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EFFECT OF INCLUDING DIFFERENT DIETARY LEVELS OF GRAPE POMACE ON PERFORMANCE, BLOOD BIOCHEMICAL PARAMETERS, AND IMMUNE RESPONSE OF MUSCOVY DUCKS

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ABSTRACT :The effects of varying amounts of grape pomace (GP) on Muscovy ducklings performance, digestibility of nutrients, immunological response, caecal microbiota, and carcass traits were studied from 7 to 70 days of age. Four experimental groups (0, 2.5, 5.0, and 7.5 % GP) comprising 200 unsexed 7-day-old ducklings were randomly assigned. The study found that diets supplemented with GP significantly improved economic efficiency, feed conversion ratio, body weight, and weight gain, with the 2.5% and 5.0% GP groups showing the most significant improvement. Duckling diets supplemented with varying levels of GP significantly enhanced digestibility coefficients (organic matter, crude protein, ether extract, and nitrogen-free extract) and intestinal *lactobacillus* counts than the control group. Also, the study found that ducklings fed 2.5 and 5.0% GP showed significantly improved blood parameters compared to the control group. Duckling fed varying levels of GP showed increased phagocyte index, immunoglobulins (A, G, and M), and blood antioxidant parameters (total antioxidant capacity, glutathione peroxidase, and superoxide dismutase) compared to the control group. The opposite trend was observed for feed consumption and Prominently, intestinal total bacterial count, *Escherichia coli*, and *Proteus spp* counts were significantly decreased. It could be concluded that dietary supplementation with 2.5 or 5.0% GP in duckling diets improved duckling productive performance, nutrient digestibility, hemato-biochemical pramateres, and immunological response, with 2.5 or 5.0% GP being the optimal inclusion level.

Keywords: Ducklings, Grape pomace, Performance, Immune response

INTRODUCTION

Growth promoters are being investigated by the scientific and commercial poultry nutrition sectors as safe antibiotic substitutes to enhance the health and growth of poultry (Kazi *et al*., 2022). Animal feedstuffs contain antioxidants that protect tissues from reactive oxygen species that may cause damage to DNA, RNA, and proteins by lowering free radicals and avoiding lipid peroxidation (Lanari *et al*., 2004; Grashorn, 2007). Oxidation damage significantly threatens poultry growth, health, and economic losses, potentially affecting poultry meat and poultry meat production (Sihvo *et al*., 2013; Est'evez, 2015). Oxidative reactions can negatively impact growth performance, meat quality, and food safety by causing oxidized lipids in food for humans (Bekhit *et al*., 2013; Est'evez, 2015).

Grape pomace, a by-product of wine-making, is a complex substrate that includes neutral pectic polysaccharides, acid pectic compounds, insoluble pro-anthocyanidins, lignocellulosic, structural proteins, and phenolic compounds. The last two components can be valuable organic sources when fractionated (Minjares-Fuentes *et al*., 2014; Abu Hafsa and Ibrahim, 2018; Ebrahimzadeh *et al*., 2018; Siska *et al*., 2018). The high levels of vitamin E, flavonoids, and proanthocyanidins in grape pomace make it an excellent source of antioxidants (AbuHafsa and Ibrahim, 2018). As a diverse blend of anthocyanidins, catechins, and their derivatives, grape pomace is a popular source of polyphenols used in health supplements and grape seeds (Muhlack *et al*., 2018). According to research (García Lomillo and González SanJosé, 2017; Gowman *et al*., 2019), GP possesses an antioxidant capacity that is twenty times stronger than fat-soluble vitamin (vitamin E) and fifty times more than vitamin C. Phenol-based compounds, known for their anti-inflammatory and antimicrobial properties, are being explored for their potential use in broiler diets to improve gastrointestinal functions and feed conversion ratio (Ao and Kim, 2019; Vacca *et al*., 2020). Smet *et al*. (2008), and Ao and Kim (2020) have demonstrated that GP improves broiler meat quality, in addition to growth traits, antioxidant capacity, gastrointestinal health, immunological function, and nutritional digestibility (Yang *et al*., 2016; Abu Hafsa and Ibrahim, 2018; Dudek-Wicher *et al*., 2018; Heuze and Trans, 2020, Erinle *et al*., 2022). The current study aimed to investigate the impact of different grape pomace amounts in Muscovy duckling diets on growth traits, nutritional digestibility, cecal microbial count, blood components, immunological function, and carcass characteristics.

