

## Research Article



# Performance, Physiological Parameters and Egg Quality Traits of Laying Hens as Affected by Dietary Supplementation of Date Palm Pollen

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**Abstract** | The current study aimed to investigate the effect of supplementation of date palm pollen (DPP) on the performance, physiological parameters and egg quality traits of laying hens. A total number of 240 Fayoumi chicken hens were classified into two equal experiments, 120 hens each (4 groups × 3 replicates × 10 birds). In each experiment, birds were divided into 4 treatment groups as follow: Normal control, positive control (0.0125% Butylated hydroxytoluene; BHT), 0.1% and 0.3% DPP, respectively. The DPP was used in two forms i.e., powder (DPP) for Exp.1 and aqueous extract (DPPE) for Exp.2. The results revealed that egg production was significantly improved ( $P < 0.01$ ) in the 0.1% DPP group (Exp.1) whereas, all groups exhibited higher ( $P < 0.05$ ) egg production (Exp.2) comparing to normal control. All treated groups exhibited an enhancement ( $P < 0.01$ ) in yolk total cholesterol comparing to either normal or positive control groups (Exp.1 and Exp.2). Spleen percentage (Exp.1) and carcass percentage (Exp.2) was significantly improved ( $P < 0.01$ ) in the 0.3% DPP group compared with all other groups. Hens fed control positive and 0.3% DPP (Exp.1), and control positive and 0.1% DPPE (Exp.2) exhibited significantly higher ( $P < 0.01$ ) yolk percentage compared with the normal control. From the obtained results it could be concluded that the supplementation of DPP up to 0.3% in either powder or extract forms enhances laying hens performance, and egg quality traits.

**Keywords** | Date Palm Pollen, Aqueous extract, Laying hens, Productive performance, Egg quality.

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## INTRODUCTION

Local breeds are preferable by most Egyptian people for their unique taste for both meat and eggs. Hence, improving birds' health is considered the secret of enhancement for productive performance, reduce stressors, production cost, intestinal harmful bacteria as well as maximizing feed efficiency (Ertaş et al., 2005). Many researchers studied the effect of adding botanical feed additives to improve immunity, antioxidant status and antimicrobial activities of

broilers (Mousa et al., 2016; 2017; Kamboh et al., 2015).

Date palm pollen (DPP) are the male gametophyte of the date palm (*Phoenix dactylifera* L.) which contains a lot of natural antioxidants (Al-Farsi et al., 2005) as polyphenolic and flavonoids (Lotito and Frei, 2006) which protect active tissues such as ovaries (Guo et al., 2004). Also, DPP contains estrogen, which motivates ovaries by encouraging follicle-stimulating hormone (FSH) and luteinizing hormone (Hammed et al., 2012).

In this respect, Shanoon et al. (2015) and Mousa et al. (2016) reported that egg production, mass and weight were significantly improved by dietary addition of powder form of DPP to laying hens comparing to an un-supplemented group. Furthermore, Arhaem (2004) used different levels of DPP extract to study the laying hens reproductive performance, some anatomical and physiological parameters; the author found a significant enhancement in egg weight and production. Regarding hemoglobin values, Refaie et al. (2019) reported a significant increase in hemoglobin for male Fayoumi chicks fed 0.1% DPP either in the form of powder or extract. On the other hand, Shihab (2018) noted that neither red nor white blood cell counts were affected by dietary supplementation of DPP to broiler chicks. Lately, Saleh et al. (2021) concluded that by supplementing DPP (5g/kg diet) to laying hens the albumen height and percentage were significantly enhanced.

Therefore, this study investigated the effect of supplementing laying hen diets with either powder or aqueous form of date palm pollen on the productive performance and some egg quality traits.

