EFFECT OF DIETARY PROPOLIS SUPPLEMENTATION ON PERFORMANCE AND ACTIVITY OF ANTIOXIDANT ENZYMES IN BROILER CHICKENS

A.E. Abou-Zeid[1]; S.Z. El-Damarawy[1]; Y.A. Mariey[2] and S.M. El-Kasass[1]

[1]Animal Production Department, Faculty of Agriculture, Tanta University, Egypt.

[2]Animal Production Research Center, Egypt.

SUMMARY

A trial was carried out to determine the effects of diet supplementation with propolis on performance and activity of antioxidant enzymes in broiler chickens. Two hundred and forty one-day-old unsexed Cobb broilers chicks were randomly distributed into four equal experimental groups; with three replicates of 20 chicks each. Chicks were fed different levels of propolis including 0, 125, 250, and 500 mg/kg diet for 6 weeks. The mean weight gain, feed consumption and feed conversion ratio were recorded weekly. Carcass traits and hematological parameters were determined at the end of the experiment. Also, plasma malondialdehyde (MDA) level, superoxide dismutase (SOD), glutathione peroxidase (GSH) and catalase (CAT) activities were determined. The results showed that, Using of propolis at 125 mg/kg in the diet lead to significant increase (P<0.001) in body weight (2866.67g); final weight gain (2825.67g) and improve feed conversion ratio (1.62). Relative organs weight, dressing and carcass percentage were improved in the supplementation groups. In addition, propolis supplementation showed significant improvement in the WBCs, RBCs, Hb, PCV and MCHC. Also, the results showed that the administration of propolis causes significant (P<0.01) decrease of malondialdehyde (MDA) level and significant (P<0.001) increase of antioxidant system as superoxide dismutase (SOD) activity, CAT and glutathione peroxidase (GSH) levels in blood. Supplementation of natural antioxidant (propolis) facilitates reduction of the negative effects on performance and enhanced the antioxidant system which resulted in decreased mortality as compared to the control. Economic efficiency of groups fed supplemented diet with propolis had improved significantly compared to control.

Keywords: *Broilers, propolis and performance traits.*

INTRODUCON

In the past, sub-therapeutic doses of antibiotics have been used to improve the growth performance, animal health, and control pathogens. However, the potential negative effects of antibiotics such as antibiotic resistance and residues problems caused the European Community to place a general ban of the use of antibiotics as a growth promoter (AGP) in animal production since January 2006. (Attia *et al.,* 2011a; Attia *et al.,* 2013).

Recently, natural materials have been investigated in order to prove its effectiveness as a growth promoter such as Propolis. It is a resinous substance collected by worker bees (*Apis mellifera*) from the bark of trees and leaves of plants (Nada *et al.,* 2011).

Several researchers (Sforcin, 2007; Galal *et al.,* 2008; Attia *et al.,* 2011b, c and Popiela-Pleban *et al.,* 2012) demonstrated that Propolis could be used as growth promoter and immune enhancers as an alternative to antibiotics. In addition, Propolis has been suggested as a suitable health supplement for consumers in developed countries (Bankova, 2005). Also, the oxidative stress that can be caused by environmental factors, disease, infection, inflammation, aging, reactive oxygen species (ROS) production include free radicals and other oxygenated molecules resulting from these factors may be minimized by antioxidant defense mechanisms that protect the cell against cellular oxidants and repair systems that prevent the accumulation of oxidatively damaged molecules.

Furthermore, polyphenols as a component of Propolis are potent antioxidants; they are able to scavenge free radicals, prevent blood clotting and protect veins, lowering levels of harmful estrogen also, epidemiological studies have found associations between lower incidence of heart disease, cancer,

gastrointestinal and neurological diseases, liver diseases, atherosclerosis, obesity and allergies (Lotito and Frei, 2006).

Consequently, the aim of this study is to investigate the effect of propolis supplementation in the diets on performance and physiological status of broiler chicks.

MATERIALS AND METHODS

The present study was carried out at a private poultry farm under supervision of Animal Production Department, Faculty of Agriculture, Tanta University, during the period from August to November 2014. This study was including; the first one was laboratory work that includes the preparation of propolis alcoholic extract by using ethanol alcohol 96%.The second was a field study that investigates the effect of feeding diets with 0, 125, 250, 500 mg ethanolic extracts of propolis (EEP) /kg diet on broiler Performance, physiological status and economic efficiency.

