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ANTIOXIDATIVE EFFECTS OF DIETARY BLACK MULBERRY (*MORUS NIGRA*) FRUIT JUICE IN MUSCOVY DUCKS UNDER HIGH AMBIENT TEMPERATURE

A. M. Abd El-Hady*, O. A. Elghalid and Samar A. Elnagar

Dep. of Poult. Prod., Fac.of Agric., Alexandria Univ. (21545), Alexandria, Egypt

Corresponding author: E-mail**:** ahmed75atta@yahoo.com

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ABSTRACT: The purpose of this study was to investigate the effect of the dietary mulberry (Morus Nigra) fruits juice as natural antioxidative additive given under high ambient temperature on their performance and some blood parameters of Muscovy ducks. The experiment was conducted for 8 weeks, using 100 Muscovy ducks, aged 21 days. The first group was fed the basal diets, while the diets of groups 2, 3 and 4 also thoroughly mixed with black mulberry fruits juice at a rate of 1, 2 and 4 %, respectively. Results showed that the average biweekly body weight gain, final weight, and feed conversion ratio were improved in mulberry juice groups compared to control group. The biweekly feed consumption was increased significantly with mulberry juice groups than control group. There were an improvement in the immune response of treated ducks, in terms of significant increases in WBCs count, Heterophils, Lymphocytes and serum globulin level in the experimental groups compared to control group. Blood glucose, HDL and GSH concentrations increased significantly in black mulberry juice groups compared with control group. But, creatinine, total lipid, cholesterol, triglyceride, LDL and MDA concentrations decreased in the experimental groups. Results indicated that slaughter weight, carcass and dressing percentage were increased significantly by mulberry juice groups, to reach (102.3, 105.2 and 109.2%); (102.9, 103.7 and 104.4%) and (102.9, 103.3 and 103.8%) of control, respectively. Liver, bursa and abdominal fat percentage were reduced significantly with the mulberry juice groups to reach (95.4, 99.0 and 92.4%), (95.4, 97.0 and 90.1%) and (97.1, 97.1 and 109.0%) of control group, respectively. It can be concluded that dietary black mulberry juice addition to high ambient temperature Muscovy ducks can reduce physiological strain, cholesterol level and oxidative effect.

Keywords: ducks; high temperature; mulberry; cholesterol; oxidative

INTRODUCTION

Oxygen reactive species (ROS) are a category of free radicals, and are generated in mitochondria following oxidative metabolism. When the amount of ROS goes beyond the capacity of the antioxidant capacity (enzymatic and non-enzymatic) in a case called oxidative stress, and lipid peroxidation parameters as a sign of oxidative stress will increase in the blood (Ozata et al. 2002). Oxidative stress causes damage to biological macromolecules (such as nucleic acids, membrane lipids and proteins) and disorders of normal metabolism and physiology (Roberts and Sindhu, 2009). The origin of Mulberry in Egypt is the north of China. Each tree produces about 20 kilograms of Mulberry. Grow berries for the purpose of breeding silkworms. Mulberry can grow well in new reclaimed lands, and marginal lands with marginal irrigated water, thus it could valuably contribute towards carrying out the current aggressive plans of expansion the utilization of marginal water, particularly in marginal lands (Yaser et al. 2009).

Black mulberry or blackberry (*Morus nigra*) , is a species of flowering plant in the family Moraceae, native to southwestern Asia, where it has been cultivated for so long that its precise natural range is unknown, but it is known of being rich in anthocyanin (RHS A-Z encyclopedia of garden plants, 2008). Anthocyanins are water-soluble vacuolar pigments that may appear red, purple, or blue depending on the pH. They belong to a parent class of molecules called flavonoids synthesized via the phenyl propanoid pathway (Andersen, 2001). Although anthocyanins have antioxidant properties in vitro, (De Rosso et al. 2008, Lotito and Frei, 2006 and Williams et al. 2004) states that this antioxidant effect is not conserved after the plant is consumed and that dietary anthocyanins. However, with the recent decline of sericulture industry, mulberry has been re-evaluated for other purposes, such as medicinal, fruit juice and animal production.