## MATERIALS AND METHODS

This study was conducted at El-Fayoum Poultry Research Farm and the Poultry Nutrition Laboratory, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

### PREPARATION OF DPP EXTRACT AND TOTAL PHENOLIC CONTENT MEASUREMENT

DPP was collected from Fayoum governorate (Egypt), separated from kernels and added to the birds diet (Exp.1). The aqueous suspension was freshly prepared daily by adding distilled water to powdered pollen with stirring for 10 minutes on a magnetic stirrer till complete dispersion according to Bahmanpour et al. (2006) method. The total phenolic compounds of Date Palm pollen Grain were determined using Folin– Ciocalteu reagent according to Singleton et al. (1999) method. The chemical composition of DPP used was: 28.8%, 31.11%, 20.74%, 1.37%, 4.57% and 13.41% for moisture, CP, EE, CF, ash and carbohydrates, respectively according to Hassan (2011). The determined total flavonoids content was 200.18 mg/100 g.

### ANIMAL EXPERIMENT

Two hundred and forty Fayoumi laying hens (42 wks old) were divided into two experiments (2 Experiments × 4 groups × 3 replicates × 10 birds). In the 1<sup>st</sup> experiment, hens were divided as follows: the first group was fed basal diet without supplementation, the second group was fed the basal diet supplemented with 0.0125% butylated hydroxytoluene (BHT), third and fourth groups were fed

the basal diet supplemented with 0.1% and 0.3% powder of date palm pollen (DPP), respectively. In the 2<sup>nd</sup> experiment, the first and second groups were the same controls used as in the first experiment while the third and fourth groups were fed the basal diet supplemented with 0.1% and 0.3% aqueous extract of date palm pollen (DPPE), respectively. Each treatment contains 30 birds in 3 replicates, 10 hens each. All layer hens were housed in individual cages (52.5×61×52 cm) and kept under similar hygienic and management conditions. Throughout the experimental periods (90 days), feed and water were supplied *ad libitum*. Hens were reared under a temperature ranged between 25-29° C, relative humidity 50-60% and exposed to 16 hours of artificial light beside the normal day light. The ingredients and chemical composition of the basal diet is shown in Table 1. The basal diet was calculated to meet the nutrient requirements recommended by the Agriculture Ministry Decree (1996). Throughout the experiment, day by day, egg numbers and weights were recognized (except of abnormal ones). Egg mass = egg's number % × it's weight. The amount of Feed (g) and egg production were documented.

**Table 1:** Composition and calculated analysis of the basal diet.

Ingredients	%
Yellow corn	60.00
Soybean meal (44%)	18.80
Corn gluten meal (60%)	6.00
Wheat bran	3.00
Soybean oil	0.60
Di-Ca Phosphate	2.0
Limestone	8.60
NaCl	0.40
Vitamins & Minerals mix *	0.30
L-lysine HCl	0.30
Total	100.0
Calculated analysis	
Crude Protein %	17.22
Metabolizable energy (Kcal/ kg)	2750
Calcium %	3.70
Available Phosphorus %	0.48
Lysine %	0.78
Methionine %	0.34
Methionine + cystiene %	0.66

\* Supplies per kg diet: Vit. A 12000 IU, Vit. D<sub>3</sub> 2000 IU, Vit. E 10 mg, Vit. K<sub>3</sub> 2 mg, Vit. B<sub>1</sub> 1 mg, Vit. B<sub>2</sub> 4 mg, Vit. B<sub>6</sub> 1.5 mg, Vit. B<sub>12</sub> 10 mg, Pantothenic acid 10 mg, Nicotinic acid 30 mg, Folic acid 1 mg, Biotin 0.05 mg, Choline 250 mg, Copper 10 mg, Iodine 1 mg, Manganese 60 mg, Zinc 55 mg, Selenium 0.1 mg, Iron 30 mg and Cobalt 0.1 mg.

**Table 2:** Effect of different treatments on laying hen productive performance

Measurements Treatments		Egg production %	Egg weight (g)	Feed intake (g)	Feed conversion ratio (g feed/g egg)
Exp.1 Date Pollen Powder	T1 (Control)	56.00 <sup>C</sup>	46.81	110	4.19
	T2 (BHT)	58.67 <sup>B</sup>	46.36	111	4.09
	T3 (0.1%)	61.50 <sup>A</sup>	45.74	111	3.91
	T4 (0.3%)	59.75 <sup>AB</sup>	45.60	115	4.22
	SE	0.53	1.50	1.62	0.11
	Sig.	**	NS	NS	NS
Exp.2 Date Pollen Extract	T1 (Control)	56.00 <sup>b</sup>	46.81	110	4.19
	T2 (BHT)	58.67 <sup>a</sup>	46.36	111	4.09
	T3 (0.1%)	59.50 <sup>a</sup>	44.82	112	4.26
	T4 (0.3%)	58.30 <sup>a</sup>	45.99	111	4.15
	SE	0.72			0.12
	Sig.	*	NS	NS	NS

\*a and b Means in each column, with same superscripts are not significantly different (P≤0.05).

