

INFLUENCE OF NATURAL CAROTENOIDS SUPPLEMENTATION IN DIET ON EGG YOLK COLOR AND SOME PRODUCTIVE PARAMETERS OF LOCAL HEN LAYERS

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(Manuscript received 19 November 2018)

Abstract

The present study was conducted to study the effect of adding different levels of lutein powder pure (LP), dried tomato pulp (DTP) and dried sweet red pepper powder (DSRP) (as natural colour additives) on some productive, egg quality parameters and economical efficiency of Silver Montazah (SM) local hen layers from the beginning of 40 to 48 weeks of birds age. A 2x3x3 factorial arrangement design was used in this experiment including two levels supplementation of LP (0 and 30 mg/kg diet), three levels of DTP (0, 15 and 30 g/kg diet), and three levels of DSRP (0, 2 and 4 g/kg diet). A total number of 162 laying hens of Silver Montazah (SM) local strain were used in this experiment. All selected birds were randomly distributed into 18 treatments equal in number (9hens / each treatment). Laying hens of each treatment were nearly of an equal average body weight and similar average daily egg production. All birds of the experimental treatments were individually housed in wire-caged batteries and kept under the same managerial, hygienic and environmental conditions. Results obtained at the end of the experiment showed that the average live body weight of layers at the end of the experimental period was significantly ($P \leq 0.05$) affected by dietary LP levels, whereas, dietary DTP, DSRP levels had no significant effect on average live body weight of hens. The heavier live body weight was attained by layers fed 0 mg / kg diet LP and layers fed 30 g / kg diet DTP recorded the average higher LBW. While, layers fed the 0 g / kg diet DSRP showed the higher average LBW. Dietary LP and DTP levels had significant ($P \leq 0.01$) effect on average daily feed intake of layers. However, the higher average of daily feed intake was recorded by hens fed dietary 0 mg/ kg diet LP, 0 g/ kg diet DTP level and 2 g / kg diet DSRP levels. Dried sweet red pepper levels had no significant effect on average daily FI of layers during most of experimental periods. The higher average daily FI was shown by layers fed 2 g / kg diet DSRP level. No significant differences were found in average feed conversion of layers attributed to the dietary DTP and DSRP levels. However, the best average FCR values (3.37g feed/g egg mass) was recorded by layers fed the diet contained 0 mg/kg diet lutein powder level. Dietary LP and DTP levels had significant ($P \leq 0.01$) effects on average egg production (EP) rate, egg weight and egg mass of layers at the end of the experimental period. While, dietary DSRP levels had no significant effect on averages of egg production rate and egg mass of layers at the end of the experimental period (40-48 weeks of age). The higher averages of egg production rate and egg mass were recorded by layers fed the diet of 0 mg/kg diet LP, 30 g/kg diet DTP and 2 g/kg diet DSRP levels, while, the higher average of egg weight was recorded by hens fed the dietary 0 mg/kg diet LP, 30 g/kg diet DTP and 0

g/kg diet DSRP levels . Dietary supplementation of LP, DTP and DSRP showed significant ($P \leq 0.01$) effect on Roche yolk color fan score at all the different experimental periods. Roche yolk color fan score increased with increasing the rate of LP, DTP and DSRP levels in the diet of laying hens. Diets contained 0 mg LP /kg diet, 0 g DTP /kg diet and 4 g DSRP /kg diet levels recorded the higher (best) relative economical efficiency percentage for egg production.

Keywords: lutein powder ,dried tomato pulp , dried sweet red pepper powder, egg quality , egg production ,Silver Montazah , hen layers

INTRODUCTION

Carotenoid molecules are present in both the plant and animal kingdoms, in which they play several important physiological functions. Family of those molecules are a group of over 600 naturally occurring colored dyes and/or pigments in living beings. More than 20 of them are common in human foods and animal feeds (During and Harrison, 2004). A variety of structurally different carotenoids are present in fruits and vegetables and animal tissues. Some of the major sources are tomatoes (lycopene), citrus fruits (β -cryptoxanthin), spinach (lutein), maize (zeaxanthin), red pepper (capsanthin) and egg yolk (lutein and zeaxanthin) Diplock *et al.*, 1998. Both artificial and natural colour additives are used in the hen's diet to improve egg-yolk colour. In the poultry industry, xanthophylls like lutein were used, so far, mainly for pigmentation of meat, skin of broilers and egg yolks, since color is an important factor in the perception of poultry products quality in many countries of the world (Rajput *et al.*, 2012). The dry tomato pulp is one of the feed ingredients, which has been widely used to manipulate the pigmentation in egg yolk color of laying hens. It was also suggested that dry tomato pomace can be used as a protein source due to its high protein content. The objective of this experiment was to determine the effects of different dietary levels of lutein powder pure, dried tomato pulp and dried sweet red pepper (as natural colour additives) on some productive parameters and egg yolk colour, of Silver Montazah (SM) laying hens.