On the other hand consumers nowadays prefer low cholesterol foods and pay attention to the relationship between dietary cholesterol and coronary diseases. In Egypt, ducks' meat is very preferable especially Muscovy ducks for their small size compared with turkey and economical prices, but it is famous of its high content of "Fat". Suwannee, (2009) and Sunder et al. (2011) investigated the effect of dietary mulberry leaves extracts used to decrease meat cholesterol concentration in broilers. Therefore the aim of the present study was to further investigate the cholesterol-lowering and antioxidative effect of dietary juice black mulberry on productive performance and some blood parameters of Muscovy ducklings under high ambient temperature.

MATERIALS AND METHODS

This study was carried out at the Poultry Research Center, Faculty of Agriculture, Alexandria University, during the period from June to September 2015.

Birds and diets

A total number of 100 one day old unsexed Muscovy ducklings with approximately similar live body weight were used in this study. They were brooded for 3 weeks and then randomly divided into four treatment groups (25 birds) with an average initial weight (703± 21.5) gm per bird.

Each group was subdivided into five replicates of 5 birds each. They were approximately similar in live body weight at this age. All experimental ducks were housed in floor pens with wood shaving litter. Floor pens were washed and disinfected prior to the beginning of the experiment.

Birds were maintained at 33 °C using gas heater and the temperature was gradually reduced by 3 °C/ week from one day until 3 weeks of age. Indoor average temperature was 33 ± 3 ^{0}C and humidity was 74± 4% throughout the experiment from 21 days until the end of experimental period. Feed and water was supplied *ad-libitum*, diets were formulated according to NRC, (1994), and ducks were vaccinated against duck plague at 10th day old.

Continuous lighting program with 23 hours light to one hour dark was maintained by the natural day light and a 60 watt bulb that placed centrally in each pen at 2 meters height above the heads of birds. Birds were daily fed *ad-libitum* on a commercial duck broiler starter ration of 22% crude protein and 2900 Kcal / Kg metabolizable energy up to 3 weeks of age and on a duck broiler finisher ration of 18% crude protein and 3000 Kcal/ Kg metabolizable energy till 11 weeks old as shown in Table (1). The chemical composition of the diets was evaluated according to the Association of Official Analytical Chemists (A.O.A.C. 2004). At 21 day of age the first group was fed on these diets without any supplements and used as a control group, while, the second, third and fourth groups were fed the finisher rations provided and thoroughly mixed with black mulberry fruit juices at a rate of 1, 2 and 4 % of diets (Hyunsook et al. 2010).

In the Spring season (March-April) fresh, mature and right mulberry fruit having attractive dark red pigment were harvested in clean polyethylene bag from trees in Abu Al-Matamir city, Beheira governorate, Egypt. Berries were washed followed by sorting and kept at –20 ºC until the experimental period started in June month. Chemical analysis, general characteristics and some physiological properties and of Black mulberry fruit juices (*Morus Nigra*) are showed in Tables (2 and 3).

The fruit bags after measuring general characteristics and some physiological properties were kept at –20 ºC until analyses. Black mulberry fruit juices were added daily to diets in fresh juice was extracted by hydraulic press machine. Black mulberry fruit juices (*M. Nigra*) were analyzed by spectrophotometric method Folin and Wu, (1920) to account the amount of different sugars, and ascorbic acid was determined by the direct colorimetric method (Ranganna, 2000). Anthocyanin content was determined following the method of (A.O.A.C. 1984). The juice chemical composition and minerals content were carried out in (Table 3) and calculated according to Mona, (2006).

Data collected

The experiment lasted eight weeks from 3 to 11 weeks of age where at this time body weight, weight gain and feed consumption were recorded biweekly. Feed conversation ratio was calculated. By the end of the experiment, ten ducks per group were randomly chosen to measure plasma parameters. Blood samples were collected from the wing vein, in a heparinized tubes, (while another sample was collected without anticoagulants to obtain blood serum) to determine the hematological parameters of the blood including erythrocytes and leukocytes counts according to Feldman et al. (2000), packed cell volume was determined according to Winterobe, (1961). Whole blood smears were prepared and stained by Gemsa stain and leukocyte differential count was determined microscopically according to

MacGregor et al. (1940). Hemoglobin was assayed by a colorimetric method using a commercial kit (spectrum hemoglobin diagnostic kits manufactured by Egyptian company for biotechnology, Cairo, Egypt) samples were kept at –20 ºC until analyses for its total protein and albumin by a colorimetric method using a commercial kit of Sclavo Diagnostics Company (Kite Italia S.P.A.). However, serum globulin was calculated by subtraction of albumin from total proteins. Plasma glucose, transaminases enzyme activities (SGOT & SGPT), creatinine, calcium, phosphorus, total lipid, triglycerides, cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) were determined calorimetrically using the commercial kits (Bio-Merieux, Franc and Stambio, USA).