\*\*A, B and C Means in each column, with same superscripts are not significantly different (P≤0.01).

**Table 3:** Effect of different treatments on carcass traits

Measurements Treatments		Carcass %	Giblets %	Abdominal fat %	Spleen %	Thymus %
Exp.1 Date Pollen Powder	T1 (Control)	65.7	4.03	2.41	0.19 <sup>B</sup>	0.04
	T2 (BHT)	65.9	5.03	3.60	0.21 <sup>B</sup>	0.08
	T3 (0.1%)	67.6	4.91	2.98	0.21 <sup>B</sup>	0.06
	T4 (0.3%)	66.6	4.60	3.4	0.25 <sup>A</sup>	0.09
	SE	1.15	0.34	0.56	0.01	0.02
	Sig.	NS	NS	NS	**	NS
Exp.2 Date Pollen Extract	T1 (Control)	65.7 <sup>B</sup>	4.03	2.41	0.19	0.04
	T2 (BHT)	65.9 <sup>B</sup>	5.03	3.60	0.21	0.08
	T3 (0.1%)	65.4 <sup>B</sup>	5.13	2.45	0.16	0.04
	T4 (0.3%)	73.1 <sup>A</sup>	4.02	2.79	0.22	0.08
	SE	0.87	0.43	0.50	0.02	0.01
	Sig.	**	NS	NS	NS	NS

\*\*A and B Means in each column, with same superscripts are not significantly different (P≤0.01).

**Table 4:** Effect of different treatments on yolk lipids

Measurements Treatments		Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	Triglycerides (mg/dl)
Exp.1 Date Pollen Powder	T1 (Control)	218.8 <sup>A</sup>	47.4 <sup>b</sup>	171.3 <sup>A</sup>	138.1 <sup>a</sup>
	T2 (BHT)	207.2 <sup>B</sup>	49.5 <sup>b</sup>	157.6 <sup>B</sup>	133.6 <sup>ab</sup>
	T3 (0.1%)	210.7 <sup>B</sup>	51.9 <sup>ab</sup>	158.8 <sup>B</sup>	135.6 <sup>ab</sup>
	T4 (0.3%)	201.5 <sup>C</sup>	55.3 <sup>a</sup>	146.2 <sup>C</sup>	129.9 <sup>b</sup>
	SE	1.45	1.59	2.27	1.68
	Sig.	**	*	**	*

Exp.2 Date Pollen Extract	T1 (Control)	218.8 <sup>A</sup>	47.4 <sup>b</sup>	171.3 <sup>A</sup>	138.1 <sup>a</sup>
	T2 (BHT)	207.2 <sup>B</sup>	49.5 <sup>b</sup>	157.6 <sup>B</sup>	133.6 <sup>ab</sup>
	T3 (0.1%)	196.7 <sup>C</sup>	57.2 <sup>A</sup>	139.5 <sup>C</sup>	132.4 <sup>B</sup>
	T4 (0.3%)	191.9 <sup>D</sup>	59.0 <sup>A</sup>	132.9 <sup>D</sup>	123.5 <sup>C</sup>
	SE	1.34	1.58	1.63	1.67
	Sig.	**	**	**	**

\*\*A and B Means in each column, with same superscripts are not significantly different (P≤0.01).

\*a and b: Means in each column, with same superscripts are not significantly different (P≤0.05).