MATERIALS AND METHODS

The present study was carried out at Inshas Poultry Breeding Research Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt, during the period from November 2015 to February 2016. A 2 x 3 x 3 factorial arrangement design was used in this experiment including two levels of lutein powder pure (LP) (0 and 30 mg/kg diet), three levels of dried tomato pulp (DTP) (0, 15 and 30 g/kg diet), three levels of dried sweet red pepper (DSRP) (0, 2 and 4 g/kg diet) (as natural colour additives). A total number of 162 laying hens of Silver Montazah (SM) local strain, at the beginning of 40 weeks old, were chosen from the farm flock and used in this experiment. All selected birds were randomly distributed into 18 treatments equal in number 9 hens each treatment). Laying hens

of each treatment were nearly of an equal average body weight and similar average daily egg production with no statistical differences. All birds of the experimental treatments were individually housed in wire-caged batteries (45×30×35cm), and kept under the same managerial, hygienic and environmental conditions. Birds were located in a temperature-controlled room, and the photo period during the experimental period was fixed at 16 hrs daily. Hens were fed ad-libitum and the fresh water was available all the time during the experimental period (9 weeks). Birds were fed a basal laying diet formulated to cover the nutrient requirements of SM laying hens recommendations according to Feed Composition Tables For Animal and Poultry Feedstuffs Used In Egypt (2001). Layers were fed either the basal diet with no supplementation (control) or supplemented with 0 or 30 mg LP /kg diet, 0, 15 or 30 g DTP /kg diet and 0, 2 or 4 g DSRP /kg diet. Feed ingredients and chemical analysis of the experimental basal diet are presented in Table 1. Birds of each experimental treatment were individually weighed to the nearest gram at the start of the experiment, and then every three weeks during the experimental period (40, 43, 46 and 48 weeks of age), while egg weight was recorded daily and feed intake was calculated weekly and then it was averaged for each treatment and expressed as grams per bird per day during the periods from 40- 42,43-45and 46-48 weeks of birds age.

Egg production rate (%) was calculated for each experimental treatment as follows:-

$$\text{Egg production rate, (\%)/hen /d ay} = \frac{\text{Number of eggs produced}}{\text{Number of live hens}} \times 100$$

Egg mass was calculated by multiplying the total egg number by the average egg weight. Feed conversion (g feed /g egg mass) was also calculated at 42,45 and 48 weeks of age. The degree of pigmentation of egg yolk was determined by Yolk Color Fan (Hoffmann La Roche) with the range of 1 to 15, as the color standard by naked-eye scoring (Vuilleumier, 1969). Data were statistically analyzed according to ANOVA procedures of SAS (SAS, Institute 2012). Mean differences were compared using Duncan's New Multiple Range test (Duncan, 1955)

Statistical Analysis:

The experiment was conducted as a completely randomized design with 18 treatments in a 2×3×3 factorial arrangements and the main effects (level of LP, DTP and DSRP supplementation) were analyzed according to ANOVA procedures of SAS (SAS, 2012). The interaction between main effects was included in the model. Mean differences were compared using Duncan's New Multiple Range test (Duncan, 1955) and the following model was used:-

$$Y_{ijkl} = \mu + L_i + D_j + S_l + LDS_{ijl} + e_{ijkl}$$

Whereas:

Y_{ijkl} = Number of observations.

μ = The overall mean of the respective variables.

L_i = Lutein powder level effect (i =1 and 2).

D_j = Dried tomato pulp level effect (j =1, 2 and 3).

S_l = Sweet red pepper level effect (l =1, 2 and 3).

LDS_{ijl} = Interaction effect between L, D and S level effect (ijl =1, 2, 3...18).

e_{ijkl} = Residual error.

RESULTS AND DISCUSSION

Growth performance traits.

Live body weight.

Results in (Table 2) revealed that dietary lutein powder (LP) levels had significant ($P \leq 0.01$ or $P \leq 0.05$) effects on Live body weight (LBW) during all the experimental periods except at 40 weeks of age (initial LBW) and 46 weeks of age. The average LBW at the end of the experimental period showed that layers fed the 0 mg/kg diet LP level recorded the higher LBW (1533.3g), Table 2. However, in this concern, Kanda *et al.* (2011), Sajjad *et al.* (2013) and Insurk *et al.* (2014) reported that there were no significant differences in body weight among laying hens fed a basal diet or the basal diet supplemented with various lutein powder levels and sources. Regardless of the dietary LP levels effects, results in Table 2 showed non-significant effects of dietary dried tomato pulp (DTP) levels on LBW of Silver Montazah laying hens during all experimental periods except at 43 weeks of age which was significant ($P \leq 0.01$). Layers fed the 30 g/kg diet DTP level recorded the higher LBW (1515.7g). These results agreed with those of Nobakht and Safamehr (2007) who found no significant differences in LBW and weight gain of laying hens fed on diets containing different levels of DTP. Data in Table 2 showed that dried sweet red pepper (DSRP) levels had no significant effect on LBW of layers during all the experimental ages. At the end of the experimental period, layers fed the control diet (0 g / kg diet DSRP) attained the higher average LBW (1523.1g). Similar results were reported by Lokaewanee *et al.* (2009) who found no significant differences in final LBW of laying hens fed different levels of DSRP.

Feed intake:

Data presented in Table 2 showed significant ($P \leq 0.01$) variations in daily feed intake (FI) due to the dietary LP levels effect during all the experimental periods except from 46-48 weeks of layers age. In general, daily FI decreased with increasing the LP level from 0 to 30 mg / kg diet . The higher average daily FI (105.0 g) was

observed by layers fed the 0 mg / kg diet LP level. In agreement with the previous results of Kanda *et al.* (2011) whom reported that dietary lutein level had no significant effect on daily FI of layers. Dietary DTP levels had significant ($P \leq 0.01$ or $P \leq 0.05$) effects on daily FI of layers during all the experimental periods. However, It is clear that daily FI almost decreased with increasing the dietary DTP level. The higher average daily FI (105.47g) was observed by layers fed the 0 g/kg diet DTP level. In concern with the previous results of Yannakopoulos *et al.* (1992) and Dotas *et al.* (1999) declared that dietary DTP had no significant effect on FI of laying hens.

