Journal of Animal and Poultry Production

Journal homepage: www.japp.mans.edu.eg
Available online at: www. jappmu.journals.ekb.eg

Effect of Dietary Proanthocyanidin Supplementation on Productive Performance and Carcass Quality of Local Domyati Ducklings

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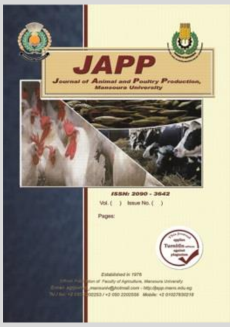

ABSTRACT

The objective of the present study was to evaluate the effect of dietary Anta®Ox FlavoSyn (as a wide source of natural Proanthocyanidins) on growth performance, carcass characteristics, blood constituents, and economic efficiency of local Domyati ducklings for 7 weeks. A total of 240 ducklings (8 weeks of age) was distributed into 4 groups with 6 equal replicates (10 ducklings/each replicate). The first group was fed the control basal diet (BD, 0.0 mg Anta®Ox FlavoSyn/kg diet) while, others fed 100, 150 and 200 mg Anta®Ox FlavoSyn/kg diet. The obtained results illustrated that ducklings fed 100 and 150 mg Anta®Ox FlavoSyn/kg diet displayed significantly ($P \leq 0.05$) higher body weight gain, and performance index, lower feed consumption, and better feed conversion ratio than those fed the high level 200 mg/kg diet or those fed free-Anta®Ox FlavoSyn BD (control group) at different experimental periods. Ducklings fed different levels of Anta®Ox FlavoSyn had significantly improved carcass traits, hematological, and serum biochemical parameters, total antioxidant capacity, and economic efficiency compared to the control group. Consequently, it could be concluded that the usefulness of Anta®Ox FlavoSyn as a promising feed additive for enhancing the productive performance, health status, physiological responses of Domyati ducklings. Owing to its low price and the high natural antioxidant properties of the tested material can be used economically in diets of growing local Domyati ducklings, especially at levels of 100 and 150 mg/kg diet.

Keywords: Ducklings, Anta®Ox, Grape seed, Green tea, Feed additive, Productivity.

INTRODUCTION

In Egypt, poultry sector is one of the main sources of animal protein supply (Abdel Gaied and Bakri, 2009). Duck production is a feature of the poultry industry, which is very popular in many areas of the world. Duck production represent the 2nd largest poultry species in Africa after chicken, as well as pure Egyptian breeds and local developed strains that have been raised for both meat and egg production (Taha *et al*., 2013). Ducks are used for meat production to meet the growing demand for animal protein, where duck meat is highly appreciated as it combines the characteristics of the red meat and the dietetic characteristics of poultry meat (Witak, 2008). One of the most important aspects of consumer's choice of meat is the benefit to health. Duck is an alternative to the widespread use of chicken and turkey. Fat content of intramuscular in the breast muscles of ducks is higher than that of chicken and turkey meat (Juodka *et al*., 2016).

Plant flavonoids are unique phytochemicals with a wide range of therapeutic activities. It has been reported that the intake of plant-derived flavonoid quercetin shows anti-lipase activity (Gatto *et al*., 2002), while in another study quercetin together with resveratrol inhibited the formation of fat cells (Yang *et al*., 2008). Several experimental studies in animals have shown that the consumption of blueberries or their content of bioactive polyphenol offers various health benefits, including the improvement of cognitive function (Joseph *et al*., 1999) and the antioxidant effect (Youdim *et al*., 2000), protection against inflammation and modulation of obesity and obesity (Lau *et al*., 2007). Likewise, Jung *et al*. (2011) have shown that the use of natural antioxidants like polyphenols or flavonoids of animal origin improves food quality in terms of their oxidation stability. In a recent study also, Kang *et al*. (2015) suggested that polyphenols and flavonoids increase obesity activity by modifying the expression of genes involved in lipid accumulation.

Proanthocyanidins are a class of phenolics which are in the form of oligomers or polymers such as (+) - catechin and (-) - epicatechin (Porter, 1993). Weber *et al*. (2007) reported that grape seed extract (GSE) is rich in polyphenolic compounds, especially proanthocyanidins. In this respect, Dorri *et al*. (2012) reported that GSE is a rich source of other polyphenolic compounds such as flavonoids, monomeric phenolic compounds, catechins and epicatechin. Grape polyphenols could act as powerful antioxidants by trapping free radicals (FR) and inactivating oxidative reactions (Brenes *et al*., 2016), and it has been shown that their antioxidant potentials is 4 to 5-fold higher than those of vitamins C or E. They were reported as very potent metal chelating agents (Shi *et al*., 2003), and to have anti-hyperlipidemic (Moreno *et al*., 2003) and anti-bacterial activities (Mayer *et al*., 2008). GSE analysis was as follows; catechin 1420, epicatechin 1080, procyanidine

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DOI: 10.21608/jappmu.2019.53643

B1 830, procyanidine B2 770 and procyanidine C 530 mg/100 g DM, respectively (Hajati *et al*., 2014).