### SAMPLING AND ANALYSIS

A total of 48 eggs were collected at 54 weeks of age (2 experiments×4 groups×3 replicates×2 eggs) to determine egg quality traits. After collecting the eggs, weighed and stored until recording its dimensions. Eggshell %, albumen %, and yolk % were calculated by dividing each items weight to egg weight. Yolk/albumen (Y/A) ratio, and Haugh unit was calculated according to Panda (1996); while egg shape index (ESI) was calculated by measuring egg length, and width using a caliper and used the following equation; ESI= width/length ×100 (Panda, 1996). By measuring up of Roche yolk color fan (Hoffman-La Roche Ltd., Basel, Switzerland), the color of egg yolk was evaluated. Yolk triglycerides, total cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) were calculated (ERBA CHEM-5, Beijing Biochemical Instrument Company, Beijing, China) according to the procedure of Folch et al. (1957) and updated by Washburn and Nix (1974).

By termination of this study, three hens per treatment were chosen based on average treatment weight to evaluate carcass characteristics. Including relative weights of carcass yield, giblets (liver, gizzard and heart), abdominal fat and some lymphoid organs (thymus and spleen) as percentages of live body weight. Two blood samples per replicate were withdrawn during slaughtering process in anti-glotinized tubes for measuring hemoglobin (Hb; g/dl), hematocrit (Ht; %), red blood cells (RBCs; 10<sup>6</sup> / mm<sup>3</sup>), and white blood cells (WBCs; 10<sup>3</sup>/μl). The following parameters were calculated:- Mean Corpuscular Volume (MCV) = Ht × 10/ RBC's (μm<sup>3</sup>), Mean Corpuscular Hemoglobin (MCH) = Hb × 10/ RBC's (Pg) and Mean Corpuscular Hemoglobin Concentration (MCHC = Hb×100/ Ht (g/dl) as documented by Clark et al. (2009).

### STATISTICAL ANALYSIS

Data collected were statistically analyzed by the analysis of variance with general linear model (GLM) procedure of SAS Institute (SAS, 2004) Significant differences among treatments were performed using Duncan's multiple range test Duncan (1955). The model used (for both experiments) was as follow:

$$Y_{ik} = \mu + T_i + e_{ik}$$

Where,  $Y_{ik}$  = An observation,  $\mu$  = Overall mean,  $T_i$  = Effect of treatments (i = 1, 2, 3 and 4 ),  $e_{ik}$  = random error

## RESULTS AND DISCUSSIONS

### HENS' PRODUCTIVE PERFORMANCE

Productive performance for Fayoumi laying hens fed different treatments is presented in Table 2. In the first experiment, hens fed the diet supplemented with 0.1% DPP recorded significantly higher egg production % by 5.5% and 2.83% compared to controls either negative (T1) or positive (T2), respectively. While the former group did not show a significant difference to those fed 0.3% DPP. On the other hand, none of the groups record variations in all parameters including egg weight, feed intake, or feed conversion ratio between all experimental groups.

In the second experiment, the treatments; T2, T3, and T4 showed significant elevation in egg production % than the negative control (T1). While, none of the treatments record any improvement in egg weight, feed intake, and FCR. The outcomes have the same opinion of Shanoon et al. (2015) who noted an improvement of egg production by feeding Lohman laying hens with 10g/kg Date Palm Pollen comparing to others fed a control diet. Also, Ibrahim et al. (2018) concluded that supplementing of 5 g Palm pollen /kg diet to laying quails, enhanced egg production compared with the control. In addition to Refaie et al. (2019) reported that feed intake of Fayoumi cocks did not affect significantly by adding DPP in both forms to their diets comparing to control or others fed basal diet + BHT. The same conclusion was reported by Batista et al., (2007) who concluded no effect on feed intake by supplementing broilers diet with flavonoids comparing to control. Recently, Saleh et al. (2021) documented that treated laying hen with 5g DPP/kg diet, the egg weight, egg mass and laying rate were significantly increased compared to those of the hens in the control group. These improvements of egg production and egg mass may be caused to increase in FSH and LH hormones (Walzem et al., 1999) regarding to elevation of estradiol and estrogen hormone in DPP (Arhaem, 2004). Moreover, the DPP diet has the ability to increase the growth of the ovary, oviduct, and those



functions and that caused in hen day production increasing. Also, [Mousa et al. \(2018\)](#) reported such improvement in egg production and in body weight as well, where they explained it as consequences to improve in liver function and morphological improvements in intestinal villi and the Payers patches.