Preparation of ethanolic extracts of propolis (EEP):

Propolis samples were purchased from Elzahaby phytopharm,in powder form. 35gm of propolis powder were mixed with 70 ml of 96% ethanol alcohol and left for 14 days, in a dark cool place (not in refrigerator) and was shaken also 3 times per day. After two weeks the solution was filtered; the liquid portion was stored in a dark green bottle in a cool, dry and dark place. The ethanolic extract solution was then filtered through a Whattman No.1 filter paper and restored to the original volume with 96% ethanol (Khojasteh and Shivazad, 2006), then different concentrations of EEP were prepared at a rate of 125, 250 and 500 mg and stored in a dark green bottle in a cool, dry and dark place.

Experimental design:

Two hundred and forty one-day-old unsexed Cobb broilers chicks were used in this experiment. They were randomly distributed into four equal experimental groups; with three replicates of 20 chicks each. The average initial body weights of the treatments groups were nearly similar with no observed significant differences. Chicks were grown in floor pens and subjected to 23 hrs lighting along the experimental period which extended to 6 weeks of age. The house temperature was kept at about 34ºC during the first 3 days, 32ºC during next 4 days and thereafter, gradually decreased by 3ºC weekly down to 24ºC. Pellets feed form and water were available *ad libitum* throughout the experimental period. All experimental groups were reared under similar managerial and hygienic conditions.

Experimental diets:

The basal diet was a commercial corn-soybean meal diet formulated to meet or exceed the nutritional requirement of growing chicks as recommended by NRC (1994) as shown in Table 1.

Dietary treatments evaluated included:

Control (Basal diet without any addition), T1 (Basal diet supplemented with 125 mg/kg EEP), T2 (Basal diet supplemented with 250 mg/kg EEP) and T3 (Basal diet supplemented with 500 mg/kg EEP).

Measurements:

Body weight, weight gain, feed consumption, feed conversion ratio and mortality rate were recorded individually throughout the experimental period from 1 week until 6 weeks of age. At 6 weeks of age, nine birds from each group were randomly selected for slaughter test, fasted for twelve hrs., weighted, slaughtered by slitting the jugular vein of the birds in the morning, then after slaughter and complete bleeding scalded and defeathered. Carcasses were eviscerated manually and weighed. Burse, thymus, spleen, liver, heart, kidney and gizzard separately weighed. All organs weights were expressed as percentage of body weight.

Hematological examination includes WBCs, RBCs, HGB, HCT, MCV, MCH and MCHC was determined by using HBVET-1 automated hematology analyzer.

For estimating the antioxidants, 9 blood samples frpm each treatment were taken into tubes containing anticoagulant (2% sodium oxalate).The samples were centrifuged at 200 g for 5 min at +4 °C; then the plasma was removed immediately and stored at -20 °C until analyzed. Plasma biochemical indicators were measured using an auto analyzer (Olympus AU600, Japan). The plasma were Left at room temperaturefor 15 min to determine malondialdehyde (MDA), reduced glutathione (GSH-Px) concentrations, CAT and superoxide dismutase (SOD) activities(Pınar *et al.*, 2009).

Economic efficiency:

Economic efficiency was calculated from the following equation:
Economic efficiency (%) = Net revenue (LE)/ Total feed cost (LE) × 100

Where:

Net revenue = Price of weight gain (LE) – Total feed cost (LE)
Price of weight gain (LE) = Body weight gain/bird × price/kg of live body weight (LE).
Total feed cost (LE) = feed consumption (kg)/bird × price/kg feed.

Statistical analysis:

Tests of significance for differences among treatments were done according to Duncan (1955). The statistical model was used for the analysis of variance to estimate the Data were statistically analyzed by one-way ANOVA, using the general linear model procedure (SAS, 1996). Effect of dietary propolis supplementation as follows:

$Y_{ijk} = U + T_i + R_j + e_{ijk}$

Where,

Y_{ijk} is the observations; U is overall mean; T_i is effect of i the treatment (i = 0, 1, 2 and 3); R_j is effect of j the replicate (j = 1, 2 and3) and e_{ijk} is residual (random error).

RESULTS AND DISCUSSION

Broiler performance and feed efficiency:

Effect of propolis supplemented diet on the body weight, weight gain, feed intake, feed conversion ratio and mortality are presented in table 2. The addition of propolis at 125 mg/kg diet significantly improved performance traits of broiler chicks when compared to control group.