According to the study by Wang *et al*. (2008), grape seed proanthocyanidins extract (GSPE) incorporated in the diet at 5, 10, 20, 40, and 80 mg/kg significantly decreased mortality and increased body weight gain of broiler chickens after the *Eimeria tenella* infection, and the protective effect of GSPE was dose-dependent and effective in reducing serum cholesterol level and improving meat quality parameters. They also stated that graded levels of grape seed (GS) (10, 20 and 40 g/kg diet) in broiler diets improved gut microflora and growth performance. In addition, the polyphenolic content of GS had antioxidant activity that conferred positive health benefits on broiler chickens (Abu-Hafsa and Ibrahim, 2018). GSE can be used as an effective natural antioxidant and immunostimulant agent in broiler diets, and that 125 to 250 ppm can be considered as the optimum dosage to enhance the antioxidant status, immune response and meat quality (Farahat *et al*., 2017). The increased antioxidant activity in green tea extract (GTE) and GSE may be due to higher levels of epicatechin and caffeic acid in GTE and epicatechin and catechin in GSE (Rababah *et al*., 2004). Green tea polyphenols have powerful antioxidant (Sahin *et al*., 2010), antiviral (Friedman, 2007) and anticoccidial properties (Jang *et al*., 2007). In addition, they can reduce cholesterol levels in meat and plasma (Yang *et al*., 2003; Singh *et al*., 2009a) and decrease the level of lipid peroxide (malondialdehyde) in plasma and meat tissues (Yang *et al*., 2003; Sahin *et al*., 2010) and improvement of growth performance and meat quality of broilers (Erener *et al*., 2011; Shahid *et al*., 2013). Therefore, the objective of the present study was to evaluate the effect of dietary Anta®Ox FlavoSyn (which contains grape pomace and green tea extract (GPGT), as a source of natural proanthocyanidins) on growth performance, carcass characteristics, blood constituents, and economic efficiency of local Domyati ducklings for 7 weeks.

MATERIALS AND METHODS

Birds and management:

The present study was conducted in El–Serw WaterFowl Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. A total of 240 local Domyati ducklings, 8 weeks of age was used. They were weighed and distributed into 4 treatments with 6 replicates (10 ducklings/replicate). Ducklings were fed a common starter diet from 1-8 weeks old and reared under similar hygienic, environmental and managerial conditions. Feed and fresh water were available all the time. The experimental basal diets (BDs, starter and finisher) were prepared and the finisher diet was supplemented with graded levels 0.0, 100, 150 and 200 mg/kg diet of commercial Anta®Ox FlavoSyn (which contains GPGT as a source of proanthocyanidins) and fed to ducklings from 8 until 14 weeks of age. Anta®Ox FlavoSyn (Phytogenic feed additives) was produced by Dr. Eckel (D-56649 Niederzissen 56651, Germany). Anta®Ox FlavoSyn is a high potential complex formula from grape, and green tea. It is consisting of Grape pomace (57.5%) (flavonoids from grape pomace extract 70,000 ppm), Grape seeds (20.0%) (flavonoids from grape seeds 20,000 ppm), natural plant extract (17.5%) (flavonoids from green tea 1000 ppm, and flavor from rosemary 2000 ppm), and calcium silicate (5%). The composition and calculated analysis of the experimental BDs are shown in Table 1.

Table 1. Composition and calculated analysis of the experimental basal diets

Ingredients (%)	Starter (1-8 weeks)	Finisher (8-14 weeks)
Yellow corn	61.70	70.70
Soybean meal (44%, CP)	34.55	25.50
Dicalcium phosphate	1.60	1.62
Limestone	1.45	1.48
Vit. & Min. premix [1]	0.30	0.30
NaCl	0.30	0.30
DL. Methionine	0.10	0.10
Total	100.0	100
Calculated Analysis (NRC, 1994)		
Crude protein (%)	20.01	16.72
Metabolizable energy (ME, kcal / kg)	2841	2941
Ether extract (%)	2.86	3.07
Crude fiber (%)	3.94	3.07
Calcium (%)	1.04	1.03
Av. phosphorus (%)	0.44	0.43
Lysine (%)	1.17	0.92
Methionine (%)	0.45	0.40
Methionine + Cystine (%)	0.78	0.69
Sodium (%)	0.13	0.13

[1]Each 3 kg of the Vit. and Min. premix manufactured by Agri-Vit Company, Egypt contains: Vitamin A 10 MIU, Vit. D 2 MIU, Vit E 10 g, Vit. K 2 g, Thiamin 1 g, Riboflavin 5 g, Pyridoxine 1.5 g, Niacin 30 g, Vit. B12 10 mg, Pantothenic acid 10 g, Folic acid 1.5 g, Biotin 50 mg, Choline chloride 250 g, Manganese 60 g, Zinc 50 g, Iron 30 g, Copper 10 g, Iodine 1g, Selenium 0. 10 g, Cobalt 0.10 g. and carrier CaCO3 to 3000 g.