### CARCASS CHARACTERISTICS

The results in [Table 3](#) show that only spleen percentage significantly improved in the T4 group (fed 0.3% DPP) in the first experiment also carcass % was significantly increased for group fed dietary 0.3% DPPE in the second experiment, while, the rest of the experimental carcass parameters did not influence by date pollen supplementation either at powder or extract form. This conclusion concur to [Saleh et al. \(2021\)](#) who realized that liver percentage of all groups either fed basal diet supplemented with DPP or un-supplemented group, did not changed. While the authors noted a significant increment in spleen weight and percentage for supplemented treatments rather than control. This observation could be explained by elevating effectiveness and function of spleen hence recover the number of white blood cells than those of control. This observation come to the same conclusion of [Nady et al. \(2014\)](#) who treated mice with 1mg DPP/kg body weight and observed a significant improvement in their spleen weight compared to the control. Moreover, the improvement in carcass% (Exp.2) could related to the enhancement in the nutrients uptake through the useful microbes in their gastrointestinal tract that grow under raising DPP level of flavonoids as reported by [Saleh et al. \(2021\)](#).

### EGG YOLK LIPIDS

As shown in [Table 4](#), it is noticeable that all yolk lipid values were significantly affected by dietary supplementation of date pollen either at powder form (Exp.1) or aqueous extract (Exp.2). Yolk total cholesterol values were gradually decreased by increasing DPP level (Exp.1) and DPPE (Exp.2). the improvement in T4 groups was 7.9 and 2.7% (Exp.1) and 12.3 and 7.4% (Exp.2) comparing to normal control (T1) and control positive (T2) respectively. The same trend was observed in LDL and triglycerides where the reduction in LDL for groups fed 0.3% either at powder or extract forms were 14.7 and 7.2% (Exp.1) while reached 22.4 and 15.7% (Exp.2) comparing to T1 and T2, respectively. Moreover, the decrease in yolk triglycerides values in hen fed diet supplemented with both forms of date pollen (powder and extract) at the level of 0.3% amounted 5.9 and 2.8% (Exp.1) and 10.5 and 7.5% (Exp.2) in comparison to control negative (T1) and positive (T2), respectively. On the other side, hens fed both levels of date pollen with both forms recorded higher yolk-HDL values rather than two controls used (normal and positive). Yolk cholesterol content appears to decrease after applying flavonoids in laying

hens, as a consequence of blocking cholesterol production enzymes (HMG-CoA reductase) as documented in earlier studies of [Lien et al. \(2008\)](#) and [Ting et al. \(2011\)](#). The improvement in yolk lipids due to treating laying hens with DPP may be reflection of the increase contents flavonoid in addition to volatile unsaturated fatty acid which act as antioxidants, have nutritional and physiological purpose hence support health status. The results are in line to [Refaie et al. \(2019\)](#) who documented a significant elevation in total antioxidant capacity in hens treated with 1% DPP and DPP extract by about 5.05% and 7.03%, respectively, rather than control. On the other hand, [Saleh et al. \(2021\)](#) did not record any significant differences between treated hens and control in blood total lipid.

### EGG QUALITY

[Table \(5\)](#) show that there were no significant differences between all groups in both experiments in yolk color and shell %. On the other hand, yolk % was affected significantly, where in Exp.1, hens fed control positive diet (T2) and others fed 0.3% DPP (T4) recorded high values without any significant differences with a group of T3 (fed 0.1% DPP) while control negative (T1) recorded the lowest value. However, in Exp.2 groups of T2 (control positive) and T3 (fed 0.1% DPPE) achieved significantly higher Yolk % rather than T1 (control negative) and T4 (fed 0.3% DPPE).