Dried sweet red pepper (DSRP) levels had no significant effect on daily FI of layers during all experimental periods except at 40-42weeks of age. However, the higher average daily FI (103.30 g) was shown by layers fed 2g / kg diet DSRP level. In accordance with the previous results, Huaqiang *et al.*, (2012) and Rossi *et al.*, (2015) found that feed intake of laying hens was not significantly affected by dietary red pepper powder or sweet green pepper.

Feed conversion:

Feed conversion ratio (FCR) for layers of different experimental treatments along the whole experimental period are presented in Table 3. Results obtained revealed that dietary LP levels had significant ($P \leq 0.01$ and $P < 0.05$) effects on FCR of hens during all experimental periods. However, it is clear that increasing the dietary LP from 0 to 30 mg / kg diet depressed the FCR of layers during all experiment periods. The best average FCR (3.37 g feed / g egg mass) was observed with layers fed the control diet (0 g / kg diet LP). In this concern, Hasin *et al.* (2006) and Sajjad *et al.* (2013) found no significant differences in FCRs of layers fed different levels of lutein. No significant differences were found in FCR of layers attributed to dietary DTP levels effect during all experimental periods except at the period from 43 to 45 weeks of age ($P \leq 0.01$). The best average FCR (3.59 g feed / g egg mass) was attained by hens fed the 30 g / kg dietary DTP level (Table 3). In partial agreement with the previous results, Yannakopoulos *et al.* (1992) agreed that FCR of laying hens was not affected by dietary DTP level. Dried sweet red pepper levels had no significant effect on FCR of layers during all experimental periods except at 43-45 weeks of layers age ($P \leq 0.05$). The best FCR (3.70 g feed / g egg mass) was observed with layers fed 4 g / kg diet DSRP level. Similar results were reported by Huaqiang *et al.* (2012) and Rossi *et al.* (2015). They indicated that red pepper and sweet green pepper levels had no significant effect on FCR of laying hens.

Egg production traits.**Egg production rate.**

The effect of dietary LP, DTP, and DSRP levels on egg production (EP) rate of Silver Montazah layers all over the experimental periods are illustrated in Table 3. Results obtained showed that dietary LP levels had significant ($P \leq 0.01$) effects on EP rate during all experimental periods. The higher average EP rate (66.10% / hen / day) was observed in hens fed the control diet (0 mg/kg diet LP). However, in this concern Hasin *et al.* (2006) and Sajjad *et al.* (2013) found non-significant effect of lutein on egg production. Data of Table 3 showed significant ($P \leq 0.01$) variations in EP rate of hens during only 43-45 and average of 40-48 weeks of hens age due to DTP levels supplementation. Hens fed the dietary 30 g / kg diet DTP recorded the higher average EP rate (62.96 % / hen / day) compared with other treatments. In partial agreement with the previous results, Nihad *et al.* (2014) reported significant ($P \leq 0.05$) improvement for laying hens in EP rate due to dietary inclusion of DTP and lycopene powder. Data in Table 3 showed that dietary DSRP levels had no significant effect on EP rate of hens except at 43 - 45 weeks of layers age ($P \leq 0.05$). Hens fed the control diet (0 g / kg diet DSRP level) recorded the higher average EP rate being 61.52 % hen / day. In close agreement with the previous results Huaqiang *et al.* (2012) and Rossi *et al.* (2015) found that red pepper and sweet green pepper had no significant effect on hen day egg production.

Egg weight.

Data presented in Table 4 showed the effect of dietary LP, DTP and DSRP supplementation levels on egg weight (EW) of Silver Montazah layers during all the experimental periods. Results obtained revealed that dietary LP levels had significant ($P \leq 0.01$) effect on EW of hens at all experimental periods. Hens fed the control diet (0 mg LP / kg diet level) recorded the higher average EW (48.07g). In this concern, Hasin *et al.* (2006) observed that the lutein supplementation had no effect on EW. Egg weight was also significantly ($P \leq 0.05$ or $P \leq 0.01$) affected by DTP levels supplementation at all periods of estimation except at 40- 42 weeks of birds age (Table4). The higher average EW (47.94 g) was recorded by layers fed the 30 g / kg diet DTP level. In partial agreement with the previous results, Nihad *et al.*, (2014) reported significant improvement ($P \leq 0.05$) in EW for treatments fed lycopene powder. Similarly, DSRP levels supplementation had significant ($P \leq 0.05$ or $P \leq 0.01$) effects on EW of hens at all periods of the experiment except at 40 to 42 weeks of layers age Table 4. The higher average EW (47.94 g) was shown by layers fed 2 g / kg diet DSRP level. The out comes of the present study are in accordance with those of Huaqiang *et*

al. (2012) who indicated that red pepper powder and hot pepper supplementation significantly improved egg weight.

Egg mass.

Data concerning egg mass (EM) of experimental birds along the different experimental periods of the study are shown in Table 4. Dietary LP levels had significant ($P \leq 0.01$) effects on EM values during all the experimental periods.