Growth performance parameters:

Live body weight (BW) of ducklings in each replication was recorded at 8, 10, 12 and 14 weeks of age. Feed consumption (FC) and mortality were also recorded. Body weight gain (BWG), FC and feed conversion ratio (FCR) were calculated on a replicate group basis through the periods from 8–10, 10–12, 12–14, and 8–14 weeks of age. Performance index (PI) was also calculated for each period as live BW (kg) / FCR × 100 (North, 1981).

Slaughter traits:

At the end of the study (14 weeks), four ducklings (n = 4) from each treatment were individually weighed and slaughtered after 12 hours fastening period and re-weighted after complete bleeding. Then, scalding, feather picking, and evisceration were performed, and different body parts, organs and abdominal fat were dissected and weighed. Relative weights of carcass traits were expressed as a percentage of live BW.

Hematological and serum biochemical parameters:

During slaughter, the whole blood samples were collected in vial tubes containing EDTA as an anticoagulant, from six ducklings (three males and three females, n = 6) per each treatment to determine total red blood cells (RBCs), hemoglobin (Hb), packed cell volume (PCV) and total white blood cells (WBCs) count as outlined by the standard avian guidelines introduced by Ritchie *et al*. (1994). Total WBCs were determined by the Unopett method (Campbell, 1995). Heterophils (H) and lymphocytes (L) were counted in different microscopic fields in a total of 200 WBCs, and the H: L ratio was calculated (Gross and Siegel, 1986). Other un-EDTA treated blood samples also were individually collected in centrifugation tubes from four ducklings per each treatment (n = 4) to get the serum samples. The samples were centrifuged at 3500 rpm for 15 minutes to separate clear sera. After that, serum total protein, albumin, globulin, total cholesterol, triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL), and antioxidant activity were determined by using commercial kits produced by Bio diagnostic Company, Egypt.

Economic efficiency parameters:

Economic efficiency of feeding (EEF, %) was computed based on BWG of ducklings and their feed intake and calculated using the following equation;

EEF (%) = (Net return by Egyptian pound (EGP) / Total feed cost EGP) × 100.

Statistical analysis:

The obtained data was statistically analyzed using General Linear Model (GLM) procedure described in SAS users guide (SAS, 2006). Differences among mean were tested for the significance ($P \leq 0.05$) using Duncan's multiple range test (Duncan, 1955) and one–way analysis of variance. The following statistical model was used;

$$Yij = \mu + Ti + eij$$

whereas,

Yij = an observation, μ = overall mean, Ti = Effect of treatment (1, 2, 3, and 4) and eij = Random error.

RESULTS AND DISCUSSION

Productive performance:

The average of live BW and BWG of ducklings throughout the whole experimental periods are presented in Table 2. Addition of Anta®Ox FlavoSyn (as a source of proanthocyanidins) to diets of local Domyati ducklings had no significant effect on BW at the whole experimental periods. While, their BWG was significantly ($P \leq 0.05$) increased by feeding 100 mg Anta®Ox FlavoSyn/kg diet compared to the control group during the period of 8-10 weeks of age. Also, ducklings fed 150 mg Anta®Ox FlavoSyn/kg diet exhibited significantly ($P \leq 0.05$) higher BWG than those fed 100 and 200 mg Anta®Ox FlavoSyn/kg diet during the period of 10-12 weeks of age. During the overall period (8-14 weeks of age) ducklings fed 100 mg Anta®Ox FlavoSyn/kg diet display significantly ($P \leq 0.05$) higher BWG than those of the control group and the group fed 200 mg Anta®Ox FlavoSyn/kg diet.