MATERIALS AND METHODS

All samples were taken according to the standard protocol without causing any discomfort or injury to the ducks, and the experimental procedures were carried out according to the Institutional Animal Care and Use Committee (IACUC) of Damanhour University, Egypt.

Study site

This study was conducted at El-Bostan Farm, Faculty of Agriculture, Damanhour University.

Grape pomace

Grape pomace was harvested from a private commercial farm in Damanhour City, Beheira Governorate, Egypt. The chemical composition of GP used in the current study is presented in Table 1.

Birds, management, and experimental design

A study involved 200 unsexed Muscovy ducklings (*Cairina moschata*), one week old and weighing 204.6 g, randomly divided into four experimental treatments with 50 ducklings each, each treatment was subdivided into 5 replicates (10 ducklings each). Grape pomace was incorporated into the starter and grower diets at levels of 0.0 (control), 2.5, 5.0, and 7.5 %. Table 2 presents The composition and chemical analysis of the experimental diet designed to meet ducklings' nutrient requirements, as per NRC (1994). Throughout the experimental period, feed and water were provided *ad-libitum*. Ducklings were exposed a conventional light regimen, initially 23 hours during the first week, then 20 hours from the second week until fattening. Upon arrival, ducklings were brooded at 33°C, gradually decreasing to 30, 27, and 24oC during the second, third weeks, and up to 70 days of age, respectively.

Productive performance

The study recorded duckling performance parameters weekly, including body weight (BW), body weight gain (BWG), feed consumption (FC), and feed conversion ratio (FCR). European Production Efficiency Index (EPEI) was calculated according to **Marcu *et al*. (2013)**. The price of duckling and experimental diets were calculated according to the cost of the native market at the time of the experiment. The economic efficiency (EE) was represented as (net revenue/total cost) X 100 while, relative economic efficiency (REE) was calculated as (economic efficiency/economic efficiency of the control) X 100 (Zewail, 1996).

Digestibility trial

At the end of the experimental period, a digestibility trial was conducted on 40 birds to assess the apparent nutrient digestibility of experimental diets (ten from each treatment). Birds were housed individually in metabolic cages (42×50×50 cm/cage) for an 11-d trial (7 d of adaptation period + 4 d of collection period). Feed consumption and total excreta output from each bird were accurately determined during the collection period. Final nitrogen was determined according to Jackobsen *et al*. (1960). The proximate analysis of feed, dried excreta, and grape pomace was carried out according to the g methods A.O.A.C (2016). Nitrogen-free extract was analyzed according to Abou-Kaya and Galal (1971).

Blood collection and hematobiochemical analyses

At the end of the experimental period, ten ducks from each treatment blood samples (about 3 ml) from each treatment were collected from the brachial vein. The sample was divided into two parts, the first part was retained without heparin to obtain serum and the second part was kept in heparinized tubes, non-coagulated blood was divided into two parts, the first part was used to test shortly after collection, for estimating complete blood count (CBC), while the second part was centrifuged to obtain plasma. Both plasma and serum were stored at -20°C until the haemato-biochemical analysis.

According to Feldman *et al*. (2000), red blood cell count (RBCs 10^6/mm^3), white blood cell count (WBCs 10^3/mm^3), and the differential count were determined. Hemoglobin (Hgb) concentration and packed cell volume percentage (PCV %) were measured according to Provan *et al*. (2004). Glucose, total protein, albumin, total lipids, triglyceride (TG), cholesterol (chol.), high-density lipoprotein (HDL), low-density lipoprotein (LDL), aspartate aminotransferase (AST), alanine aminotransferase (ALT), uric acid, creatinine, total antioxidant capacity (TAC), glutathione peroxidase (GSH-PX), glutathione (GSH), superoxide dismutase (SOD), malondialdehyde (MDA), tri-iodothyronine (T3), and immunoglobulin fractions (IgG and IgM) concentration were determined using specific kits obtained from sentinel CH Milano, Italy, CAL-TECH Diagnostics, Inc., Chino, CA, USA, using a spectrophotometer (Beckman DU-530, Hanau, Germany), Diagnostic Products Corporation, Los Angeles, USA, or Reactivos GPL, Barcelona, Spain, according to kits manufacturers recommendations. The method of Leijh *et al*. (1986) was used to determine the phagocyte index and activity (PI and PA). Serum bactericidal activity (BA) in the Aeromonas hydrophilia strain was determined according to Rainger and Rowley (1993). Serum lysozyme activity (LA) was measured with the turbidimetric method described by Engstad *et al*. (1992) and the results are expressed as one unit of lysozyme activity that is defined as a reduction in absorbance at 0.001/min. The lymphocyte transformation test (LTT) was done following the method described by Balhaa *et al*. (1985).