The best average EM value (31.73 g/hen/day) was observed in hens fed the 0 mg / kg diet LP level. However, Sajjad *et al.* (2013) mentioned that dietary levels and sources of lutein had no significant effect on EM. Dietary DTP levels supplementation had significant ($P \leq 0.01$) effects on EM only at 43-45 and average (40 to 48) weeks of birds age Table 4. Layers fed the diet supplemented with 30 g / kg diet DTP attained the higher (30.24 g / hen / day) average EM value. The previous results agreed with those of Nihad *et al.*, (2014) who get significant ($P \leq 0.05$) improvement in EM for layers fed lycopene powder. Egg mass values were not significantly affected by dietary DSRP levels at all periods of estimation except at the period from 43 -45 weeks of layers age ($P \leq 0.05$), Table 4. Hower, the higher average EM value (29.15g / hen / day) was shown by layers fed the control diet (0 g / kg diet DSRP). In close agreement with the previous results, Rossi *et al.* (2015) reported that EM was not significantly affected by the addition of sweet green pepper to the diet .

Some egg quality traits :

Roche yolk color fan score.

The egg yolk color was visually examined using the Roche Yolk Color Fan (RYCF), as shown in Figure 1. Data presented in Table 5 and Figures 2,3 and 4 showed that the RYCF score was increased by increasing dietary LP, DTP and DSRP levels supplementation during all periods of estimation. Dietary LP levels had significant ($P \leq 0.01$) effect on RYCF score during all experimental periods. Increasing the LP level increased the RYCF scores as presented in Table 5. Hens fed 30 mg /kg diet LP attained the higher (9.47) average RYCF score. In agreement with the previous results Hasin *et al.* (2006) reported that the yolk color parameters were significantly improved as compared to the control by the addition of dietary marigold and orange skin as sources of lutein. Similarly, Kanda *et al.* (2011) claimed that dietary lutein significantly increased yolk color and lutein content in the eggs. Similarly, dietary DTP levels had significant ($P \leq 0.01$) effect on RYCF score of laying hens during all the experimental periods. The higher (9.11) averag RYCF score was shown by layers fed the 30 g/kg diet DTP level (Table 5). The previous results are in

accordance with those reported by Dotas *et al.* (1999) who stated the inclusion of DTP up to 120g / kg diet significantly improved the egg yolk color. Also, Jafari *et al.* (2006) and Calislar and Uygur (2010) indicated that the addition of DTP had significant effect on egg yolk color. Moreover, Shahsavari (2015) with 5% DTP added to laying hen diets recorded significant improvement in egg yolk color.

Results in Table 5 indicated that DSRP levels had significant ($P \leq 0.01$) effect on RYCF score of layers during all the experimental periods. Hens fed 4 g/kg diet DSRP level recorded the higher (8.78) average RYCF score. The results obtained are in accordance with those reported by Lokaewmanee *et al.* (2009) showed that red pepper supplementation of three kinds of red pepper at dietary 0.5% level from three kinds significantly increased the Roche yolk color fan value. Similarly results were reported by Shahsavari (2015) and Rossi *et al.* (2015) using 225 ppm sweet green pepper improved egg yolk color .

Economical efficiency

Economical efficiency of egg production as affected by LP, DTP and DSRP levels supplementation at the end of the experimental period (48 weeks of age) are shown in Table 6. Results obtained revealed that the 0 mg /kg diet LP level recorded the higher (best) relative Eef percentage being 100% and the diets supplemented with 0g/kg diet DTP and 4g/ kg DSRP levels attained the higher relative Eef values, being 58.60 % and 134.41%, respectively. In this concern, Dotas *et al.* (1999) indicated that feed efficiency (kg feed / kg egg mass) was not significantly affected by the inclusion of dietary DTP at levels 40,60 and 120 g/kg diet. Also, Lokaewmanee *et al.* (2009) evaluate the effect of three kinds of red pepper supplementation in laying hens diets at 0 % (control) or 0.5 %, compared with the control group no significant difference in feed efficiency was observed.

Table 1. Feed composition and chemical analysis of the basal laying diet.

Ingredients	%
Yellow corn	65.14
Soybean meal (44 %)	25.10
Limestone (CaCO ₃)	7.60
Di-calcium phosphate	1.50
Salt (NaCl)	0.30
DL-Methionine 99%	0.06
Vit + Min. premix*	0.30
Total	100
<u>Chemical Analysis:-</u>	
Crude protein,%.	16.42
ME, Kcal/kg.	2744
Calcium, %	3.29
Available phosphorus, %.	0.40
Lysine, %.	0.90
Methionine,%	0.35
Methionine + cystine %.	0.62
<u>b-Determined analysis ***:-</u>	
Crude protein,%.	16.42
Crude fiber,%.	3.72
Ash %.	3.10

*Vit. Min. premix: Each 3 kg of vitamin and mineral premix (Commercial source AGRIVET Co.) contains Vit. A. 12000000 IU, Vit. D₃ 2000000 IU, Vit. E. 10000 mg, Vit. K₃ 2000 mg, Vit. B₁ 1000 mg, Vit. B₂ 5000 mg, Vit. B₆ 1500 mg, Vit. B₁₂ 10 mg, Biotin 50 mg, Choline 250000 mg, Pantothenic acid 10000 mg, Nicotinic acid 30000 mg, Folic acid 1000 mg, Manganese 60000 mg, Zinc 50000 mg, Iron 30000 mg, Copper 10000 mg, Iodine 1000 mg, Selenium 100 mg, Cobalt 100 mg, Carrier (Ca CO₃) add to 3kg. *** Determined according to the methods of AOAC (2005).

Table 2. Live body weight and feed intake $\bar{X} \pm SE$ of Silver Montazah layers as affected by lutein powder, dried tomato pulp and sweet red pepper levels during the different experimental periods.