Table 2. Effect of dietary Anta®Ox FlavoSyn supplementation on growth performance traits of local Domyati ducklings during the experimental period from 8 to 14 weeks of age

Items	Dietary treatments (mg Anta®Ox FlavoSyn/kg diet)				± SEM
	0.0 (control)	100	150	200	
Live body weight (BW, g):					
8 weeks	1263.00	1263.00	1266.00	1267.00	36.59
10 weeks	1593.00	1672.00	1629.00	1641.00	29.81
12 weeks	1836.00	1898.00	1894.00	1857.00	29.30
14 weeks	1944.00	2007.00	1996.00	1954.00	36.22
Body weight gain (g):					
8-10 weeks	330.00^{b}	409.00^{a}	363.00^{ab}	374.00^{ab}	16.10
10-12 weeks	243.00^{ab}	227.00^{b}	265.00^{a}	216.00^{b}	11.61
12-14 weeks	107.00	108.00	102.00	98.00	5.83
8-14 weeks	686.00^{c}	744.00^{a}	730.00^{ab}	688.00^{bc}	15.5
Feed consumption (g):					
8-10 weeks	1461.00	1451.00	1459.00	1464.00	13.32
10-12 weeks	1532.00^{a}	1352.00^{b}	1392.00^{b}	1354.00^{b}	22.97
12-14 weeks	1601.00^{a}	1412.00^{c}	1444.00^{bc}	1461.00^{b}	12.20
8-14 weeks	4594.00^{a}	4214.00^{b}	4294.00^{b}	4279.00^{b}	30.93
Feed conversion ratio (FCR, g feed/g gain):					
8-10 weeks	4.49^{a}	3.56^{b}	4.09^{ab}	3.93^{ab}	0.19
10-12 weeks	6.46^{a}	6.00^{ab}	5.31^{b}	6.29^{a}	0.29
12-14 weeks	15.26	13.38	14.14	14.99	0.66
8-14 weeks	6.77^{a}	5.67^{c}	5.92^{bc}	$6.2\,3^{b}$	0.14
Performance index (BW, kg / FCR × 100):					
8-10 weeks	36.30^{b}	47.12^{a}	40.62^{b}	41.88^{ab}	1.95
10-12 weeks	29.11^{b}	31.94^{ab}	36.14^{a}	29.57^{b}	1.71
12-14 weeks	13.08	15.32	14.15	13.08	0.83
8-14 weeks	28.08^{c}	35.45^{a}	34.03^{ab}	31.40^{bc}	1.14
Viability (%):					
8-14 weeks	85	95	100	100	0.00

a,b,c: Mean in the same row with different superscripts are significantly different (P<0.05)

The average FC of Domyati ducklings during all experimental periods was significantly ($P \leq 0.05$) higher in the control group than those of the other treatments (Table 2). The reduction in FC of ducklings fed different levels of Anta®Ox FlavoSyn, could be attributed to its better and astringent taste, which in many cases reduced palatability and consequently led to a reduction in FC. The present findings showed that FCR was ($P \leq 0.05$) improved in the group of ducklings fed 100 mg Anta®Ox FlavoSyn/kg diet compared to the control group during the period of 8-10 weeks of age. But ducklings fed 150 mg Anta®Ox FlavoSyn/kg diet during the period of 10-12 weeks of age displayed significantly ($P \leq 0.05$) better FCR than those received 200 mg Anta®Ox FlavoSyn/kg diet and the control group. While, all levels of tested Anta®Ox FlavoSyn significantly improved FCR ($P \leq 0.05$) as compared to the control group during the overall period of 8-14 weeks of age, where the best level was 100 followed by 150 and 200 mg Anta®Ox FlavoSyn/kg diet (Table 2).

Ducklings fed 100 mg Anta®Ox FlavoSyn/kg diet realized the best ($P \leq 0.05$) PI value as compared to those fed 150 mg Anta®Ox FlavoSyn/kg diet and the control group during the period of 8-10 weeks of age (Table 2). While, during the period of 10-12 weeks of age ducklings fed 150 mg Anta®Ox FlavoSyn /kg diet achieved ($P \leq 0.05$) higher PI value compared to those given 200 mg Anta®Ox FlavoSyn/kg diet and the control group. During the overall period (8-14 weeks of age) the best PI was obtained by ducklings given 100 followed by 150 and 200 mg Anta®Ox FlavoSyn/kg diet as compared to the control group (Table 2). No mortality was detected in ducklings fed 150 and 200 mg Anta®Ox FlavoSyn/kg diet, while, 9 deaths were recorded in the control group during the overall period (8-14 weeks) in addition to 3 cases for those fed 100 mg Anta®Ox FlavoSyn/kg diet.

Regarding the current improvement of the productive performance, which was observed by feeding ducklings on 100 or 150 mg Anta®Ox FlavoSyn/kg diet may be due to several mechanisms reported by many authors. For examples, Lau *et al.* (2007) suggested that consumption of polyphenols may offer numerous health profits such as protection against inflammation. Additionally, polyphenols reduce oxidative stress by preventing or reducing the progress of FR and increasing antioxidant capacity in adipose tissue (Jung *et al*., 2011), as well as by stimulating β oxidation of fatty acids and improving lipolysis (Lasa *et al*., 2012).