Carcass characteristics

The experiment involved ten ducks, slaughtered at 70 days, and their carcass, organs (liver, gizzard, pancreas, spleen, and thymus gland), and abdominal fat were weighed after bleeding, feather picking, and evisceration. The percentages of empty carcasses and internal organs were calculated based on the pre-slaughter weight.

Intestinal bacterial count

Ten intestinal samples from each treatment were collected for bacterial count, *Escherichia coli*, *proteus*, and *Lactobacillus spp*. colony-forming units using modified methods from Baurhoo *et al*. (2007).

Statistical analysis

Data were analyzed in a completely randomized design using the general linear model procedure of SAS program 9.4 (SAS Inst. Inc. Cary, NC, USA) (**SAS, 2002**). The percentage data of the studied traits were transformed to square root or arc sine, while bacterial counts were converted using Log transformation before statistical analysis. The experimental unit for each studied parameter was the replicate. The statistical model used was:

$Yij = \mu + Ti + eij$

Where; Yij = an observation, μ = overall mean, Ti = effect of treatment (i = 1,2, ….4), and eij = experimental random error. The difference among means was determined using Duncan's new multiple range test (**1955**), and the significance was considered at $p \leq 0.05$.

RESULTS AND DISCUSSION

Productive performance

Table 3 displays the productive performance (body weight, body weight; gain, BWG; feed consumption, FC; and feed conversion ratio, FCR), economic efficiency EE, and European production efficiency index (EPEI) of ducks fed the control diet with graded levels of GP from 7-70 days of age. Table 3 shows that ducks fed a basal diet with GP significantly ($p \leq 0.05$) improved BW, BWG, FCR, EE, REE, and EPEI compared with those for the control group. The groups fed a basal diet containing 2.5 and 5% of GP showed the best values of the previously mentioned parameters compared to the other groups. In addition, FC for ducks fed basal diet with 2.5 and 5.0 % during periods from 36 to 70 and 7 to 70 days of age were significantly decreased compared with those for the other groups. Our findings align with previous studies indicating that grape pomace supplementation in Cobb 500 broiler diets , enhances broiler BWG compared to the control group (Hajati *et al*., 2015; Pascariu *et al*., 2017; Ebrahimzadeh *et al*., 2018). Abdallah *et al*. (2017) found that adding grape seeds to broilers' diets significantly increased their final LBW and BWG. Tag El-Din *et al*. (2019) discovered that incorporating grape seed into broiler chick diets can enhance BW and BWG. The natural antioxidants found in grape seed (GS) or grape pomace (GP), such as phenolic substances, help protect the mucosa of the gastrointestinal tract from damage caused by oxidative stress, limit peristaltic activity, and enhance nutrient absorption in digestive disorders (Hassan *et al*., 2019). Grape seed or grape pomace can improve BWG by enhancing villus length, absorption surface area, enzymatic expression, and nutrient transport systems (Vacca *et al*., 2020). Erinle *et al*. (2022) discovered that broiler chickens fed GP as an antibiotic replacement showed significantly improved growth performance compared to the control group.

Apparent nutrient digestibility

Table 4 reveals that ducks fed graded levels of GP showed a significant increase in digestibility coefficient (OM, CP, EE, and NFE) values compared with the control group. However, there were no significant differences in digestibility. The digestibility coefficient values of CP and NFE significantly increased in groups fed a basal diet complemented with 2.5 and 5.0% of GP, without statistical differences. In previous reports, Brenes *et al*. (2010) showed that GS extract significantly improved ileal protein and extractable polyphenol digestibility in excreta birds when compared to a basal diet. Supplementation in broiler chicks significantly enhanced digestibility of crude protein and ash ratio, while diets containing GS significantly enhanced digestibility of crude protein and dry matter compared with control group (El-Kelawy *et al*., 2018).

Herbs, spices, and plant extracts also stimulate appetite and digestion, besides their antimicrobial effectiveness against microorganisms (Razavi *et al*., 2019, Vacca *et al*., 2020).

Hematological parameters

Table 5 shows significant ($p \leq 0.05$) increases in RBCs, Hb, PCV, WBCs lymphocytes, and Heterophils in duckling-fed basal diets with varying levels of GP compared with control. According to the results of the present study, Orji et al. (1986b) reported that supplementation with GP significantly improved RBCs, hemoglobin, PCV, WBC, and lymphocytes compared to the control group, but did not significantly impact MCV, MCH, MCHC, monocytes, basophils, eosinophils, or heterophils.