Items	Live body weight (g) at weeks					Feed intake (g/hen/day)at weeks			
	40	43	46	48	Average (40-48)	40-42	43-45	46-48	Average (40-48)
LP	NS	**	NS	*	*	**	**	NS	**
0	1435.4±15.9 ^b	1455.6±19.2 ^a	1604.3±19.4 ^a	1638.0±20.1 ^a	1533.3±17.2 ^a	91.38±1.49 ^a	100.23±1.29 ^a	123.38±1.52	105.0±0.90 ^a
30	1438.7±16.0 ^a	1336.2±18.5 ^b	1555.1±18.5 ^b	1584.4±18.8 ^b	1478.6±16.8 ^b	82.61±1.11 ^b	94.82±1.73 ^b	120.36±2.59	99.26±1.35 ^b
DTP	NS	**	NS	NS	NS	**	*	**	**
0	1445.8±20.8	1416.2±26.3 ^{ab}	1563.7±23.9	1631.5±24.6	1514.3±22.1	88.70±1.80 ^a	101.11±1.96 ^a	126.6±1.72 ^a	105.47±1.28 ^a
15	1436.6±18.8	1337.9±17.3 ^b	1567.9±19.4	1609.5±21.3	1487.9±18.0	82.63±1.29 ^b	95.27±1.50 ^b	122.5±3.22 ^{ab}	100.13±1.33 ^b
30	1428.7±18.9	1433.7±26.9 ^a	1607.5±26.4	1592.6±26.2	1515.7±23.1	89.66±1.85 ^a	96.18±2.13 ^b	116.51±2.5 ^b	100.78±1.64 ^{ab}
DSRP	NS	NS	NS	NS	NS	*	NS	NS	NS
0	1452.6±20.0	1429.1±23.5	1576.4±21.5	1634.5±23.4	1523.1±20.4	89.30±1.47 ^a	98.67±1.42	119.62±2.86	102.53±1.31
2	1435.1±22.3	1371.4±25.1	1579.8±27.0	1602.2±26.0	1497.1±23.7	87.07±1.61 ^{ab}	99.02±1.85	123.81±2.74	103.30±1.57
4	1423.4±15.4	1387.3±24.3	1582.9±21.7	1596.9±22.8	1497.7±19.1	84.62±1.98 ^b	94.88±2.32	122.18±2.17	100.56±1.47

$(\bar{X} \pm SE)$ = Average \pm standard error. LP = Lutein powder levels (mg/kg diet). DTP = Dried tomato pulp levels (g/kg diet). DSRP = Dried Sweet red pepper levels (g/kg diet). Means having different letters at the same column are significantly ($P \leq 0.05$) different. NS = Not significant. * = ($P \leq 0.05$) and ** = ($P \leq 0.01$).

Table 3. Feed conversion and egg production $\bar{X} \pm SE$ of Silver Montazah layers as affected by lutein powder, dried tomato pulp and sweet red pepper levels during the different experimental periods.

Items	Feed conversion (g.feed/g.egg mass) at weeks				Egg production (%/hen/day) at wks			
	40-42	43-45	46-48	Average (40-48)	40-42	43-45	46-48	Average (40-48)
LP	*	**	*	**	**	**	**	**
0	3.19±0.11 ^a	4.21±0.22 ^a	3.34±0.09 ^a	3.37±0.06 ^a	66.02±1.57 ^a	56.44±1.96 ^a	75.84±1.25 ^a	66.10±1.13 ^a
30	3.57±0.16 ^b	5.39±0.20 ^b	4.30±0.41 ^b	4.07±0.15 ^b	57.67±1.71 ^b	40.86±1.25 ^b	67.61±1.90 ^b	55.38±1.24 ^b
DTP	NS	**	NS	NS	NS	**	NS	**
0	3.19±0.09	4.68±0.23 ^a	3.72±0.12	3.69±0.09	63.67±1.69	51.59±2.46 ^a	71.25±1.51	62.17±1.46 ^a
15	3.33±0.15	5.54±0.29 ^a	4.16±0.57	3.88±0.15	59.61±1.83	40.30±1.42 ^b	71.34±2.32	57.08±1.29 ^b
30	3.62±0.23	4.17±0.26 ^b	3.57±0.27	3.59±0.19	62.26±2.62	54.06±2.36 ^a	72.57±2.25	62.96±1.96 ^a
DSRP	NS	*	NS	NS	NS	*	NS	NS
0	3.27±0.11	4.49±0.20 ^b	4.19±0.57	3.71±0.17	63.67±1.81	51.23±2.09 ^a	69.66±2.25	61.52±1.59
2	3.39±0.18	5.36±0.36 ^a	3.48±0.15	3.74±0.16	61.90±2.17	45.86±2.55 ^b	73.81±1.65	60.52±1.73
4	3.48±0.20	4.55±0.21 ^b	3.79±0.24	3.70±0.12	59.96±2.26	48.85±2.12 ^{ab}	71.69±2.18	60.17±1.57

$(\bar{X} \pm SE)$ - Average \pm standard error. LP = Lutein powder levels (mg/kg diet). DTP = Dried tomato pulp levels (g/kg diet). DSRP = Dried Sweet red pepper levels (g/kg diet). Means having different letters at the same column are significantly ($P \leq 0.05$) different. NS = Not significant. * = ($P \leq 0.05$) and ** = ($P \leq 0.01$).

Table 4. Egg weight and egg mass g ($\bar{X} \pm SE$) of Silver Montazah layers as affected by lutein powder, dried tomato pulp and sweet red pepper levels during the different experimental periods.