In respect of albumen %, there were no significant differences between all groups (Exp.1) while in the second experiment, groups of T4 and T1 recorded higher albumen % than groups of T2 and T3. In this regard, [Saleh et al. \(2021\)](#) concluded a significant improvement in albumen height and albumen% for hens fed diet enriched with various levels of DPP (1.25, 2.5, and 5 g/kg diet).

In the first experiment, all tested groups (T2, T3 and T4) recorded an increase in Yolk/Albumen ratio while control negative recorded the lowest value. But in the second experiment, groups of T2 and T3 achieved significantly higher yolk/albumin (Y/A) ratio than T1 and T4.

Hu unit in Exp.1 improved in two controls used (negative; T1 and positive; T2) while the lowest values were recorded for T3 and T4 groups. On the other hand, there was no significant improvement between all groups in Exp.2. According to the egg shape index (ESI), none of the experimental groups record any enhancement in ESI (Exp.1) whereas, T4 group achieved significantly the best ESI comparing to other treatments in Exp.2. The results disagree with the conclusion of [Shanoon et al. \(2015\)](#) who reported that there was no significant effect of adding DPP to laying hens in their egg quality except for shell weight and thickness.

**Table 5:** Effect of different treatments on egg quality.

Treatments	Measurements	Yolk color	Yolk %	Albumen %	Shell %	Y/A ratio	Hu unit	ESI
Exp.1 Date Pollen Powder	T1 (Control)	7.33	30.30 <sup>B</sup>	59.35	10.35	51.20 <sup>b</sup>	92.92 <sup>a</sup>	78.02
	T2 (BHT)	7.00	32.59 <sup>A</sup>	57.68	9.73	56.62 <sup>ab</sup>	90.69 <sup>ab</sup>	77.83
	T3 (0.1%)	7.11	32.24 <sup>AB</sup>	57.54	10.22	56.21 <sup>ab</sup>	86.13 <sup>b</sup>	77.63
	T4 (0.3%)	6.89	34.01 <sup>A</sup>	57.01	8.98	60.01 <sup>a</sup>	85.89 <sup>b</sup>	79.04
	SE	0.31	0.75	0.75	0.38	2.03	1.93	0.87
	Sig.	NS	**	NS	NS	*	*	NS
Exp.2 Date Pollen Extract	T1 (Control)	7.33	30.30 <sup>B</sup>	59.35 <sup>ab</sup>	10.35	51.20 <sup>B</sup>	92.92	78.02 <sup>b</sup>
	T2 (BHT)	7.00	32.59 <sup>A</sup>	57.68 <sup>b</sup>	9.73	56.62 <sup>A</sup>	90.69	77.83 <sup>b</sup>
	T3 (0.1%)	7.22	32.50 <sup>A</sup>	57.85 <sup>b</sup>	9.65	56.28 <sup>A</sup>	89.68	79.11 <sup>b</sup>
	T4 (0.3%)	7.78	29.86 <sup>B</sup>	60.62 <sup>a</sup>	9.52	49.42 <sup>B</sup>	92.11	85.76 <sup>a</sup>
	SE	0.36	0.56	0.70	0.39	1.52	2.01	2.02
	Sig.	NS	**	*	NS	**	NS	*

\*\*A and B Means in each column, with same superscripts are not significantly different (P≤0.01).

\*a and b: Means in each column, with same superscripts are not significantly different (P≤0.05).

BHT= Butylated hydroxytoluene; Y/A ratio= Yolk/albumin ratio; ESI= egg shape index.