Blood glutathione (GSH) concentration was measured using the method described by (Beutler et al. 1963). Blood malondialdehyde (MDA) concentration was determined using the method described by (Yagi, 1984). At the end of the experiment, ten ducks from each treatment were chosen randomly and slaughtered after 12 hour fastening period. Weight of inedible part (blood, feathers, legs, head, and viscera), giblets (Gizzard, liver, & heart), some lymphoid organs (spleen & bursa) and abdominal fat was estimated and calculated as a percentage of live body weight. Edible part (giblets & carcass) and carcass percentage were recorded.

Statistical Analysis

The experiment was set in a completely randomized design. Data were analyzed by analysis of variance using the general liner model procedure (Proc GLM; SAS Institute, 1996).

The following model was used:

$Y_{ijl} = \mu + Di + Rj + e_{ijl}$

Where:

Y_{ijkl} The dependent variable under study,

μ Over all mean,

Di Effect of treatment by black mulberry fruit juices (1, 2, 3 and 4)

Rj Effect of replicate,

e_{ijl} The random residue error

Differences among means were determined using Duncan’s test (Duncan, 1955).

RESULTS AND DISCUSSION

Live Body weight and body weight gain

The average live body weight (LBW) and body weight gain (LBWG) of ducklings throughout the eight weeks experimental period as affected by feed additives are presented in Table (4). After only one week of treatment, mulberry fruit juices' addition caused a significant increase in body weight in a dose dependent manner which was sustained throughout the whole experimental period. At the end of the experimental period, black mulberry fruit juices addition caused an increase of (2.2, 5.3 and 9.1%) and (2.1, 6.2 and 11.5%) in LBW and LBWG compared to control group with the three doses of mulberry fruit juices, respectively ($p \leq 0.001$).

Feed consumption and feed conversion ratio

Effects of different levels of black mulberry fruit juices on feed consumption are presented in Table (4). By the end of the experimental period different levels of juice addition did not have any significant effect on birds' feed consumption.

Feed conversion ratio of ducklings throughout the eight weeks experimental period as affected by juice black mulberry fruit juices is presented in Table (4). Throughout the whole experimental period different levels of fruit juice addition improved feed conversion ratio in a dose dependent manner by 3, 5 and 10%

compared to control, respectively ($p \leq 0.001$).

The significant improvement of live body weight of fruit juice treated groups can be attributed to the better feed conversion ratio as shown in (Table 4). Results are in agreement with the findings of (Biswas et al. 2011) who indicated that use of natural antioxidants is an effective way of getting the best result in terms of body weight gain in broiler birds. Moreover, with the findings of (Rezaeipour et al. 2011) who reported a linearly improved feed conversion ratio with increase of antioxidant (α- Tocopheryl) in the feed of broilers. Arshad et al. (2013) had also reported that antioxidant (α-lipoic acid) feed treatments had significant variation on the body weight and feed conversion ratio of broilers.

Blood hematological and chemical characteristics

Blood hematological characteristics hemoglobin (Hb), red blood cells (RBCs), packed cell volume (PCV), (MCV), (MCH) and (MCHC) as shown in Table 5 were not significantly affected by the juice mulberry treatments of birds except PCV % which showed significant increases ($P \leq 0.005$) by mulberry treatments. The percentages of that increases compared with control were 9.5, 7.6 and 8.9 %. Data from the same table showed no significant increases in Hb and RBC with mulberry treatments compared to control group. From these results it can be drawn that adding natural antioxidant fruit juices like black mulberry in duckling diet exerts protective effect by improving resistance of erythrocytes against hemolysis (Soto-Salanova and Sell 1996, Schiavone et al. 2010).

Otherwise, white blood cells count, heterophils and lymphocyte% had significantly ($p \leq 0.01$) increased with juice mulberry treatments to reach (103, 110 and 115%); (104.8, 109.3 and 110.7%) and (104.1, 105.8 and 107.9%) of control, which can be attributed to the increased glutathione levels observed in this study Table (6), as Glutathione boosts white blood cell production particularly lymphocytes (Fidelus and Tsan, 1987), which was also increased significantly ($p \leq 0.05$) in a dose dependent manner with the three doses of mulberry treatments, respectively.