Items	Egg weight (g) at weeks				Egg mass (g/hen) % at weeks			
	40-42	43-45	46-48	Average (40-48)	40-42	43-45	46-48	Average (40-48)
LP	**	**	**	**	**	**	**	**
0	45.59±0.29 ^a	47.83±0.33 ^a	50.26±0.33 ^a	48.07±0.29 ^a	30.11±0.74 ^a	27.06±0.96 ^a	38.04±0.66 ^a	31.73±0.55 ^a
30	44.10±0.25 ^b	46.33±0.32 ^b	48.96±0.28 ^b	46.66±0.26 ^b	25.43±0.76 ^b	18.89±0.58 ^b	33.21±0.98 ^b	25.84±0.59 ^b
DTP	NS	**	*	*	NS	**	NS	**
0	44.95±0.35	47.16±0.37 ^{ab}	49.31±0.38 ^b	47.28±0.35 ^{ab}	28.65±0.80	24.48±1.22 ^a	35.15±0.8	29.44±0.73 ^a
15	44.43±0.34	46.27±0.42 ^b	49.20±0.35 ^b	46.87±0.34 ^b	26.50±0.80	18.57±0.64 ^b	35.13±1.18	26.67±0.61 ^b
30	45.16±0.34	47.81±0.42 ^a	50.33±0.41 ^a	47.94±0.35 ^a	28.17±1.22	25.87±1.16 ^a	36.59±1.19	30.24±0.96 ^a
DSRP	NS	*	**	*	NS	*	NS	NS
0	44.94±0.37	47.09±0.43 ^{ab}	49.49±0.37 ^{ab}	47.28±0.35 ^{ab}	28.74±0.91	24.24±1.06 ^a	34.44±1.14	29.15±0.83
2	45.05±0.33	47.72±0.41 ^a	50.36±0.42 ^a	47.94±0.36 ^a	27.98±1.01	21.96±1.23 ^b	37.20±0.94	29.06±0.85
4	44.56±0.33	46.43±0.38 ^b	48.98±0.34 ^b	46.87±0.32 ^b	26.59±0.97	22.72±1.05 ^{ab}	35.22±1.10	28.15±0.73

($\bar{X} \pm SE$) = Average \pm standard error. LP = Lutein powder levels (mg/kg diet). DTP = Dried tomato pulp levels (g/kg diet). DSRP = Dried Sweet red pepper levels (g/kg diet). Means having different letters at the same column are significantly ($P \leq 0.05$) different NS = Not significant. * = ($P \leq 0.05$) and ** = ($P \leq 0.01$)

Table 5. Roche yolk color fan score ($\bar{X} \pm SE$) of Silver Montazah layers as affected By dietary Lutein powder, dried tomato pulp and dried sweet red pepper levels during the different experimental periods.

Items	Roche yolk color fan score			
	40-42	43-45	46-48	Average (40-48)
LP	**	**	**	**
0	7.67±0.22 ^b	6.11±0.22 ^b	7.96±0.25 ^b	7.25±0.20 ^b
30	9.85±0.18 ^a	8.89±0.22 ^a	9.67±0.16 ^a	9.47±0.16 ^a
DTP	**	**	**	**
0	7.89±0.36 ^b	6.33±0.37 ^c	7.78±0.37 ^c	7.33±0.34 ^c
15	9.06±0.26 ^a	7.72±0.42 ^b	9.11±0.20 ^b	8.63±0.27 ^b
30	9.33±0.36 ^a	8.44±0.34 ^a	9.56±0.23 ^a	9.11±0.29 ^a
DSRP	**	**	**	**
0	8.33±0.43 ^b	7.06±0.47 ^b	8.22±0.30 ^c	7.87±0.38 ^c
2	8.67±0.30 ^b	7.72±0.34 ^a	8.89±0.35 ^b	8.43±0.30 ^b
4	9.28±0.31 ^a	7.72±0.46 ^a	9.33±0.28 ^a	8.78±0.33 ^a

($\bar{X} \pm SE$)—Average ± standard error. LP = Lutein powder levels (mg/kg diet). DTP = Dried tomato pulp levels (g/kg diet). DSRP = Dried sweet red pepper levels (g/kg diet). Means having different letters at the same column are significantly ($P \leq 0.01$) different. ** = ($P \leq 0.01$).

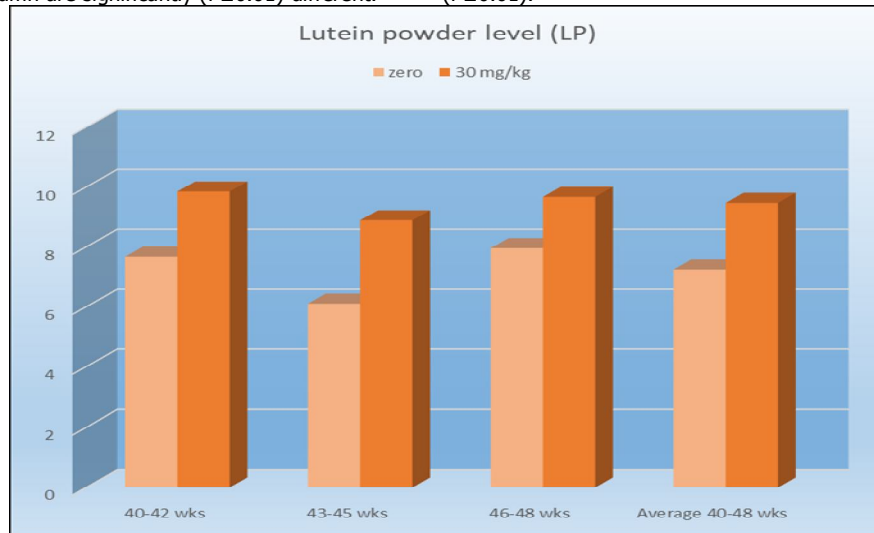


Fig. 1. Effects of dietary lutein powder (LP) on egg Roche Yolk Color Fan (RYCF) scor.

