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

Riry F. Shata; M. M. Beshara; Kout Elkloub M. El. Moustafa and Mona A. Ragab

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 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 ≤ 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 therapeutics 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 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 diet in broiler diets improved gut microflora and growth performance. In addition, the polyphenolic content of GSPE 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 (Rahabah 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 Domiyati 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 Domiyati 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**

<table>
<thead>
<tr>
<th>Ingredients (%)</th>
<th>Starter (1-8 weeks)</th>
<th>Finisher (8-14 weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow corn</td>
<td>61.70</td>
<td>70.70</td>
</tr>
<tr>
<td>Soybean meal (44%, CP)</td>
<td>34.55</td>
<td>25.50</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.60</td>
<td>1.62</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.45</td>
<td>1.48</td>
</tr>
<tr>
<td>Vit. &amp; Min. premix</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>NaCl</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>DL. Methionine</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Calculated Analysis (NRC, 1994)

<table>
<thead>
<tr>
<th>Ingredient (%)</th>
<th>Starter (ME, kcal/kg)</th>
<th>Finisher (ME, kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>20.01</td>
<td>16.72</td>
</tr>
<tr>
<td>Metabolizable energy</td>
<td>2841</td>
<td>2941</td>
</tr>
<tr>
<td>Ether extract</td>
<td>2.86</td>
<td>3.07</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>3.94</td>
<td>3.07</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.04</td>
<td>1.03</td>
</tr>
<tr>
<td>Av. phosphorus (%)</td>
<td>0.44</td>
<td>0.43</td>
</tr>
<tr>
<td>Lysine (%)</td>
<td>1.17</td>
<td>0.92</td>
</tr>
<tr>
<td>Methionine (%)</td>
<td>0.45</td>
<td>0.40</td>
</tr>
<tr>
<td>Methionine + Cystine (%)</td>
<td>0.78</td>
<td>0.69</td>
</tr>
<tr>
<td>Sodium (%)</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

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 ng, Choline chloride 250 g, Manganese 60 g, Zine 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 x 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
Viability (%): 12 10 8

Feed intake (g):

14 weeks 12 weeks 10 weeks 8 weeks

12 10 8 6

Body weight gain (g):

14 weeks 12 weeks 10 weeks 8 weeks

12 10 8 6

Items

Dietary treatments (mg Anta®Ox FlavoSyn/kg diet)

0.0 (control) 100 150 200

± SEM

Live body weight (BW, g):

8 weeks 10 weeks 12 weeks 14 weeks

1263.00 1593.00 1836.00 1944.00

1263.00 1672.00 1898.00 2007.00

1266.00 1629.00 1894.00 1996.00

1267.00 1641.00 1857.00 1954.00

Body weight gain (g):

8-10 weeks 10-12 weeks 12-14 weeks 8-14 weeks

330.00b 243.00ab 107.00 686.00c

409.00a 227.00b 108.00 744.00a

363.00ab 265.00a 102.00 730.00ab

374.00ab 216.00b 98.00 688.00bc

Feed consumption (g):

8-10 weeks 10-12 weeks 12-14 weeks 8-14 weeks

1461.00 1532.00a 1601.00a 4594.00a

1451.00 1352.00b 1412.00c 4214.00b

1450.00 1392.00b 1444.00bc 4294.00b

1464.00 1354.00b 1461.00b 4279.00b

Feed conversion ratio (FCR, g feed/g gain):

8-10 weeks 10-12 weeks 12-14 weeks 8-14 weeks

4.49a 6.46a 15.26 6.77a

3.56b 6.00ab 13.38 5.67c

4.09ab 5.31b 14.14 5.92bc

3.93ab 6.29b 14.99 6.23b

Performance index (BW, kg / FCR × 100):

8-10 weeks 10-12 weeks 12-14 weeks 8-14 weeks

36.30b 29.11b 13.08 28.08b

47.12a 31.94ab 15.32 35.45a

40.62b 36.14a 14.15 34.03ab

41.88ab 29.57b 13.08 31.40bc

Viability (%):

8-14 weeks

85 95 100 100

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 ≤ 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 ≤ 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 ≤ 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 ≤ 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 ≤ 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 ≤ 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 example, Lau et al. (2007) suggested that consumption of polyphenols may offer numerous health benefits 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 GPGL 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 ≥ 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 ≤ 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 free-Anta®Ox FlavoSyn BD displayed significantly (P ≤ 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 ≤ 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 ≤ 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