Meanwhile, mulberry juice treatments had significant effect on globulin, glucose and creatinine levels in Table (5). Globulin significantly ($p \leq 0.05$) increased with the mulberry fruit juice treatments to reach 113, 122, and 122% of control level with the three fruit juice doses, respectively. Fruit juice treatments exerted similar effect on blood glucose which increased significantly ($p \leq 0.0001$) to reach 111, 120, and 121% of control level with the three fruit juice doses, respectively. On the other hand creatinine was significantly ($p \leq 0.01$) influenced by mulberry juice treatments as it was reduced in a dose dependent manner to reach 94, 78 and 71% of control with the three doses of fruit juice, respectively, indicating a better kidney function under fruit juice treatments.

Blood SGOT, SGPT, calcium and phosphorous as presented in Table (5) were not significantly affected by the fruit juice treatments of birds.

Juice mulberry treatments had significantly reduced total lipids ($p \leq 0.05$) to reach 93, 84 and 77% of control, triglyceride ($p \leq 0.0001$) to reach 92, 81 and 82% of control, cholesterol ($p \leq 0.01$) to reach 92, 89 and 86% of control, LDL ($p \leq 0.0001$) to reach 74, 61, and 50% of control, and significantly increased ($p \leq 0.0001$) HDL to reach 120, 138, and

142% of control, with the three doses of fruit juice treatments, respectively. These results are in good agreement with the findings of Kalt et al. (2008) who reported that pigs' supplementation with1, 2 and 4% mulberries resulted in a decrease in total, LDL- and HDL-cholesterol. Coban et al. (2013) also reported that blueberry treatment reduced oxidative stress and cholesterol accumulation in the aorta and liver of the guinea pigs. The underlying mechanism associated with the hypo-cholesterolemic activity of black mulberry can be explained by the study of Liang et al. (2013) who reported that dietary supplementation of 0.5 and 1.0 % blueberry anthocyanins to hamsters for 6 weeks decreased plasma total cholesterol concentration by 6–12 % in a dose-dependent manner, which was accompanied by increasing the excretion of fecal neutral and acidic sterols by 22–29 % and 41–74 %, respectively. In poultry, mulberry leaves were found to regulate the metabolic activity of lipids, with concentrations of 3% MLM being the most effective in decreasing total cholesterol and LDL-cholesterol, while at the same time increasing HDL cholesterol and glucose concentrations (Park et al. 2012). Dietary inclusion of mulberry decreased the concentration of saturated fatty acids, the omega 6 (n-6) to omega 3 (n-3) ratio and cholesterol in broilers (Margareta et al. 2015). Real-time PCR analyses demonstrated that incorporation of blueberry anthocyanins into diet down-regulated the genes of NPC1L1, ACAT-2, MTP, and ABCG 8. In addition, blueberry anthocyanins were also able to down-regulate the gene expression of hepatic HMG-CoA reductase, indicating that blueberries influence gene signaling to lower cholesterol (Hyunsook et al. 2010).

Blood glutathione was significantly ($p \leq 0.05$) increased (Table 6) in a dose dependent manner to reach 156, 165 and 166% of control with the three doses of juice mulberry, respectively. Berries preserved high amount of glutathione because it reduced free radicals, so the glutathione level was not used by glutathione peroxidase or glutathione reductase to eliminate the free radicals.

Meanwhile blood malondialdehyde was reduced significantly ($p \leq 0.05$) to reach 90, 91, and 80% of control with the three doses of fruit juice, respectively. The increase in glutathione and the decrease in malondialdehyde may be related to blueberries anti-oxidative potential, and comes in agreement with the findings of (Papandreou et al. 2009). Rapid growth rate and various challenges in broiler chicks and ducks cause increasing free radicals, which result in in-creased oxidative stress. The birds become susceptible to many disorders, such as ascites and sudden death syndrome (Roberts and Sindhu, 2009). Consumption of products rich in antioxidants as additives in duck diets could increase physiological antioxidant defenses, which results in a decrease in oxidative stress.

The use of black mulberry fruit juices in duckling diets has been shown to promote anti-oxidative properties (Sunder et al. 2011).

Slaughter traits

Results indicated that slaughter weight, carcass and dressing percentage were increased significantly ($p \leq 0.05$) by juice mulberry treatments, to reach (102.3, 105.2 and 109.2%); (102.9, 103.7 and 104.4%) and (102.9, 103.3 and 103.8%) of control, respectively in Table (7).