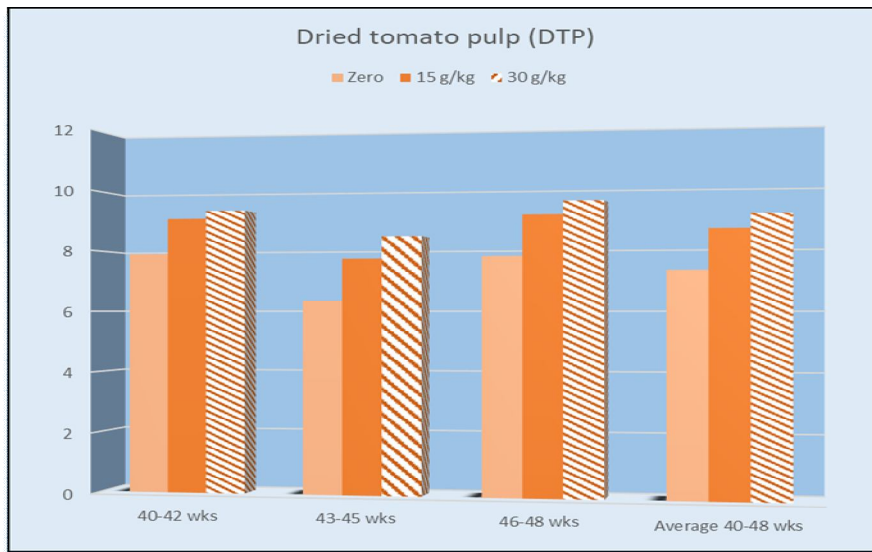


Fig. 2. Effects of dietary dried tomato pulp (DTP) on egg Roche Yolk Color Fan (RYCF) scor.

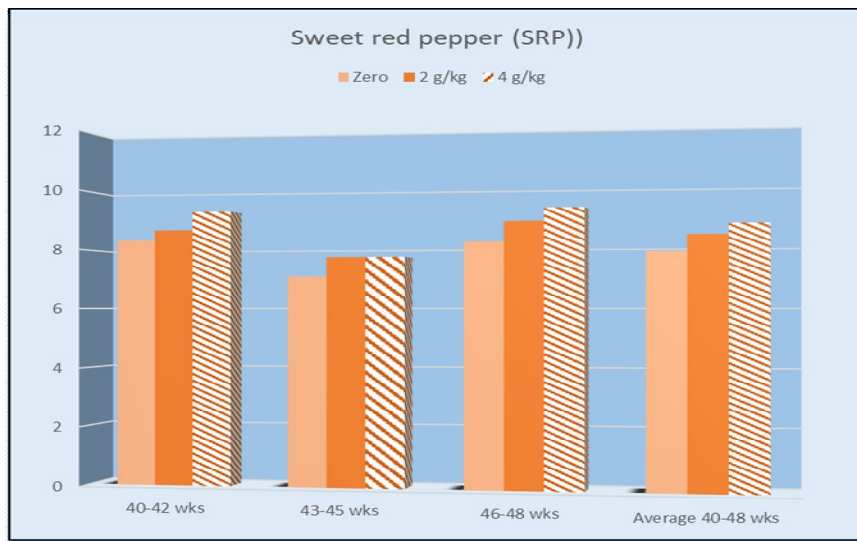


Fig. 3. Effects of dietary sweet red pepper (SRP) on egg Roche Yolk Color Fan (RYCF) scor.



Figure 5: Pictures of egg yolk coloration in raw eggs from hens fed dietary various levels from lutein powder (LP), dried tomato pulp (DTP) and sweet red pepper (SRP) (according to Roche yolk color fan score).

Table 6. Economical efficiency of egg production of Silver Montazah layer as affected by dietary lutein powder, dried tomato pulp and dried sweet red pepper levels supplementation at the end of experimental period (48 weeks of age).

Items	Egg number (hen/ period)	Cost / egg (LE)	Total revenue hen (LE)	Total feed intake/hen (kg)	Price /kg feed (LE)	Total feed cost/hen (LE)	Fixed hen price (LE)	Total cost hen (LE)	Net revenue/ hen (LE)	Economical efficiency (EEf)	Relative EEf %
LP											
0	41.64	0.75	31.23	6.62	3.70	24.45	2.00	26.45	4.78	0.18	100.00
30	34.89	0.85	29.66	6.25	4.07	25.46	2.00	27.46	2.19	0.08	44.23
DTP											
0	39.17	0.75	29.38	6.64	3.70	24.56	2.00	26.56	2.81	0.11	58.60
15	35.96	0.85	30.57	6.31	4.30	27.10	2.00	29.10	1.46	0.05	27.80
30	39.66	0.85	33.72	6.35	4.90	31.09	2.00	33.09	0.62	0.02	10.45
DSRP											
0	38.76	0.75	29.07	6.46	3.70	23.88	2.00	25.88	3.19	0.12	68.23
2	38.13	0.85	32.41	6.51	3.74	24.32	2.00	26.32	6.09	0.23	128.11
4	37.91	0.85	32.22	6.34	3.78	23.93	2.00	25.93	6.29	0.24	134.41

LP = Lutein powder levels (mg/kg diet).