Results showed that, chickens fed propolis supplemented diets had significant ($p< 0.001$) higher body weight (group I 2866.67g > group II 2683.33g > group III 2676.67g) when compared to control group (2650g). These results revealed the growth promoting effect of propolis.

In addition, chickens fed propolis supplemented diets (125 mg/kg) improved weight gain by 8.3% when compared to control group but, there wasn't significant difference between control group and the supplemented diets with propolis (250, 500 mg/kg diet).

These results are in the same direction with Zeng *et al.* (2004) who noted that, the body weights of broilers given a combination of flower pollen and propolis at a 2.5:1 ratio were increased by 10%, in comparison with the control group. Also quails that received propolis at 0.5 to 1.5 g kg–1 feed had significantly higher body weights than those fed a non-supplemented diet (Denli *et al.*, 2005).

Futhermore, results indicated that, there were significant differences in mortality rate between groups fed supplemented diet with propolis (0%) when compared with that fed control diet (5%). This finding was due to the antiviral activity of propolis. This activity is attributed to the flavone and flavonoid constituents of propolis as induced by Serkedjieva *et al.* (1997) in influenza virus, Abd El Hady & Hegazi (2002) in NDV and Machado *et al.* (1991) in various animal viruses.

Also, the results were in agreement with the findings of (Shalmany and Shivazad, 2006; Seven *et al.*, 2008; Seven *et al.*, 2011 and Hassan and Abdulla, 2011) which indicate that the significantly increase in body weight gain with the supplementation of propolis. It could be inferred that the antimicrobial activity of the components of the propolis extract, resulted in better intestinal health and improved digestion and absorption (Denli *et al.*, 2005).

Carcass traits:

The results of carcass traits and relative organs weight are shown in Table 3. The supplementation of 125 mg propolis/kg diet reduced significantly ($p<0.001$) the relative weight of thymus and bursa by 36.6 and 30.4 % respectively, when compared to control. The relative weight of spleen, kidney and gizzard showed that, no significant differences between all treatments.

On the other hand, the inclusion of 500 mg pro /kg diet decreased significantly ($p<0.01$) the relative weight of liver while, the group fed supplemented diet with 125mg pro./kg has significantly ($p<0.05$) the lowest heart weight. The relative total giblets weight of chickens fed 125 mg propolis / kg diet were increased insignificant by 5.6% when compared to control. However, the relative total giblets weight of

chickens fed 250 mg propolis / kg diet were increased significantly ($p<0.01$) by 12.3% when compared to control.

The dressing and carcass percentages were affected significantly ($p<0.001$) by propolis supplementation, where all supplemented diets with propolis improved % dressing by 8.1, 4.7 and 6.2 % respectively, when compared to control. Also, the carcass percentage where improved in groups fed supplemented diets with 125, 250 and 500 mg/kg diet by 8.3, 4.2 and 6.6 % respectively, when compared to control.

These results are in agreement with the findings of Sahin *et al*. (2003), Seven *et al*. (2008), Abdullah *et al*. (2009), and Hassan and Abdullah (2011) they found that the propolis supplementation on bird's diet had significant effects on carcass weight at 42 days of age due to the increase in bird weight.

Also, Denli *et al*. (2005) reported that, carcass weight was significantly ($p<0.01$) higher in quail fed diet with propolis and flavomycin. In addition, at the end of the study, the group receiving 0.5, 1 and 1.5 g/kg propolis in the diets showed lower liver weights than control and flavomycin groups. However, no differences were noted in gizzard.

Blood hematological parameters:

The hematological parameters of broilers chicks affected by propolis are tabulated in Table 4. The hematological parameters of broilers chicks fed diet supplemented with propolis were significantly affected. The chicks were supplied with propolis in diet with showed significant improvement in the WBCs, RBCs, Hb, PCV, MCHC and PLT. While, there were insignificant changes in MCV and MCH when compared to these fed control diet.

These results are in the same trend with those reported by Attia *et al*., (2014) who reported that the bee pallon (BP) and Pro. , alone or in combination, increased ($P<0.05$) the RBC count compared with the control treatment when administered continuous. The increase in RBC, hemoglobin, and PCV may indicate the enhanced effect on health status of broilers, which could be attributed to increasing nutrient utilization, particularly iron. Furthermore, Propolis can improve the utilization of iron and, consequently, the regeneration of hemoglobin (Bratter *et al.,* 1999; Haro *et al.,* 2000).