In this respect, Hajati *et al.* (2014) indicated that adding 200 mg GSE/kg diet increased BW of broilers before and after exposure to heat stress. Also, incorporation of GSPE in the diet at 5, 10, 20, 40 and 80 mg/kg diet significantly increased BWG of broiler chickens after the *E. tenella* infection (Wang *et al.,* 2008). More recently, Beshara *et al*. (2019) explained that inclusion of 150 mg GPGT extract/kg diet can be used to maximize the productive performance and economic efficiency of Sinai hen's (47 - 62 weeks of age). On the contrary, Hughes *et al*. (2005) reported that BW decreased when broilers fed GSE. While, Farahat *et al*. (2017) found no significant differences were observed in the growth performance and percent livability of broiler chickens when they used GSE at levels of 125, 250, 500, 1000 and 2000 mg/kg diet as compared to the control group. In the respect of GTE, the results are consistent by Erener *et al*. (2011) and Shahid *et al.* (2013), who showed a positive effect on the growth performance of broiler chickens fed 200 mg GTE/kg diet. While, Khalaji *et al*. (2011) did not observe any significant improvement in growth performance of broilers fed 300 mg GTE/kg diet as compared to GTE-untreated group.

Carcass characteristics:

Data in Table 3 summarized the impact of different levels of Anta®Ox FlavoSyn on carcass traits at 14 weeks of age for Domyati ducklings (expressed as percentages of live BW). It was observed that the percentages of carcass yield, breast and gizzard were not significantly ($P \geq 0.05$) affected by either dietary levels of the tested material as compared to the control. While, ducklings fed 200 mg Anta®Ox FlavoSyn/kg diet exhibited significantly ($P \leq 0.05$) higher thigh and heart (%), than those of the control or birds fed 150 mg Anta®Ox FlavoSyn/kg diet. The birds fed 200 mg Anta®Ox FlavoSyn/kg diet and fed the free-Anta®Ox FlavoSyn BD displayed significantly ($P \leq 0.05$) higher percentages of abdominal fat than those received 100 and 150 mg Anta®Ox FlavoSyn/kg diet. On the other hand, significantly higher ($P \leq 0.05$) percentages of spleen and liver were observed when ducklings were administrated 100 mg Anta®Ox FlavoSyn/kg diet than those of birds given 150 and 200 mg/kg diet. The highest relative weight of pancreas was observed in ducklings received 100 mg Anta®Ox FlavoSyn/kg diet compared to those given 200 mg Anta®Ox FlavoSyn/kg diet. Also, significantly higher ($P \leq 0.05$) percentage of total edible parts was detected for ducklings given 100 mg Anta®Ox FlavoSyn than those received 150 mg Anta®Ox FlavoSyn/kg diet (Table 3).

Table 3. Effect of dietary Anta®Ox FlavoSyn supplementation on some carcass characteristics of local Domyati ducklings

Items	Dietary treatments (mg Anta®Ox FlavoSyn/kg diet)				± SEM
	0.0 (Control)	100	150	200	
Carcass characteristics (%), relative to live BW:					
Carcass yield	68.46	69.93	67.42	68.95	0.83
Breast	40.00	42.69	43.34	42.07	1.44
Thigh	22.53^{b}	23.57^{ab}	22.79^{b}	25.14^{a}	0.61
Gizzard	2.725	2.957	2.617	2.795	0.17
Liver	2.481^{ab}	2.937^{a}	1.94^{c}	2.203^{bc}	0.17
Abdominal fat	0.531^{a}	0.431^{b}	0.340^{b}	0.550^{a}	0.07
Heart	0.71^{b}	0.73^{ab}	0.77^{ab}	0.83^{a}	0.03
Spleen	0.064^{ab}	0.066^{a}	0.052^{c}	0.057^{bc}	0.005
Pancreas	0.305^{ab}	0.365^{a}	0.270^{ab}	0.220^{b}	0.036
Total edible parts*	74.36^{ab}	76.55^{a}	72.73^{b}	74.78^{ab}	0.81

a,b,c: Mean in the same row with different superscripts are significantly different (P<0.05). * Total edible parts = dressing + gizzard + liver + heart.

Hematological and biochemical parameters:

The hematological findings presented in Table 4 indicated that RBCs counts of ducklings received 150 and 200 mg Anta®Ox FlavoSyn/kg diet was significantly ($P \leq 0.05$) higher than birds given 100 mg/kg diet. The birds fed 200 mg Anta®Ox FlavoSyn/kg diet recorded significantly higher Hb (g/dL) than those given 100 mg Anta®Ox FlavoSyn/kg diet. The control ducklings exhibited significantly higher values of PCV than those birds fed 200 mg Anta®Ox FlavoSyn/kg diet. While, ducklings fed dietary levels of 100 and 200 mg Anta®Ox FlavoSyn/kg diet displayed significantly ($P \leq 0.05$) higher total WBCs count than the control group or those fed 150 mg Anta®Ox FlavoSyn/kg diet. The percentage of lymphocyte (L) cells was significantly ($P \leq 0.05$) increased by addition of 150 mg Anta®Ox FlavoSyn/kg diet and of the control group as compared to those given 100 and 200 mg Anta®Ox FlavoSyn/kg. On the other hand, the birds fed 100 mg Anta®Ox FlavoSyn/kg diet recorded significantly ($P \leq 0.05$) higher eosinophil percent than other treatments.