Biochemical constituents

Table 6 shows the impact of different GP supplementation levels on duckling protein and lipid profiles at 70 days of age. The study found significant ($p \leq 0.05$) increases in total protein, globulin, γ-Globulin, triglycerides, and HDL values in ducks fed different GP levels compared with the control group. Total lipid, cholesterol, and LDL decreased significantly ($p \leq 0.05$), while albumin, α–globulin, and β–globulin showed no statistical differences among experimental groups. The results of this study are in agreement with Razavi *et al.* (2019) who stated that Poultry's increased serum total globulin levels due to natural antioxidant-fortified diets suggest an improvement in their immune status. A diet containing GP reduced serum TC and LDL concentrations. While lipid oxidation compounds pose health risks due to mutagenic, carcinogenic, and cytotoxic properties.

Table 6 shows that ducklings fed different levels of GP showed significant ($p \leq 0.05$) decreases in liver (AST and ALT) and kidney (creatinine and uric acid) function indicators compared with the control group. These results coincided with the results of Erinle *et al*. (2022) showed that dietary GP supplementation had effects on ALT and AST significantly reduced in birds fed GP diets compared to the control diet on Pekin ducks.

Data in Table 6 demonstrated that values of glucose concentration and thyroid hormones (T3 and T4) in ducklings fed different levels of GP were significantly ($p \leq 0.05$) increased compared with the control group. The results herein are in accordance with those reports of Amer *et al*. (2021) and Bacou *et al*. (2021) detected that broiler chicks fed GP-supplemented diets had significantly higher serum levels of T3 and T4.

Table 7 reveals that ducklings fed varying levels of GP exhibited significant increases in TAC, GSH-PX, GSH, and SOD activity compared to the control group. The study found that ducklings fed different levels of GP (2.5 and 5.0%) significantly decreased MDA compared to the control group.

Consumers today are highly concerned about the quality of meat and meat products, demanding safer and healthier options (Ao and Kim, 2019; Erinle *et al*., 2022). Poultry meat's higher polyunsaturated fatty acid content increases its lipid susceptibility to lipid oxidation compared to other meats (Magne *et al*., 2020). The study confirmed that grape seed extract (GP) can enhance serum SOD, GSH-PX, TAC, and CAT levels while decreasing serum MDA. According to Lipinski *et al*. (2017), the GP can activate the antioxidant enzyme system, which could lead to a decrease in reactive free radicals and oxidative stress. Grape seed metabolites may enhance antioxidant activity in ducks (Ao and Kim, 2020) and broilers (Yang *et al*., 2017; Samuel *et al*., 2017).

Table 8 shows that ducklings fed a basal diet with graded levels of GP significantly improved their immunity indices ($p \leq 0.05$). The basal diet supplemented with different levels of GP significantly improved various immune system parameters, including Immunoglobulins (IgG, IgA, and IgM), Phagocytic activity (PA), Phagocytic index (PI), lysozyme activity (LA), bactericidal activity (BA), Lymphocyte transformation test (LTT) compared to the control group. The results obtained herein are in good agreement with those of Lipinski *et al.* 2017 discovered that GSE supplementation increased serum C4, IL-2, and INF-g levels, implying suggesting GSE could improve the immune response in Pekin ducks by controlling antibodies, complements, and cytokines. Furthermore, this finding was consistent with those of Ebrahimzadeh *et al*. (2018) showing a noticeably higher serum IgG concentration with rising GP consumption in diet.