DTP = Dried tomato pulp levels (g/kg diet).

DSRP = Dried sweet red pepper levels (g/kg diet).

Egg number (hen/period) = (average egg production % /100) x 63 days

Fixed hen (LE) = Rearing cost.

Total revenue = Egg number / hen X Price/egg (LE).

Total feed intake/hen(kg) = (average feed intake g /hen/day) x 63 days /1000

Fixed hen (LE) = Rearing cost.

Net revenue/hen (LE) = Total revenue - Total cost/hen.

EEf = Net revenue/hen (LE) / Total cost/hen (LE).

Relative EEf %, assuming that EEf of the control equals 100

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تأثير اضافة الصبغات الطبيعية فى العلف على لون صفار البيض وبعض المقاييس الانتاجية للدجاج البياض المحلى

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صممت هذه التجربة لدراسة تأثير إضافة مستويات مختلفة من مسحوق كل من الليوتين ومسحوق الطماطم المجففة ومسحوق الفلفل الأحمر الحلو على لون الصفار و الاداء الانتاجى وانتاجية ونوعية البيض والكفاءة الاقتصادية لسلالة الدجاج المنتزه الفضى البياض المحلية من بداية عمر 40 إلى 48 أسبوعاً شملت هذه الدراسة تجربة عاملية 2*3*3 تضمنت مستويين من الليوتين (صفر، 30 مجم / كجم علف) وثلاث مستويات من مسحوق الطماطم (صفر، 15، 30 مجم /كجم علف) وثلاث مستويات من مسحوق الفلفل الحلو الاحمر (صفر، 2، 4 مجم /كجم علف) واجريت هذه الدراسة على عدد 162 دجاجة بياضة قسمت الى 18 مجموعة كل مجموعة (9 دجاجة) وكانت الطيور فى المعاملات متساوية تقريبا فى الوزن وانتاج البيض اليومى وجميع الطيور تم تسكينها فرديا فى القفص من السلك وكانت تحت نفس الظروف البيئية والرعاية.

اظهرت النتائج المتحصل عليها عند نهاية التجربة

أدى استخدام مستويات مختلفة من الليوتين الى ظهور تأثير معنوى (عند مستوى 0.05%) على متوسط وزن الجسم الحى للطيور بينما لم يكن لأى من أضافة مستويات من مسحوق الطماطم المجفف والفلفل الاحمر الحلو/ كجم علف اى تأثير معنوى على هذه الصفة وقد أظهرت الطيور المغذاة على عليقة الكنترول بدون اضافة أعلى متوسط لوزن الجسم الحى للطيور .أدت أضافة مستويات من الليوتين ومسحوق الطماطم المجفف ومخلوط من الليوتين ومسحوق الطماطم المجفف والافلفل الاحمر الحلو الى تأثير معنوى (عند مستوى 0.01%) على كمية الغذاء المستهلك يوميا وقد سجلت الطيور المغذاة على عليقة يحتوى على صفر من الليوتين ، صفر مسحوق الطماطم المجفف ، 2جم الفلفل الاحمر الحلو أعلى متوسط لكمية الغذاء المستهلك يوميا .

لاتوجد أختلافات معنوية فى متوسط كفاءة التحويل الغذائى للطيور المغذاة على علائق مضاف لها مستويات من مسحوق الطماطم المجفف والفلفل الاحمر الحلو . وقد سجلت الطيور المغذاة على علائق تحتوى على مستوى صفر ليوتين ، 30 جم مسحوق طماطم مجفف و 2 جم من الفلفل الاحمر الحلو أفضل كفاءة تحويل غذائى .

أضافة الليوتين ومسحوق الطماطم المجفف ومخلوط من الليوتين والطماطم المجفف والفلفل الاحمر الحلو ادى الى تاثير معنوى (0.01%) على معدل انتاج البيض، وزن البيض ، كتلة البيض. بينما اضافة مستويات من مسحوق الفلفل الاحمر الحلو لم يؤثر معنويا على متوسط معدل انتاج البيض وكتلة البيض فى نهاية فترة التجربة (40-48 أسبوع).

وقد سجلت الطيور المغذاة على عليقة تحتوى على مستوى صفر من الليوتين و 30 جم من مسحوق الطماطم المجفف و 2 جم من الفلفل الاحمر الحلو / كجم علف أعلى متوسط نسبة لمعدل انتاج البيض وكذلك كتلة البيض بينما سجلت الطيور المغذاة على عليقة بها مستوى صفر من الليوتين و 30 جم من مسحوق الطماطم المجفف ومستوى صفر من مسحوق الفلفل الاحمر الحلو / كجم علف أعلى متوسط لوزن البيض.

أدت اضافة الليوتين ومسحوق الطماطم المجفف والفلفل الاحمر الحلو الى تاثير معنوى (عند مستوى 0.01%) على درجات لون الصفار (ومروحة روش فان) خلال فترات التجربة المختلفة . فزادت درجات لون صفار البيض مع زيادة مستويات الليوتين ومسحوق الطماطم المجفف والفلفل الاحمر الحلو الى علائق الدجاج البياض .

العلائق المحتوية على مستوى صفر من الليوتين ومستوى صفر من مسحوق الطماطم المجفف ومستوى 4 جم من الفلفل الحلو / كجم علف سجلت أعلى قيمة لمتوسط الكفاءة الاقتصادية النسبية لانتاج البيض.