However, all levels of the tested Anta®Ox FlavoSyn led to significantly ($P \leq 0.05$) reduction in monocytes percent as compared to the control treatment. The heterphil/ lymphocyte ratio was significantly ($P \leq 0.05$) higher when birds received 100 and 200 mg Anta®Ox FlavoSyn/kg diet than those of the control group and 150 mg Anta®Ox FlavoSyn/kg diet.

Table 4. Effect of dietary Anta®Ox FlavoSyn supplementation on hematological traits of local Domyati ducklings

Items	Dietary treatments (mg Anta®Ox FlavoSyn/kg diet)				± SEM
	0.0 (Control)	100	150	200	
RBCs ($\times 10^6$/mm^3)	3.16^{ab}	3.04^{b}	3.30^{a}	3.30^{a}	0.06
Hb (g/dL)	15.10^{ab}	14.80^{b}	15.33^{ab}	15.57^{a}	0.21
PCV (%)	49.33^{a}	46.67^{ab}	48.00^{ab}	45.67^{b}	1.04
WBCs ($\times 10^3$/mm^3)	30.33^{b}	34.33^{a}	29.33^{b}	34.00^{a}	0.82
Heterophils (%)	29.40	29.67	30.10	34.20	1.76
Lymphocytes (%)	51.00^{a}	37.67^{c}	48.67^{a}	43.33^{b}	1.02
Eosinophils (%)	1.00^{b}	2.00^{a}	1.00^{b}	1.00^{b}	0.26
Monocytes (%)	9.00^{a}	7.00^{b}	5.30^{b}	6.00^{b}	0.60
H / L ratio	0.58^{b}	0.79^{a}	0.64^{b}	0.78^{a}	0.38

a,b,c Mean in the same row with different superscripts are significantly different (P<0.05).

RBCs= Red blood cells; Hb= hemoglobin; PCV= packed cell volume; WBCs= White blood cells; H/L ratio = Heterophil / Lymphocyte ratio.

Data in Table 5 demonstrate that Domyati ducklings fed different levels of Anta®Ox FlavoSyn significantly ($P \leq 0.05$) increased serum total protein as compared to the control group. Feeding diets containing 150 and 200 mg Anta®Ox FlavoSyn/kg diet resulted in a significant increase of serum albumin level as compared to the control and 100 mg Anta®Ox FlavoSyn treatments. But ducklings supplemented with 100 mg Anta®Ox FlavoSyn/kg diet achieved the best value of globulin than other treatments. However, the lowest value of total cholesterol was recorded by ducklings fed 100 mg Anta®Ox FlavoSyn/kg diet as compared to those fed 150 and 200 mg Anta®Ox FlavoSyn/kg. Significantly higher values of HDL were recorded when ducklings were treated with all levels of tested dietary Anta®Ox FlavoSyn as compared to the untreated group. Moreover, dietary supplementation of 100 and 150 mg Anta®Ox FlavoSyn/kg caused a decrease of serum LDL as compared to the control group and those received 200 mg Anta®Ox FlavoSyn/kg diet. The highest mean of serum triglycerides was recorded for ducklings fed untreated-BD as compared to the other treatments. Birds fed different levels of Anta®Ox FlavoSyn led to significantly ($P \leq 0.05$) increases of serum total antioxidant capacity compared to the control group.

Generally, the improvement in hematological traits due to the tested Anta®Ox FlavoSyn closely agrees with the results of Farahat *et al*. (2016) who reported that GTE was effective as antioxidant and immune stimulant for broilers when supplemented to their diets, and its optimum inclusion level ranged from 125 to 500 mg/kg diet. These results may be attributed to GS which represent as a rich source of flavonoids, monomeric phenolic compounds, epicatechins and catechins (Dorri *et al*., 2012). Additionally, Meydani and Hasan (2010) illuminated that catechins in GT are responsible for its anti-obesity effects, as well as the grape polyphenols could act as powerful antioxidants by eliminating FR and dismissing oxidative reactions (Brenes *et al*., 2016), where antioxidant activity of phenolic acids depends on the number of hydroxyl group in the molecules (Rababah *et al.*, 2004). The present findings are also inagreement with those attained by Goni *et al*. (2007) and Brenes *et al*. (2008) who suggested that GSE improved antioxidant status and immunity of birds as compared to the control group and vit. E diets. Also, Farahat *et al*. (2017) found that GSE can be used as an effective natural antioxidant and immune stimulating agent in broiler diets from 125 to 250 mg/kg diet. Recently, Ebrahimzadeh *et al*. (2018) reported that dietary addition of grape pomace could increase the antioxidant and immune responses parameters of treated broilers.