Carcass characteristics

Table 9 reveals that ducks fed varied amounts of GP had significantly higher dressing and total edible parts percentages than the control group. The opposite tendency appeared with abdominal fat. The groups fed 2.5, 5.0, and 7.5% of GP showed significant improvements in dressing, total edible part, and abdominal fat percentages compared to the control group. Furthermore, there was no statistically significant difference between the experimental groups in terms of liver, gizzard, pancreas, spleen, bursa, and thymus percentages. These results are coincident with the results of Tag El-Din *et al*. (2019) indicated that the grape seeds diet increased broiler chicks' carcass weight and total edible portions at 35 days of age. Brenes *et al*. (2010) noted that dietary GSE addition did not significantly impact the weights of pancreas, liver, liver, and abdominal fat in broiler chicks compared with the control group. Also, Hajati *et al*. (2015) discovered that dietary supplementation with GSE did not affect the percentage of edible carcass, liver, or abdominal fat in birds. Siska *et al*. (2018) found that GP did not significantly impact the carcass traits of commercial broilers compared with the control diet. Ebrahimzadeh *et al*. (2018) found that the addition of dietary grape pomace did not significantly impact the carcass, liver, heart, and abdominal fat weights of broiler chicks. El-Kelawy *et al*. (2018) revealed that adding natural polyphenol supplements to broiler chicken diets increased the dressing and total edible parts percentage compared to the control. In addition, Abu Hafsa and Ibrahim (2018) discovered that broilers' percentage of liver and gizzard remained unaffected when thegrape seed was supplemented to their feed, however the carcass and dressing weights did increase. In addition, neither GSE nor grape proanthocyanidins decreased the abdominal fat percentage in the broiler chicks, according to many studies (Hajati *et al*., 2015; Yang *et al*., 2017). According to Erinle *et al*. (2022), grape seed prevents the accumulation of fatty tissue, lowers calorie needs, and increases effort tolerance as a result of its antioxidant characteristics, which in turn enhance β-oxidation of fatty acids and increase energy utilization, resulting in a reduction of abdominal fat.

Intestinal bacterial count

Table 10 shows that ducklings fed different GP levels significantly decreased total bacterial count, *E. coli,* and *Proteus* counts than the control group, with a contrary trend noted for *Lactobacillus sp*. Stabilizing ileal microflora is crucial for gut health, and grape byproducts can promote beneficial bacteria growth while excluding pathogenic ones (Song *et al*., 2014; Brenes *et al*., 2016). The study observed that grape seed supplementation positively impacted ileal bacterial populations, as reported by Abu Hafsa and Ibrahim (2018) showed that broilers fed diets containing 1 to 4% grape seed showed raised ileal *Lactobacillus* counts but lowered *E. coli* counts. Ebrahimzadeh *et al*. (2018) demonstrated that grape seed extracts (GSE) increase beneficial bacteria populations in broilers, reduce pathogenic ones, and have been confirmed to have antibacterial activity against *E. coli* (Kumanda *et al*., 2019). The elevated counts of Lactobacilli in the ileum may be attributed to their capacity to consume and metabolize phenolic substances as nutritional substrates (Viveros *et al*., 2011; Abdel-Wareth *et al*., 2019). Moreover, the enhanced immunity may also reflect the favorable impact of GSE on the microorganisms in the ileum, since polyphenols have the potential to promote the release of beneficial bacteria (such as Lactobacillus), indirectly improving both immunological function and gastrointestinal health (Paszkiewicz *et al.*, 2012).

CONCLUSION

The study's findings indicate that increasing the amount of GP in duckling diets (between 2.5% and 7.5%) had no negative effects on productive performance, nutritional digestibility, physiological status, immunological function, or economic efficiency. Nevertheless, the most optimal outcomes were observed with GP concentrations of 2.5% or 5%. GP has garnered significant interest due to its multitude of advantages as an antioxidant. Consequently, further extensive research is required to fully explore its potential.

Table (1): Chemical composition and amino acid contents of grape pomace (GP).

Chemical Analysis (%)	
Crude protein	10.0
Crude fiber	26.11
Crude fat	9.47
Ash	8.01
Total carbohydrate	34.7
Moisture	8.7
Amino Acids contents (%)	
Glutamic acid	1.61
Methionine	0.21
Tyrosine	0.39
Phenylalanine	0.44
Hisitidine	0.34
Lysine	0.61
Argnine	0.70
Cysteine	0.22

Table (2): Composition and chemical analysis of the experimental basal diets containing different levels of grape pomace (GP) for growing ducks during starter and grower periods.