Liver and bursa percentage was reduced significantly ($p \leq 0.05$) with the mulberry treatments to reach (95.4, 99.0 and 92.4%)

and (95.4, 97.0 and 90.1%) of control, which may be attributed to the lipid-lowering effect of mulberry fruit juices and increased level of secretion B cells from body, so bursa percentage was decreased. The results demonstrated that heat stress decreased bursa of farbricius weight and also high ambient temperature decreased humoral and cell-mediate immune responses and increased hetrophils to lymphocyte ratio (H/L) (Rashidi et al. 2010). Al-Mufarrej, (2014) noticed that, the relative weight of bursa farbricius at 35 days of chicken age was decreased when compared at 21 days of age. There is extensive cell division in the bursa, particularly during the first few weeks of life during which time the bursa cellularity increases as well as the production of B cells that immigrate to the organ periphery Lydyard et al. (1979), with increasing age at least relative weight of the bursa of farbricius and this is linked with an increased level of secretion B cells of the immune system in the body and therefore less weight of bursa of farbricius gland gradually.

Abdominal fat percentage was significantly affected by fruit juice treatment in Table (7). Mulberry treatments reduced ($p \leq 0.0001$) abdominal fat percentages to reach about 49% of control. It can be concluded that dietary black mulberry fruit juices can exert antioxidative effects on ducks evidenced by increased blood glutathione and decreased blood malondialdehyde, furthermore they have a "fat-lowering" effect wish is reflected on both birds blood and abdominal fats, leading to the production of "leaner ducks" which are preferable to consumers. Lipid stability of poultry products during storage depends on the pro-oxidant and antioxidant content, fat content, the fatty acid profiles of fat and the degree of processing as well as storage conditions of products. It is well known that the quality of dietary lipids and dietary supplementation with super nutritional amounts of antioxidants, such as anthocyanins and α-tocopheryl acetate (α-TA), significantly improves quality of meat poultry products through the improvement of lipid stability during storage (Bou et al. 2009).

Several studies have been conducted in vivo in order to test if natural compounds were able to improve lipid stability in meat. It has been demonstrated that dietary supplementation with both synthetic and natural antioxidants such as vitamin E Avanzo et al. (2001), ascorbic acid Florou-Paneri et al. (2006), rosemary Lopez-Bote et al. (1998), and black burry fruit juice extract De Rosso et al. (2008) may improve antioxidant defenses and meat quality.

CONCLUSION

It concluded that black mulberry juice supplemented with 4% to Muscovy ducks diets in growing period subjected to Egyptian summer conditions can enhance their physiological strain results under high ambient temperature, and improving their performance as observed with better body weight gain, feed conversion and slaughter traits. Moreover, black mulberry juice reduced cholesterol level, increased HDL and enhanced antioxidant status that resulted under high ambient temperature.

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Table (1): Composition and calculated analysis of the basal diets supplementation of Muscovy ducklings.

Ingredient	Starter (0-21 d)	Finisher (21- 77 d)
Yellow corn	58.30	69.85
Soybean meal (44%)	35.20	23.15
Corn gluten meal (60%)	2.50	2.80
Di-calcium phosphate	2.00	2.00
Limestone	1.20	1.30
Sodium chloride	0.30	0.30
Vit. and min. mix*	0.30	0.30
Dl- methionine	0.10	0.20
L- lysine	0.10	0.10
Total	100	100
Proximate chemical analysis %		
Crude protein (CP)	22.00	18.00
Crude fiber (CF)	3.79	3.21
Ether extract (EE)	2.59	2.91
Calculated values:		
Metabolizable energy (Kcal/kg)**	2830	2963
Calcium %	0.96	0.94
Available phosphorus %	0.52	0.51
Lysine %	1.20	0.93
Methionine + Cysteine %	0.73	0.64

* Each 3 kg Vitamins and minerals contain: Vit. A120000 IU, Vit. D3 22000 IU, Vit.E100 mg, Vit.K3 20 mg, Vit. B1 10 mg, Vit. B2 50 mg, Vit. B6 15 mg, Vit.B12 100 µg, Pantothenic acid 100mg, Niacin 300 mg, Folic acid 10 mg, Biotin 500 µg, iron 300 mg, Manganese 600 mg, Choline chloride 500 mg, Iodine 10 mg, Copper 100 mg, Selenium 1 mg, Zinc 500 mg and 1200 mg Anti-oxidant.