**Table 6:** Effect of different treatments on hematological parameters.

Treatments	Measurements	WBC (×10 <sup>3</sup> / μl)	Hb (g/dl)	RBC's (10 <sup>6</sup> /mm <sup>3</sup> )	Ht (%)	MCV (μm <sup>3</sup> )	MCH (Pg)	MCHC (g/dl)
Exp.1 Date Pollen Powder	T1 (Control)	220.47 <sup>a</sup>	12.6 <sup>a</sup>	2.76 <sup>a</sup>	36.3 <sup>a</sup>	131.5	45.65	34.71 <sup>b</sup>
	T2 (BHT)	199.2 <sup>c</sup>	10.07 <sup>b</sup>	2.15 <sup>b</sup>	29.76 <sup>b</sup>	138.4	46.8	33.83 <sup>b</sup>
	T3 (0.1%)	202.70 <sup>bc</sup>	11.4 <sup>ab</sup>	2.42 <sup>ab</sup>	30.6 <sup>b</sup>	126.4	47.1	37.30 <sup>a</sup>
	T4 (0.3%)	213.60 <sup>ab</sup>	11.63 <sup>ab</sup>	2.54 <sup>ab</sup>	33.56 <sup>ab</sup>	132.1	45.7	34.60 <sup>b</sup>
	SE	3.59	0.52	0.13	1.3	6.3	1.35	0.46
	Sig.	*	*	*	*	NS	NS	*
Exp.2 Date Pollen Extract	T1 (Control)	220.47	12.6 <sup>A</sup>	2.76 <sup>A</sup>	36.3 <sup>A</sup>	131.5	45.65	34.71
	T2 (BHT)	199.2	10.07 <sup>B</sup>	2.15 <sup>B</sup>	29.76 <sup>B</sup>	138.4	46.8	33.83
	T3 (0.1%)	219.1	12.5 <sup>A</sup>	2.73 <sup>A</sup>	34.87 <sup>A</sup>	127.7	45.78	35.84
	T4 (0.3%)	223.1	13.57 <sup>A</sup>	2.96 <sup>A</sup>	38.57 <sup>A</sup>	130.3	45.84	35.18
	SE	5.99	0.47	0.10	1.26	5.5	1.23	0.60
	Sig.	NS	**	**	**	NS	NS	NS

\*\*A and B Means in each column, with same superscripts are not significantly different (P≤0.01).

\* a and b: Means in each column, with same superscripts are not significantly different (P≤0.05).

BHT: Butylated hydroxytoluene; Ht= hematocrit; Mean Corpuscular Volume (MCV) = Ht × 10/ RBC's (μm<sup>3</sup>); Mean Corpuscular Hemoglobin (MCH)=Hb × 10/ RBC's (Pg); Mean Corpuscular Hemoglobin Concentration (MCHC) = Hb×100/ Ht (g/dl)

**HEMATOLOGICAL PARAMETERS**

Results in Table (6) show that negative control recorded the highest WBC count followed by T4, T3 and finally T2 (Exp.1) while in Exp.2, there are no significant differences in WBC count between all tested groups. According to Hb values, negative control (T1) recorded the highest value without significant differences to T3 and T4 groups but with significant variations to T2 (Exp.1). Whereas, all groups recorded significantly higher Hb values than T2 (Exp.2). The same trend was observed in RBC count ei-

ther in Exp.1 or Exp.2. Results declare that Ht values were increased in the negative control (T1) without significant differences to T4 group and with significant variations to T2 and T3 (Exp.1). Also, T1, T3, and T4 groups recorded significantly higher Ht value than positive control; T2 (Exp.2). All groups in both experiments did not show any improvement in MCV and MCH values. On the other hand, MCHC values were significantly enhanced in T3 comparing to T1, T2, and T4 (Exp.1). However, in the second experiment, all groups did not gain any improve-

ment in MCHC values. In this work, hemoglobin was significantly raised in birds fed diets added with DPP; the enhancement due adding DPP could protect RBC membrane from attacking by free radicals also, improving iron absorption in gastrointestinal tract as reported by Saleh et al. (2021). Furthermore, the same authors explained the improvement in WBCs count, in hens enriched by DPP may increase their contents of minerals; also antioxidant properties in flavonoids and vitamins (B1, B2, B12), so augment the immune status in treated hens. In this respect, Abuoghaba et al. (2018) illustrated that hemoglobin level was significantly higher in the chicks supplied with bee pollen compared with untreated ones.

## CONCLUSION

From the obtained results it could be concluded that the supplementation of date palm pollen in either powder or extract forms enhances laying hens performance, and egg quality traits. Moreover, date palm pollen supplementation has no any adverse effects in laying hens as evidenced by hematological parameters.

## CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

## AUTHORS CONTRIBUTION

All authors contributed equally according to their tasks and approved the final manuscript.

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