Table 5. Effect of dietary Anta®Ox FlavoSyn supplementation on serum constituents of local Domyati ducklings

Items	Dietary treatments (mg Anta®Ox FlavoSyn/kg diet)				± SEM
	0.0 (Control)	100	150	200	
Total protein (g/dL)	4.219^{ab}	5.075^{a}	4.865^{a}	4.940^{a}	0.09
Albumin (g/dL)	2.236^{b}	2.148^{ab}	2.556^{a}	2.510^{a}	0.063
Globulins (g/dL)	1.983^{b}	2.927^{a}	2.309^{b}	2.431^{b}	0.139
A/G ratio	1.147^{a}	0.746^{b}	1.107^{a}	1.035^{a}	0.07
Total cholesterol (mg/dL)	210.45^{ab}	192.81^{b}	223.53^{a}	233.98^{a}	8.68
Triglycerides (mg/dL)	114.96^{a}	76.64^{c}	73.49^{c}	99.21^{b}	5.31
HDL (mg/dL)	31.92^{c}	55.67^{b}	79.42^{a}	59.85^{b}	2.50
LDL (mg/dL)	178.53^{a}	137.140^{b}	144.109^{b}	174.137^{a}	9.08
Total antioxidant capacity (mmol/L)	0.189^{c}	0.527^{a}	0.402^{b}	0.425^{b}	0.009

a,b,c Mean in the same row with different superscripts are significantly different (P<0.05). A/G ratio = Albumin/Globulin ratio; HDL= High density lipoprotein; LDL= low density lipoprotein.

Regarding the blood biochemical parameters, Hajati *et al.* (2014) indicated that addition of 450 mg GSE/kg to broiler diet decreased total cholesterols, triglycerides, LDL and vLDL. In contrast, Farahat *et al.* (2017) observed no significant differences in the total lipid, HDL and vLDL, when broilers were supplemented with GSE or butylated hydroxytoluene (BHT) as compared to the control group. Also, they reported that total cholesterol and LDL were significantly decreased after broilers intake of dietary GSE compared to BHT. Similarly, El-Damrawy (2014) reported a significant decrease in the serum LDL due to supplementation of heat-stressed broilers by GSE at levels of 100 and 200 mg/kg diet. Tannins and polyphenols can bind cholesterol and increase their excretion in the excreta (Roy and Schneeman, 1981). Chamrorro *et al.* (2013) did not observe significant differences in the serum triglycerides and total cholesterol levels in 3 weeks old broilers due to dietary inclusion of GSE at levels ranged from 25 to 5000 mg/kg diet. In addition, Yoshino *et al.* (1994) confirmed that hypocholesterolimic and hypolipidemic properties due to dietary addition of GT polyphenols, either via reduced absorption of dietary and biliary cholesterol and increased fecal excretion (Koo and Noh, 2007) and/or inhibition of cholesterol synthesis in the liver through inactivation of 3-hydroxy-3-methylglutaryl coenzyme A reductase and activation of adenosine monophosphate kinase (Singh *et al*., 2009a). On the other hand, Khalaji *et al*. (2011) and El-Deek *et al*. (2012) did not observe any significant effect on the serum lipid profile due to inclusion of 300 mg/kg diet of GTE or up to 3000 mg/kg of GT powder, respectively. Regarding to antioxidant capacity, the antioxidant properties of GT are attributed to its polyphenol content, which scavenge FR and subsequently stabilize cell wall, protect cell molecules and delay or inhibit the onset of lipid peroxidation (Sahin *et al*., 2010). The antioxidant capacity of GT was reported to be much higher than that of α-tocopherol and ascorbic acid (Vastag, 1998).