** Calculated according to (Mona, 2006) recommendation of Muscovy ducks.

ducks; high temperature; mulberry; cholesterol; oxidative

Table 2: Chemical composition and minerals content of Black mulberry fruits juice (*Morus Nigra*).

Characteristics	Black mulberry fruit juices (M. Nigra)
Ether extract %	6.05
Crude protein %	9.50
Crude fiber %	5.36
Nitrogen free extract %	73.87
Ash %	5.22
Minerals	
Ca (mg/100 gm)	261.03
Fe (mg/100 gm)	14.21
K (mg/100 gm)	987.72
P (mg/100 gm)	313.58

Table (3): General characteristics content of Black mulberry fruit (*Morus Nigra*).

Characteristics	Black Mulberry fruit
Fruit weight (g)	1.89±0.07
Fruit dimensions	
Length (cm)	1.93 ± 0.31
Diameter (cm)	1.23 ± 0.03
Size (cm^3/ fruit juice)	1.66 ± 0.04
Juice yield (%)	76.54± 1.86
Pomace yield (%)	23.46± 0.39
Total soluble solids (%)	17.70± 0.36
Total sugars (%)	13.70± 0.04
Reducing sugars (%)	13.48± 0.03
Glucose (%)	5.28 ± 0.03
Fructose %)	8.20 ± 0.19
Glucose/ Fructose ratio	1:1.55
PH value	5.70 ± 0.19
Ascorbic acid (mg/100g)	4.15 ± 0.18
Pectin (%)	1.74 ± 0.02
Anthocyanins (mg/100g)	200.96± 0.99

Table (4): Mean (± SE) live body weight (LBW) at 3 and 11 week and biweekly body weight gain (LBWG), feed consumption(FC) and feed conversion ratio (FCR) of Muscovy ducks fed 1, 2, or 4 % black mulberry fruit juices.

Items	Control	1 %	2 %	4 %	P- value
Live Body Weight (LBW)					
(3 wk)	697.7±25.2	711.2±23.5	701.3±20.4	687.6±17.8	NS
(11wk)	3705.3±202.3[c]	3787.5±223.9[bc]	3902.8±215.3[b]	4041.2±222.2[a]	0.01
Body Weight Gain (BWG)					
(3-5 wk)	459.5±21.7[c]	485.6±27.4[c]	635.6±33.5[b]	749.6±29.6[a]	0.001
(5-7 wk)	760.0±51.4[b]	799.6±55.9[b]	925.6±67.4[a]	940.0±68.6[a]	0.001
(7-9 wk)	801.6±72.4[ab]	864.0±70.3[a]	783.3±71.5[ab]	771.2±66.5[b]	0.05
(9-11wk)	966.9±76.8[a]	899.6±78.6[ab]	841.7±69.7[b]	892.8±77.4[ab]	0.05
(3-11wk)	3006.9±194.8[c]	3071.7±215.8[bc]	3194.4±201.8[b]	3353.6±196.4[a]	0.001
Feed Consumption (FC)					
(3-5 wk)	1544.0±67.3[b]	1512.0±51.8[b]	1865.0±35.5[a]	1936.0±35.7[a]	0.001
(5-7 wk)	2956.0±86.7[a]	2896.0±82.1[a]	2816.0±113.3[a]	2420.0±95.9[b]	0.001
(7-9 wk)	2096.0±70.6[b]	2250.0±86.1[a]	2176.0±59.7[ab]	2271.0±46.8[a]	0.01
(9-11wk)	2888.0±119.7[a]	2615.8±135.3[b]	2694.0±79.6[b]	2880.0±114.8[a]	0.001
(3-11wk)	9484.0±316.5	9273.8±321.9	9551.0±269.9	9507.0±196.3	NS
Feed Conversion Rate (FCR)					
(3-5 wk)	3.40±0.21[a]	3.30±0.29[a]	3.10±0.19[a]	2.63±0.12[b]	0.001
(5-7 wk)	4.15±0.24[a]	3.86±0.19[a]	3.24±0.15[b]	2.75±0.15[c]	0.001
(7-9 wk)	2.91±0.26	2.84±0.16	3.03±0.19	3.25±0.19	NS
(9-11wk)	3.22±0.15	3.24±0.24	3.47±0.22	3.50±0.23	NS
(3-11wk)	3.30±0.14[a]	3.19±0.11[b]	3.15±0.17[b]	2.96±0.13[c]	NS

[a, b,c…] Means with different letters in the same row are significantly different at P≤ 0.05

Table (5): Mean (± SE) blood hematology parameters and some biochemical characteristics of Muscovy ducks fed 1, 2, or 4 % black mulberry fruits juice.