Antioxidant enzymes:

Plasma SOD activity was significantly increased in the propolis groups (67.52, 137.68 and 248.83) compared to control group (59.55). Propolis supplementation in the diets with 125, 250 and 500 mg/kg increased significantly ($p<0.001$) the activity of CAT in blood plasma by 20.5, 22.1 and 34.7 respectively, when compared to control. It was determined that the plasma GSH activity of the control group (1.49 n.mol/ml) was significantly ($p<0.001$) lower than the treatment 3 (3.11 n.mol/ml). On the other hand, propolis supplementation in the diets with 125, 250 and 500 mg/kg decreased significantly ($p<0.01$) the activity of MDA in blood plasma by 39.5, 54.3 and 68.6 % respectively, when compared to control (table 5).

It may be considered that dietary propolis doses decreased lipid peroxidationradical generation. The rise of lipid peroxidation increases the MDA level in blood and tissues (Okutan *et al.,* 2005; Ates *et al.,* 2006).

Antioxidant enzyme activities such as SOD and CAT in lipid peroxidation may sometimes decrease (Wohaieb and Godin, 1987; Ozkaya *et al.,* 2002) or increase (Huang *et al.,* 1999; Aliciguzel *et al.,* 2003). In the present study, the increase of antioxidant enzyme activities such as SOD, CAT and GSH may be considered as a protective mechanism against induced free radical production and lipid peroxidation.

Antioxidant enzymes such as catalase (CAT), superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and malondialdehyde (MDA) play a vital role in protecting cellular damage from harmful effects of ROS (Altan *et al.,* 2003). So, the propolis supplementation decreased the rate of mortality.

Economic efficiency:

Results of economic efficiency of broilers fed the experimental diets are summarized in Table 6. Broilers fed 125mg propolis /kg diet has the higher net revenue (13.27%).The lowest value of net revenue was noticed in broilers fed supplemented diet with 500mg/kg propolis (10.37%).

CONCLUSIONS

In conclusion, this study demonstrated that propolis supplementation particularly at 125 mg/kg feed, increased the growth performance and improved feed conversion ratio. Moreover, the daily administration of propolis extract to chickens changed the antioxidants enzymes levels as well as stimulated the immune system which resulted in decreased mortality as compared to the control chicks.

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Table (1). Composition and calculated analysis of experimental starter, grower and finisher diets.

Ingredients	Experimental diets		
	Starter	Grower	Finisher
Yellow corn	48.61	54.78	57.95
Soybean meal (44%)	36.4	32.5	28
Corn gluten meal (62%)	5	3.4	5
Soybean oil	5.8	5.7	5.55
Dl-Methionine	0.21	0.23	0.19
Limestone	1.1	1.1	1.1
Dicalcium phosphate	1.9	1.5	1.4
Salt	0.24	0.29	0.25
Premix**	0.30	0.30	0.3
Sodium bicarbonate	0.3	0.1	0.15
L. Lysine	0.14	0.1	0.11
Total	100.00	100.00	100.00
Calculated analysis			
Crude protein (%)	23.01	20.05	19.03
ME (Kcal/Kg)	3150	3200	3250
Ether extract (%)	2.40	2.50	2.66
Crude fiber (%)	3.50	3.50	3.30
Calcium (%)	1.03	0.90	0.86
Available phosphorus (%)	0.45	0.35	0.39
Methionine (%)	0.5	0.43	0.399
Lysine (%)	1.11	1.00	0.90

** *Each 3kg of premix contained: Vit. A 12000IU, Vit.D 2200IU, Vit.E 10mg, Vit.K_3 2000mg, Vit.B_1 1000mg, Vit. B_2 5000mg, Vit. B_6 1500mg, Vit. B_{12} 10mg, Pantothenic acid 10mg, Niacin 30mg, Folic acid 1000mg, Biotin 50mg, Choline chloride 300mg, Manganese 60mg, Zinc 50mg, Copper 10mg, Iron 30mg, Iodine 1000mg, Selenium 100mg, Cobalt 100mg and $CaCo_3$ to 3g.*

Table (2). Effect of dietary propolis supplementation on performance traits of broiler at 6 weeks of age.

