B	13.88±0.23 A	89.59±1.37 A
14	7.34±0.11 B	13.05±0.23 B	81.12±1.37 B
Grand mean	6.32±0.48	12.36±1.01	74.70±6.14
ANOVA[1]			
Treatment (T)	5.62***	5.56***	4.34**
Interval (I)	143.57***	30.21***	69.15***
T × I	5.58***	4.65***	6.48***

1= The F-ratio is shown for all single sources of variation and their interactions.

Means having similar letters in each column are not significantly different.

** = $P<0.01$ *** = $P<0.001$

Table 6. Least square means, standard errors and tests of significance for the applying Egg Plus on feed consumption and conversion.

Item	Feed consumption (g/hen/day)	Feed conversion (kg feed / kg eggs)
Egg plus (kg/ton)		
0	110.83±0.54 B	3.34±0.16 B
1.0	112.43±0.54 A	3.24±0.16 B
1.5	106.68±0.54 C	2.99±0.16 A
2.0	112.23±0.54 AB	3.27±0.16 B
Intervals (wks)		
At sexual maturity (0 wk)	77.65±0.77 G	8.02±0.22 A
2	87.20±0.77 F	4.32±0.22 B
4	104.20±0.77 E	3.06±0.22 C
6	115.00±0.77 D	2.32±0.22 D
8	119.25±0.77 C	1.98±0.22 D
10	125.60±0.77 B	1.78±0.22 D
12	129.65±0.77 A	1.97±0.22 D
14	125.75±0.77 B	2.29±0.22 D
Grand mean	110.54±3.43	3.21±1.0
ANOVA[1]		
Treatment (T)	24.25***	6.16***
Interval (I)	627.43***	400.87***
T × I	9.77***	4.77***

1= The F-ratio is shown for all single sources of variation and their interactions.
Means having similar letters in each column are not significantly different.
*** = P<0.001

Table 7. Least square means, standard errors and tests of significance for the effect of applying Egg Plus on plasma calcium, inorganic phosphorus, total lipids and cholesterol.

Item	Plasma calcium mg/100 ml	Inorganic phosphorus mg/100 ml	Total lipids g/100 ml	Cholesterol mg/100 ml
Level of Egg plus kg/ton				
0	15.83±0.53 C	5.13±0.16 A	14.09±0.22 C	179.4±3.99 B
1.0	16.13±0.53 BC	5.39±0.16 A	15.88±0.22 B	181.0±3.99 B
1.5	17.51±0.53 AB	5.49±0.16 A	16.97±0.22 A	221.1±3.99 A
2.0	18.34±0.53 A	5.74±0.16 A	15.99±0.22 B	187.9±3.99 B
Intervals				
At sexual maturity	15.13±0.46 A	5.21±0.13 A	15.40±0.19 B	186.5±3.50 B
At the peak of egg production	16.98±0.46 B	5.67±0.13 A	15.62±0.19 B	192.0±3.50 AB
At the end of the experiment	18.74±0.46 C	5.43±0.13 A	16.19±0.19 A	198.7±3.50 A
Grand mean	16.95±2.07	5.44±0.60	15.73±0.85	192.4±15.46
ANOVA[1]				
Treatment (T)	4.87***	2.66 ns	30.08***	23.85***
Interval (I)	15.19***	2.85 ns	4.60**	3.12*
T × I	3.24***	0.84 ns	10.46***	10.50***

1= The F-ratio is shown for all single sources of variation and their interactions.
Means having similar letters in each column are not significantly different.
ns = not significant * = $P < 0.05$ ** = $P<0.01$ *** = $P<0.001$

Table 8. Least square means, standard errors and tests of significance for the applying Egg Plus on yolk total lipids and cholesterol.

Item	Yolk total lipids (g/100g)	Yolk cholesterol mg/g
Egg Plus (kg/ton)		
0	39.23±0.22 A	44.83±0.28 A
1.0	38.16±0.22 B	40.94±0.28 C
1.5	38.18±0.22 B	41.49±0.28 C
2.0	38.31±0.22 B	43.14±0.28 B
Intervals		
At sexual maturity	38.62±0.19 A	42.38±0.24 B
At the peak of egg production	38.12±0.19 A	42.13±0.24 B
At the end of the experiment	38.65±0.19 A	43.30±0.24 A
Grand mean	38.46±0.84	42.60±1.10
ANOVA[1]		
Treatment (T)	5.22**	39.66***
Interval (I)	2.48 ns	6.45***
T × I	0.03 ns	0.10 ns

1= The F-ratio is shown for all single sources of variation and their interactions.
Means having similar letters in each column are not significantly different.
ns = not significant ** = $P<0.01$ *** = $P<0.001$

Table 9. Economical evaluation of feeding Egg Plus kg/ton to layer.