<table>
<thead>
<tr>
<th>Items</th>
<th>Dietary treatments (mg Anta®Ox FlavoSyn/kg diet)</th>
<th>0.0 (Control)</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass characteristics (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breast</td>
<td></td>
<td>68.46</td>
<td>69.93</td>
<td>67.42</td>
<td>68.95</td>
<td>0.83</td>
</tr>
<tr>
<td>Thigh</td>
<td></td>
<td>40.00</td>
<td>42.69</td>
<td>43.34</td>
<td>42.07</td>
<td>1.44</td>
</tr>
<tr>
<td>Gizzard</td>
<td></td>
<td>22.53</td>
<td>23.57</td>
<td>23.79</td>
<td>25.14</td>
<td>0.61</td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td>2.725</td>
<td>2.957</td>
<td>2.617</td>
<td>2.795</td>
<td>0.17</td>
</tr>
<tr>
<td>Abdominal fat</td>
<td></td>
<td>2.481</td>
<td>2.937</td>
<td>1.941</td>
<td>2.203</td>
<td>0.17</td>
</tr>
<tr>
<td>Heart</td>
<td></td>
<td>0.531</td>
<td>0.431</td>
<td>0.340</td>
<td>0.550</td>
<td>0.07</td>
</tr>
<tr>
<td>Spleen</td>
<td></td>
<td>0.71</td>
<td>0.73</td>
<td>0.77</td>
<td>0.83</td>
<td>0.03</td>
</tr>
<tr>
<td>Pancreas</td>
<td></td>
<td>0.064</td>
<td>0.066</td>
<td>0.052</td>
<td>0.083</td>
<td>0.03</td>
</tr>
<tr>
<td>Total edible parts</td>
<td></td>
<td>0.305</td>
<td>0.365</td>
<td>0.365</td>
<td>0.220</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*</td>
<td>74.36</td>
<td>76.55</td>
<td>72.73</td>
<td>74.78</td>
</tr>
</tbody>
</table>

Table: 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 ≤ 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 ≤ 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 ≤ 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 ≤ 0.05) higher eosinophil percent than other treatments. However, all levels of the tested Anta® Ox FlavoSyn led to significantly (P ≤ 0.05) reduction in monocytes percent as compared to the control treatment. The heterophil/lymphocyte ratio was significantly (P ≤ 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

<table>
<thead>
<tr>
<th>Items</th>
<th>Dietary treatments (mg Anta® Ox FlavoSyn/kg diet) ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0 (Control) 100 150 200</td>
</tr>
<tr>
<td>RBCs (x 10^6/mm³)</td>
<td>3.16ab 3.04b 3.30a 3.30a 0.06</td>
</tr>
<tr>
<td>Hb (g/dL)</td>
<td>15.10d 14.80b 15.33b 15.57a 0.21</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>49.33a 46.67ab 48.00b 45.67b 1.04</td>
</tr>
<tr>
<td>WBCs (x 10^3/mm³)</td>
<td>30.33b 34.33a 29.33b 34.00a 0.82</td>
</tr>
<tr>
<td>Heterophils (%)</td>
<td>29.40 29.67 30.10 34.20 1.76</td>
</tr>
<tr>
<td>Lymphocyte (%)</td>
<td>51.00a 37.67b 48.67b 43.33b 1.02</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
<td>1.00b 2.00a 1.00b 1.00b 0.26</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>9.00a 7.00b 5.30b 6.00b 0.60</td>
</tr>
<tr>
<td>H/L ratio</td>
<td>0.58b 0.79a 0.64b 0.78a 0.38</td>
</tr>
</tbody>
</table>

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 ≤ 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 ≤ 0.05) increases of serum total antioxidant capacity compared to the control group.

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

<table>
<thead>
<tr>
<th>Items</th>
<th>Dietary treatments (mg Anta® Ox FlavoSyn/kg diet) ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0 (Control) 100 150 200</td>
</tr>
<tr>
<td>Total protein (g/dL)</td>
<td>4.219ab 5.075b 4.865b 4.948b 0.09</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>2.236b 2.148b 2.556b 2.510b 0.063</td>
</tr>
<tr>
<td>Globulins (g/dL)</td>
<td>1.983b 2.927b 2.30b 2.43b 0.139</td>
</tr>
<tr>
<td>A/G ratio</td>
<td>1.147ab 0.746a 1.107b 1.035b 0.07</td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>210.45ab 192.81b 223.53b 233.98b 8.68</td>
</tr>
<tr>
<td>Triglycerides (mg/dL)</td>
<td>114.96b 76.64b 73.49b 92.21b 5.31</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>31.92a 55.67a 79.42a 59.85a 2.50</td>
</tr>
<tr>
<td>LDL (mg/dL)</td>
<td>178.53a 137.14ab 144.10b 174.13b 9.08</td>
</tr>
<tr>
<td>Total antioxidant capacity (mmol/L)</td>
<td>0.189ab 0.527ab 0.402ab 0.425ab 0.09</td>
</tr>
</tbody>
</table>

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.

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 stimulator 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. (2006) 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.

Regarding the blood biochemical parameters, Hajati et al. (2014) indicated that addition of 450 mg GSE/kg to broiler diet decreased total cholesterol, 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). Chamorro 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 hypcholesterolimic 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 Dimayati ducklings

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

EGP = Egyptian pound; 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 Dimayati 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.

REFERENCES