Items	Control	1 %	2 %	4 %	P- value
Blood hematology					
Hb (g/dl)	9.42±0.26	9.65±0.32	9.93±0.37	9.90±0.25	NS
RBCs (10^6/mm)	3.85±0.18	4.08±0.22	4.06±0.29	4.36±0.29	NS
PCV (%)	30.51±0.38[b]	33.40±0.37[a]	32.82±0.44[a]	33.22±0.60[a]	0.001
MCV (fl)	7.96±0.36	8.30±0.46	8.21±0.48	7.72±0.50	NS
MCH (pg)	2.47±0.17	2.41±0.19	2.50±0.21	2.29±0.15	NS
MCHC (g/dl)	30.90±0.94	28.91±0.95	30.30±1.22	30.11±0.68	NS
WBC (10^3/mm)	26.60±0.69[c]	27.50±0.64[bc]	29.25±0.66[ab]	30.46±0.65[a]	0.01
Heterophils (%)	27.21±0.78[b]	28.52±0.84[ab]	29.74±0.77[a]	30.11±0.69[a]	0.01
Lymphocyte (%)	59.53±0.99[b]	61.97±1.12[ab]	62.99±1.24[ab]	64.24±1.27[a]	0.05
Biochemical characteristics					
T. protein (g/dl)	4.47±0.27	4.82±0.34	4.98±0.28	5.17±0.24	NS
Albumin (g/dl)	3.05±0.19	3.21±0.23	3.18±0.22	3.45±0.27	NS
Globulin (g/dl)	1.41±0.17[b]	1.60±0.10[a]	1.72±0.15[a]	1.72±0.12[a]	0.05
Glucose (mg/dl)	145.00±3.98[c]	160.83±2.64[b]	174.17±5.31[a]	175.17±2.31[a]	0.0001
SGOT (IU/L)	56.33±4.23	57.64±5.38	56.56±4.66	57.83±3.95	NS
SGPT (IU/L)	19.32±1.31	21.65±1.27	19.83±1.94	20.50±1.31	NS
Creatinine (mg/dl)	0.97±0.09[a]	0.91±0.04[ab]	0.76±0.11[bc]	0.69±0.14[c]	0.01
Ca (mg/dl)	7.23±0.28	6.95±0.17	7.10±0.22	6.90±0.22	NS
P (mg/dl)	4.10±0.56	4.51±0.29	4.60±0.37	4.68±0.30	NS

[a, b,c…] Means with different letters in the same row are significantly different at $P \leq 0.05$.

Table (6): Mean (± SE) blood hematology parameters and some biochemical characteristics of Muscovy ducks fed 1, 2, or 4 % black mulberry fruits juice.

Items	Control	1 %	2 %	4 %	P- value
Total lipid (mg/dl)	320.83±18.68^{a}	297.09±4.62^{ab}	270.50±11.31^{bc}	246.67± 6.48^{c}	0.05
Cholesterol (mg/dl)	142.42±3.81^{a}	130.55±1.68^{b}	126.95±3.03^{b}	121.93±4.37^{b}	0.01
Triglyceride(mg/dl)	120.98±2.41^{a}	111.97±3.36^{b}	98.15±1.38^{c}	99.58±3.97^{c}	0.0001
LDL (mg/dl)	48.50±3.66^{a}	36.12±1.17^{b}	29.50±0.79^{c}	24.35±1.13^{c}	0.0001
HDL (mg/dl)	65.70±2.42^{c}	78.73±2.65^{b}	90.55±2.38^{a}	93.43±3.19^{a}	0.0001
GSH (U/Ml)	67.55±0.98^{b}	105.75±0.95^{a}	111.77±0.84^{a}	112.38±0.94^{a}	0.05
MDA (nmol/mL)	1.13±0.06^{a}	1.02±0.07^{ab}	1.03±0.03^{ab}	0.90±0.04^{b}	0.05

$^{a, b, c…}$ Means with different letters in the same row are significantly different at P≤ 0.05

Table (7): Mean (± SE) Slaughter traits of Muscovy ducks fed 1, 2, or 4 % black mulberry fruits juice.