Treatments	Parameters					
	Initial BW (g)	Final BW (g)	Weight gain (g)	Feed intake (g)	FCR	Mortality rate (%)
T0 control	41±0.58	2650±28.87^{b}	2609±29.16^{b}	4665.72±31.76^{a}	1.79±0.01^{b}	5
T1(125mg propolis/kg diet)	41±0.58	2866.67±17.64^{a}	2825.67±18.02^{a}	4573.22±33.33^{ab}	1.62±0.01^{a}	-
T2(250mg propolis/kg diet)	41±0.58	2683.33±33.33^{b}	2642.33±33.83^{b}	4488.82±36.11^{b}	1.7±0.03^{ab}	-
T3(500mg propolis/kg diet)	41±0.0	2676.67±53.64^{b}	2635.67±53.64^{b}	4535.67±58.99^{ab}	1.72±0.05^{ab}	-
Significance	NS	***	**	*	*	--

-Means of each column followed by the same letter are not significantly different at the 5% level according to Duncan, s Multiple Range Test.

-NS indicate not significant. - indicate P<0.05 -** indicate P<0.01 -*** indicate P<0.001*

Table (3). Effect of Diet Propolis Supplementation on carcass trails (Mean±SE) of broiler chickens at 6 week of age of broiler.

Treatments	Thymus (% LBW)	Bursa (% LBW)	Spleen (% LBW)	Liver (% LBW)	Kidney (% LBW)	Gizzard (% LBW)	Heart (% LBW)	Giblets (% LBW)	Dressing (%)	Carcass (%)
T0	0.30±0.03^{a}	0.23±0.02^{a}	0.15±0.03	2.44±0.10^{ab}	0.45±0.02	1.32±0.06	0.59±0.03^{ab}	4.80±0.06^{b}	73.29±1.06^{b}	68.48±1.05^{b}
T1	0.19±0.03^{b}	0.16±0.01^{b}	0.15±0.03	2.75±0.13^{a}	0.48±0.04	1.35±0.05	0.49±0.03^{b}	5.07±0.16^{ab}	79.25±0.16^{a}	74.17±0.25^{a}
T2	0.28±0.04^{ab}	0.16±0.01^{b}	0.12±0.01	2.76±0.13^{a}	0.53±0.04	1.48±0.08	0.62±0.04^{a}	5.39±0.12^{a}	76.72±1.15^{a}	71.33±1.17^{ab}
T3	0.25±0.04^{ab}	0.15±0.02^{b}	0.17±0.04	2.25±0.1^{b}	0.56±0.05	1.49±0.05	0.57±0.03^{ab}	4.87±0.18^{b}	77.85±1.55^{a}	72.99±1.63^{a}
significance	*	**	NS	**	NS	NS	*	**	***	***

Table (4). Effect of Dietary Propolis Supplementation on hematological parameters (Mean±SE) of broiler chickens at 6 weeks of age.

Treatments	Hematological profile						
	RBCs $\times 10^{6}$/µl	Hb g/ µl	PCV %	MCV fl	MCH pg	MCHC %	WBCs $\times 10^{3}$/µl
T0	2.84±0.13^{b}	16.95±0.45^{b}	47±1.95^{b}	88.83±1.98	44.00±0.76	40.17±0.60^{b}	14.08±0.27^{b}
T1	3.42±0.14^{a}	18.92±0.34^{a}	51.08±2.05^{ab}	87.0±0.89	43.33±0.40	43.50±1.12^{ab}	15.09±0.26^{a}
T2	3.47±0.15^{a}	18.27±0.51^{a}	55.25±1.45^{a}	89.25±0.77	98.92±60.02	42.92±0.97^{ab}	15.45±0.22^{a}
T3	3.70±0.11^{a}	18.27±0.35^{a}	54.65±1.51^{a}	88.92±1.12	36.83±0.65	44.17±1.62^{a}	15.52±0.12^{a}
significance	***	*	**	NS	NS	*	***

-Means of each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

-NS indicate not significant - indicate P<0.05 -** indicate P<0.01 -*** indicate P<0.001*

-T0=Control (C) Basel diet, T1= (125 mg pro/kg), T2= (250 mg pro/kg), T3= (500 mg pro/kg).

Table (5). Effect of Dietary Propolis Supplementation (Mean±SE) on antioxidant enzymes activity of broiler chickens.