Item	0	1.0	1.5	2.0
Fixed cost/hen L.E	12.00	12.00	12.00	12.00
Management/hen L.E[1]	1.50	1.50	1.50	1.50
Total feed cost/hen L.E	5.40	5.43	5.34	5.72
Total costs /hen L.E.	18.90	18.93	18.84	19.22
Total No. of egg/hen	67.46	68.90	69.33	69.43
Total egg price/hen L.E.[2]	14.84	15.16	15.25	15.27
Price of sold bird L.E.	9.00	9.00	9.00	9.00
Total revenue/hen L.E.	23.84	24.16	24.25	24.27
Net revenue/hen L.E.	4.94	5.23	5.41	5.05
Economic efficiency[3]	0.261	0.276	0.287	0.263
Relative E. E.	100	106	110	101

1- Include medication, vaccines and sanitation.

2- The price of an egg at the time of the experiment = 22 P.T.

3- Net revenue per unit of total costs.

The price of 1 kg EP=19 L.E.

Table 10. Correlation coeffici[illegible] parameters.

Trait correlated	Total lipids
Egg weight	-0.011^{ns}
Albumen weight	-0.011^{ns}
Yolk weight	0.014^{ns}
Shell weight	-0.040^{ns}
SWUSA	-0.040^{ns}
Egg production	-0.148^{ns}
Yolk total lipids	
Yolk cholesterol	
Plasma calcium	
Plasma phosphorus	
Plasma cholesterol	

ns = not significant * = P[illegible]

Table 11. Multivariable reg[illegible] egg traits and yolk [illegible]

Trait	
Egg weight	35.61 + [illegible]
Egg production	-79.4 + [illegible]
Shell weight	2.42 + [illegible]
Albumen weight	26.81 + [illegible]
Yolk weight	6.98 + [illegible]
SWUSA	53.64 + [illegible]
Yolk total lipids	37.75 + [illegible]
Yolk cholesterol	52.39 + [illegible]

Pca= plasma calcium, ppl=p[illegible] plasma total lipids.

Table 10. Correlation coefficient values between some traits of egg and some plasma parameters.

Trait correlated	Yolk		Plasma			
	Total lipids	Cholesterol	Calcium	phosphorus	Cholesterol	Total lipids
Egg weight	-0.011^{ns}	0.365^{ns}	0.372^{ns}	0.070^{ns}	-0.003^{ns}	0.081^{ns}
Albumen weight	-0.011^{ns}	0.341**	0.189^{ns}	0.010^{ns}	-0.003^{ns}	0.049^{ns}
Yolk weight	0.014^{ns}	0.355**	0.424***	0.149^{ns}	-0.033^{ns}	0.057^{ns}
Shell weight	-0.040^{ns}	0.255*	0.526***	0.085^{ns}	0.022^{ns}	0.099^{ns}
SWUSA	-0.040^{ns}	0.158^{ns}	0.483***	-0.025^{ns}	0.088^{ns}	0.156^{ns}
Egg production	-0.148^{ns}	0.080^{ns}	0.411	0.261^{ns}	0.129^{ns}	0.133^{ns}
Yolk total lipids		-.254*	-0.119^{ns}	0.010^{ns}	-0.160^{ns}	0.090^{ns}
Yolk cholesterol			0.070^{ns}	-0.161^{ns}	-0.172^{ns}	-0.368***
Plasma calcium				0.187^{ns}	0.306**	0.274**
Plasma phosphorus					-0.059^{ns}	-0.094^{ns}
Plasma cholesterol						0.663***

ns = not significant * = P<0.05 ** = P<0.01 *** = P<0.001.

Table 11. Multivariable regression coefficients among plasma contents and each of egg traits and yolk total lipids and cholesterol.

Trait	Regression equation
Egg weight	$35.61^{**} + 0.97^{**}pca + (-0.09)^{ns} pph + (-0.05)^{ns} pchol + 0.41^{ns} ptl$
Egg production	$-79.4^{ns} + 4.23^{**}pca + 9.12^{ns} pph + (-0.02)^{ns} pchol + 1.03^{ns} ptl$
Shell weight	$2.42^{ns} + 0.29^{**}pca + (-0.06)^{ns} pph + (-0.01)^{ns} pchol + 0.07^{ns} ptl$
Albumen weight	$26.81^{**} + 0.27^{ns}pca + (-0.17)^{ns} pph + (-0.01)^{ns} pchol + 0.64^{ns} ptl$
Yolk weight	$6.98^{ns} + 0.40^{**}pca + 0.22^{ns} pph + (-0.02)^{ns} pchol + 0.14^{ns} ptl$
SWUSA	$53.64^{**} + 1.94^{**}pca + (-2.02)^{ns} pph + (-0.05)^{ns} pchol + 0.64^{ns} ptl$
Yolk total lipids	$37.75^{**} + (-0.04)^{ns} pca + 0.06\, pph + (-0.01)^{*} pchol + 0.21^{*} ptl$
Yolk cholesterol	$52.39^{**} + 0.15^{ns}pca + -0.73^{*} pph + 0.01^{ns} pchol + 0.60^{**} ptl$

Pca= plasma calcium, pph=plasma phosphorus, pchol= plasma cholesterol and ptl = plasma total lipids.