Economic efficiency of feeding (EFF):

In the respect of EEF of duckling's production, results in the current study illustrate that EEF for ducklings fed diet supplemented with different levels of Anta®Ox FlavoSyn was improved compared with those fed the control diet (Table 6). Whereas, EEF was 13.6% for the control group and it was 13.56% of ducklings fed 200 mg Anta®Ox FlavoSyn /kg diet. Meanwhile, the best EEF was 29.37%, and 22.30% for ducklings received diet supplemented with 100 and 150 mg Anta®Ox FlavoSyn /kg diet, respectively. The superiority of these levels (100 and 150 mg/kg diet) of dietary Anta®Ox FlavoSyn for achieving the best EEF of ducklings may be seriously related to their positive effects on productivity measurements (Table 2), carcass traits (Table 3), physiological and antioxidant responses (Tables 4 and 5) compared to the control group or those received 200 mg Anta®Ox FlavoSyn/kg diet. Duck production plays a great role in the agricultural economy of many African countries, like Egypt. To increase the revenue from rearing of ducks, producers can modulate the management of ducks (Mohammed *et al*., 2014). Feed is one of the most important factors to consider in any farming venture, where it is alone constituent around 70% of total production cost (Singh *et al*., 2009b). Thus, in commercial duck production using of feed supplementation can be avoided and subsequently reduction of feeding cost (Adzitey and Adzitey, 2011).

Table 6. Effect of dietary Anta®Ox FlavoSyn supplementation on economic efficiency of local Domyati ducklings

Dietary treatments (mg Anta®Ox FlavoSyn / kg diet)	Total feed consumed/ duck (kg)	Feed cost/ kg (EGP)[1]	Total feed consumed cost/ duck (EGP)	Weight gain/ duck (kg)	Price of one kg (EGP)	Total return (EGP)	Net return (EGP)	EEF (%)[2]
0.0 (Control)	4.59	5.26	24.16	0.686	40	27.45	3.29	13.60
100	4.21	5.46	23.01	0.744	40	29.77	6.76	29.37
150	4.29	5.56	23.88	0.730	40	29.20	5.32	22.30
200	4.28	5.66	24.22	0.688	40	27.50	3.28	13.56

[1] EGP= Egyptian pound; [2] EEF (%) = Economic efficiency of feeding.

CONCLUSION

In conclusion, tested dietary Anta®Ox FlavoSyn (as a wide source of proanthocyanidins) at levels of 100, and 150 mg/kg diet could be safely used in ducklings' diets at these levels according to their roles as potentially growth promoter, antioxidants, immunostimulatory, and physiologically enhancer agents, besides the economically improving for rearing local Domyati ducks. Further studies are seriously needed of this hopeful feed additive (Anta®Ox FlavoSyn) not only in ducks, but also in different experimental or farm animals regarding its properties for enhancing their productivity, health status, management conditions in the farms, which consequently led to improve meat quality, maximizing the profitability and receiving the safety food for human consumption.

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تأثير إضافة البروانثوسيانيدين للعليقة على الأداء الإنتاجي وجودة الذبيحة للبط الدمياطي المحلي

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تهدف الدراسة الحالية إلى تقييم تأثير الإضافة الغذائية لـ Anta®Ox FlavoSyn (كمصدر واسع للبروانثوسيانيدات الطبيعية) على أداء النمو، وخصائص الذبائح ومكونات الدم والكفاءة الاقتصادية للبط الدمياطى المحلي لمدة 7 أسابيع. تم توزيع مجموعه 240 بطة 8 أسابيع من العمر في 4 مجموعات مع 6 مكررات (10 بطة/كل مكرره). تم تغذية المجموعة الأولى على العليقة الأساسية (0.0 ملجم Anta®Ox FlavoSyn/كجم علف)، بينما غذيت المجموعات الأخرى بـ 100، 150 و200 ملجم Anta®Ox FlavoSyn/كجم علف. أظهرت النتائج التي تم الحصول عليها أن البط الذي غذى بـ 100 و150 ملجم Anta®Ox FlavoSyn/كجم علف أدى إلى زيادة معنوية ($P \leq 0.05$) فى وزن الجسم، دليل الأداء، انخفاض استهلاك الأعلاف، وتحسين معدل تحويل الأعلاف مقارنة مع تلك التي تغذت على المستوى المرتفع 200 ملجم/كجم علف أو تلك التي تغذت على العليقة الأساسية الخالية من Anta®Ox FlavoSyn (المجموعة الضابطة) في فترات تجريبية مختلفة. البط الذي غذى بمستويات مختلفة من Anta®Ox FlavoSyn حسّن بشكل كبير من قياسات الذبيحة، والدم، والكيمياء الحيوية للسيرم، ومضادات الأكسدة الكلية مقارنة بالمجموعة الضابطة. وبالتالي يمكن أن نخلص إلى أهمية Anta®Ox FlavoSyn كإضافة غذائية واعدة لتعزيز الأداء الإنتاجي، الحالة الصحية، والاستجابات الفسيولوجية. نظرًا للسعر المنخفض والخصائص المضادة للأكسدة الطبيعية العالية للمادة المختبرة، يمكن استخدامها اقتصاديًا في علائق البط الدمياطي المحلي النامي، خاصة في المستويات 100 و150 ملجم/كجم علف.