Treatments	SOD(u/ml)	GSH-px (n.mol)	MDA(n.mol/l)	CAT (u.mol/l)
T0 control	59.55±2.12^{b}	1.49±0.07^{c}	4.2±0.85^{a}	65.07±3.37^{c}
T1	67.52±15.51^{b}	2.21±0.1^{b}	2.54±0.29^{b}	81.9±1.72^{b}
T2	137.68±26.85^{b}	2.07±0.05^{b}	1.92±0.32^{b}	83.57±7.09^{b}
T3	248.83±56.86^{a}	3.11±0.01^{a}	1.32±0.05^{b}	99.67±4.32^{a}
significance	**	***	**	***

-Means of each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.
*-** indicate P<0.01*
*-*** indicate P<0.001*
-T0=Control (C) Basel diet, T1= (125 mg pro/kg), T2= (250 mg pro/kg), T3= (500 mg pro/kg).

Table (6). Effect of dietary propolis supplementation on economic efficiency of broiler.

Parameter	control	T1	T2	T3
1-Price of feed (LE/kg diet)	4.25	4.31	4.37	4.5
2-Average feed consumption (kg/bird)	4.665	4.573	4.488	4.535
3-Total feed cost (Pt)[1]	19.83	19.69	19.61	20.40
4-Average body weight (kg)	2.65	2.866	2.683	2.676
5- Price of body weight (LE)[2]	30.48	32.96	30.85	30.77
6-Net revenue (Pt) [3]	10.65	13.27	11.23	10.37
7-Economic efficiency [4]	53.71	67.39	57.30	50.83
8- Relative economic efficiency%	100	125.47	106.68	94.63

[1] Feed cost = Feed consumption (kg) / bird during experimental period × price of kg feed.
[2] Price of weight gain = Body weight / bird × price of kg of live body gain which was 11.50 LE at experimental trial
[3] Net revenue = Difference between price of body weight and feed cost.
[4] Economic efficiency = (Net revenue / feed cost) × 100.

تاثير إضافة البروبوليس فى العلائق على الأداء الانتاجى والنشاط الإنزيمى فى دجاج اللحم.

عادل السيد أبوزيد[1] ، سعد زغلول الدمراوي[1]، يحيى عزيز مرعى[2] و صلاح محمد القصاص[1]

[1]قسم الإنتاج الحيواني – كلية الزراعة – جامعة طنطا – مصر.

[2]محطة بحوث الانتاج الحيوانى - مصر.

أجريت هذه الدراسة لتحديد تاثير إضافة البروبوليس فى العلائق على الأداء الانتاجى والنشاط الانزيمى فى دجاج اللحم. تم توزيع 240 كتكوت من سلالة الكوب عمر يوم واحد في أربع معاملات قسمت داخليا إلي 4 مكررات كل واحدة منها تضم 20 كتكوت. وتضم المستويات المختلفة من البروبوليس (0، 125، 250، و 500 ملجم / كجم عليقة) لمدة 6 أسابيع. وكانت أهم النتائج المتحصل عليها هي حدوث زيادة معنوية في وزن الجسم الحي ومعدل الزيادة في الوزن والكفاءة الغذائية التحويلية للطيور المغذاه علي علائق تحتوى على البروبوليس مقارنة بالطيور المغذاه علي عليقة الكنترول (بدون اضافات). كذلك عدم حدوث نفوق الا فى المجموعة المغذاه علي عليقة الكنترول مقارنة بباقي المجاميع. أما بالنسبة لخصائص الذبيحة والوزن النسبي للاعضاء الداخلية فقد كان هناك فروق عالية المعنوية بين المجموعه المغذاه علي عليقة الكنترول وبين باقي المجموعات في الوزن النسبي للأجزاء المأكولة ونسبة التصافى التى بلغت 79.25% فى المجموعه الأولى ونسبة الذبيحة التى بلغت 74.17% . بالنظر للصفات الهيماتولوجية للدم فقد وجد فروق معنوية لمعظم الصفات بين المعاملات المختلفة تمثلت في زيادة عدد كرات الدم الحمراء وخلايا الدم البيضاء والهيموجلوبين للطيور المغذاه علي العلائق المضاف إليها الى البروبوليس مقارنة بالكنترول. وأيضا أدت إضافة البروبوليس الى انخفاض معنوى فى محتوى الدم من MDA مع زيادة نشاط كل من انزيمات CAT, GSH, SOD فى الدم. تحسنت الاستجابة المناعية والحد من الاثار السلبية على صحة الطيور وبالتالى عدم ظهور حالات نفوق . ومن هنا نوصى باستخدام البروبوليس بمعدل 125 ملجم /كجم فى علائق الدواجن.