الإستجابه الفسيولوجيه لإستخدام الأج -بلس فى علائق الدجاج البياض وتـــأثيره على الكفاءه الإنتاجيه

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صممت التجربه لتقدير تأثير الأج-بلس على الإستجابه الفسيولوجيه والكفاءه الإنتاجيه فى الدجاج البياض ولتحقيق ذلك أختيرت عشوائياً ٢٤٠ دجاجه من نوع الهاى لاين عمر ٢٢ أسبوع حيث قسمت الطيور إلـــى أربعة مجموعات تم تغذيتها على علائق الدجاج البياض المضاف إليها الأج بلس بمستوى صفر، ١، ٥ر١ و ٢ كجم/طن عليقة. ويمكن تلخيص النتائج المتحصل عليها فيما يلى. أرتفع معدل إنتاج البيض بمقدار ٧٨ر١% دجاجه/يوم للدجاج المغذى على عليقه مضاف إليها الأج-بلس بمقدار ٢ كجم/طن أعلـــى مـــن مجموعـــة المقارنه. بينما أرتفع وزن البيضه وكتلة البيضه بمقدار ٤٦ر٢ جم و ٥٠ر٢جم/دجاجه/يوم على الـــترتيب للدجاج المغذى على عليقه بها ٥ر١ كجم أج بلس لكل طن .أظهر تحليل التباين أختلافات عالية المعنويه لتأثير المعاملات على وزن البيضه فقط. أظهرت الطيور المغذاه على عليقه بها ٥ر١ كجم أج بلس/طـــن تفوقاً زياده معنويه للوزن المطلق والنسبى للبياض، بينما كان للدجاج المغذى على عليقه بها ٢كجم / طـــن أج - بلس أعلى وزن مطلق ونسبى للصفار. أدى إضافه الأج-بلس بمستوى ١، ٥ر١ ، ٢ كجم/طن إلـــى زيادة وزن القشره لكل وحدة من مساحه السطح. أدت التغذيه على علائق محتويه على ٥ر١ كجم أج-بلـــس لكل طن إلى تحسين معنوى فى كفاءة تحويل الغذاء بالمقارنه بالمعاملات الأخرى.

أرتفع مستوى البلازما من الكالسيوم والفوسفور الغير عضوى بزيادة مستوى الأج-بلس فى العليقه كمـا أدى تغذية الدجاج على عليقه بها ٥ر١ كجم لكل طن عليقه إلى زياده معنويه فى محتـــوى البلازمـــا مـــن الليبيدات الكليه والكولسترول، بينما كان لمجموعة المقارنه أقل قيمه. أظهر تحليل التباين إلى وجود إختلافات عالية المعنوية فى محتوى البلازما من الكالسيوم ، الليبيدات الكليه والكولسترول نتيجه لتأثير الفتره التجريبيه. أدى إضافة الأج-بلس إلى العليقه إلى حدوث إنخفاض معنوى فى محتوى الصفار من الكولسترول والليبـــدات الكليه. أختلف محتوى البلازما والصفار من الليبيدات الكليه والكولسترول بإختلاف الفتره التجريبيه حيـــث وصلت أقصى قيم لها عند نهاية التجربه . وجد إرتباط معنوى موجب بين وزن الصفار وكل مـــن محتـــوى الصفار من الكولسترول وكالسيوم البلازما. وجدت علاقه عكسيه بين كولسترول الصفار ومحتوى البلازمـــا من الليبيدات الكليه والكولسترول. كان هناك إرتباط معنوى موجب بين كالسيوم البلازما وكل من الليبيـــدات الكليه والكولسترول فى البلازما. كان معامل الإنحدار عالى المعنويه لوزن البيضه، إنتـــاج البيـــض، وزن القشره ووزن الصفار ووزن القشر لكل وحده من مساحة السطح على كالسيوم البلازما.

من وجهة النظر الإقتصاديه يمكن أن نوصى بإضافة الأج-بلس بمعدل ١,٥ و ١ كجم/طن عليقه علـــى الترتيب لعلائق الدجاج البياض.