Items	Control	1 %	2 %	4 %	P- value
Slaughter weight (gm)	3701.7±205.8[c]	3787.5±365.9[bc]	3892.5±379.8[ab]	4041.7±227.2[a]	0.01
Carcass (%)	64.18±0.57[b]	66.06±0.78[ab]	66.55±0.99[a]	67.02±0.74[a]	0.05
Dressing (%)	74.11±0.49[b]	76.27±0.76[a]	76.52±0.93[a]	76.89±0.79[a]	0.05
Giblets (%)	5.87±0.19	6.17±0.19	6.15±0.13	6.17±0.18	NS
Liver (%)	2.38±015[a]	2.27±0.17[ab]	2.36±0.11[a]	2.20±0.19[b]	0.05
Gizzard (%)	2.97±0.18	3.09±0.15	3.19±0.08	3.02±0.12	NS
Bursa (%)	0.131±0.013[a]	0.125±0.013[a]	0.127±0.010[a]	0.118±0.014[b]	0.05
Abdominal fat (%)	2.09±0.33[a]	1.03±0.05[b]	1.03±0.10[b]	1.00±0.09[b]	0.0001

[a, b,c…] Means with different letters in the same row are significantly different at $P \leq 0.05$

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الملخص العربى

التأثيرات المضادة للأكسدة لعصير ثمار التوت الأسود فى عليقة البط المسكوفى تحت درجات الحرارة المرتفعة

أحمد محمد عبد الهادى , اسامه احمد الغليض ,سمر على النجار
قسم إنتاج الدواجن – كلية الزراعة – جامعة الاسكندريه– الاسكندريه 21545- جمهورية مصر العربية

تهدف الدراسة الى دراسة تاثير أضافة عصير ثمار التوت كمضاد طبيعى للاكسدة تحت درجات الحرارة المرتفعة لعلائق البط المسكوفى على صفات النمو وبعض تقديرات الدم. أستمرت التجربة لمدة 8 اسابيع واستخدم عدد 100 بطة مسكوفى عمر 21 يوم. المجموعة الأولى تغذت على عليقة ضابطة، بينما المجموعة 2، 3، 4 تم خلط العليقة الضابطة بعصير ثمار التوت بمعدل 1، 2، 4 % على الترتيب. أوضحت النتائج أن متوسط وزن الجسم المكتسب كل اسبوعين والوزن النهائي والكفاءة الغذائية تحسنت مع مجاميع عصير التوت بالمقارنة بالمجموعة الضابطة. زاد أستهلاك العلف زيادة معنوية كل أسبوعين مع مجاميع عصير التوت بالمقارنة مع المجموعة الضابطة. لوحظ تحسن فى الأستجابة المناعية للبط المعامل وكانت هناك زيادة معنوية فى عدد كرات الدم البيضاء والخلايا القاعديةوالخلايا الليمفوية ومستوى جلوبيولين الدم فى المجاميع المعاملة بالمقارنة بالمجموعة الضابطة. تركيزات الجلوكوز والكوليسترول العالى الكثافة والجلوتاثيون فى الدم زادت زيادة معنوية فى المجاميع المعاملة بعصير التوت الأسود بالمقارنة مع المجموعة الضابطة. لكن تركيزات الكرياتين و الدهون الكلية والكوليسترول والدهون الثلاثية والكوليسترول المنخفض الكثافة والمالوندهيد إنخفضت فى المجاميع المعاملة. أشارت النتائج إلى أن الوزن النسبى البط المعد للذبح ونسبة الأجزاء المأكولة ونسبة التصافى زادت معنوياً للمجاميع المعاملة بعصير التوت لتصل إلى نسبة (102.3، 105.2 ، 109.2%) و (102.9 ، 103.7 ، 104.4%) و (102.9 ، 103.3 ، 103.8%) من المجموعة الضابطة على الترتيب. الوزن النسبى للكبد والبرسا والدهن الحشوى انخفض معنوياً مع المجاميع المعاملة بعصير التوت لتصل إلى (95.4 ، 99.0 ، 92.4%) و (95.4 ، 97.0 ، 90.1%) و (97.1 ، 97.1 ، 109.0 %) بالمقارنة بالمجموعة الضابطة على الترتيب.

تشير النتائج بصفة عامة أن أضافة عصير التوت الأسود مع ارتفاع درجات الحرارة لعلائق البط المسكوفى تقلل من العبأ الفسيولوجى ومستوى الكوليسترول والتأثير التأكسدى.