Ingredient (%)	Starter (7-35 d)				Grower (36- 70 d)			
	0.0	GP levels %			Control	GP levels %		
Grape pomace (GP)	**0**	**2.5**	**5.0**	**7.5**	**0**	**2.5**	**5.0**	**7.5**
Yellow corn	57.20	54.30	51.60	48.00	68.00	65.30	62.10	59.00
Soybean meal (44%)	38.00	38.00	38.00	38.10	26.60	26.60	26.70	26.74
Sunflower oil	0.85	1.90	2.80	4.15	1.40	2.40	3.53	4.65
Limestone	0.75	0.40	0.30	0.00	1.10	0.70	0.25	0.00
Dicalcium phosphate	2.40	2.10	1.50	1.45	2.10	1.70	1.60	1.30
DL-Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.11
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit+Min premix [a]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Antifungal	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100	100	100	100
Chemical analysis (% on DM basis)								
ME, kcal/Kg [b]	2860	2859	2858	2859	3013	3015	3015	3016
Crude protein [c]	22.12	22.11	22.13	22.11	18.05	18.06	18.07	18.06
Crude fiber [c]	4.24	4.83	5.43	6.01	3.56	4.15	4.75	5.34
Ether extract [c]	3.65	4.82	5.86	6.94	4.45	5.58	6.83	7.95
Lysine [b]	1.17	1.18	1.19	1.19	0.89	0.90	0.91	0.92
Methionine [b]	0.44	0.44	0.44	0.44	0.38	0.38	0.40	0.39
Methionine + Cystine	0.79	0.84	0.89	0.94	0.64	0.69	0.74	0.79
Calcium [b]	0.93	0.93	0.95	0.97	0.94	0.95	0.94	0.96
Available phosphorus [b]	0.45	0.43	0.45	0.44	0.39	0.38	0.40	0.40

a Vit+Min premix. Provided per kilogram of the diet: vit. A: 7000 IU, vit. E (dl-α-tocopherol acetate: 10 IU, menadione: 2.5 mg, vit. D3: 2000 ICU, riboflavin: 2.5 mg, calcium pantothenate: 10 mg, nicotinic acid: 12 mg, Choline chloride: 300 mg, vit. B12: 4 µg, vit. B6: 5 mg, thiamine: 3 mg, folic acid: 0.50 mg and biotin: 0.02 mg, Mn: 80 mg, Zn: 70 mg, Fe: 35 mg, Cu: 8 mg and Se: 0.1 mg.
b Calculated.
c Analyzed.

Table (3): Effect of different dietary inclusion levels of grape pomace (GP) on growth performance and economic efficiency of Muscovy ducklings during 7-70 days of age.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P Value*
		2.5	5.0	7.5		
Body weight (g)						
7d	200	205	208	210	4.98	0.099
35d	1000[b]	1400[a]	1460[a]	1490[a]	19.98	0.001
70d	3010[c]	3760[a]	3700[a]	3300[b]	22.89	0.001
Body weight gain (g)						
7-35 d	800.9[b]	1195[a]	1252[a]	1200[a]	21.98	0.002
36-70 d	2010[b]	2360[a]	2240[a]	1890[ab]	19.56	0.001
7-70 d	2810[b]	3555[a]	3492[a]	3090[b]	12.87	0.001
Feed consumption (g)						
7-35 d	4200	4020	3980	3880	15.99	0.098
36-70 d	6000[a]	4980[b]	5220[b]	5420[b]	18.54	0.002
7-70 d	10200[a]	9000[b]	9200[b]	9300[b]	30.98	0.001
Feed conversion ratio (g feed/g gain)						
7-35 d	5.00[a]	3.364[b]	3.179[b]	3.031[b]	12.98	0.006
36-70 d	3.08[a]	2.110[c]	2.330[c]	2.994[b]	21.98	0.001
7-70 d	3.63[a]	2.532[c]	2.635[c]	3.010[b]	0.987	0.002
Economic efficiency and production index						
EE, %	66.98[c]	98.87[a]	90.71[a]	87.98[b]	12.98	0.001
REE, %	100.0	147.6	135.4	131.4	-	-
EPEI, %	122.8[c]	213.1[a]	201.1[a]	157.2[b]	12.98	0.001

[a,b,c] Means in the same row followed by different letters are significantly different at ($p<0.05$); SEM, Standard error of mean.EE = Economic efficiency, REE = Relative economic efficiency, EPEI = European production efficiency index.

Table (4): Effect of including different dietary levels of grape pomace (GP) on apparent nutrient digestibility of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P Value*
		2.5	5.0	7.5		
Apparent nutrient digestibility (%)						
Organic matter	69.01[b]	73.93[a]	72.96[a]	71.94[a]	2.09	0.001
Crud protein	65.9[c]	72.34[a]	73.12[a]	70.91[b]	3.012	0.002
Ether extract	63.87[b]	70.09[a]	71.12[a]	72.09[a]	5.098	0.001
Crud fiber	34.98	38.17	32.07	33.17	1.879	0.876
Nitrogen free extract	63.98[c]	76.01[a]	75.17[a]	70.09[b]	3.01	0.001

[a,b,c] Means in the same row followed by different letters are significantly different at ($p<0.05$), SEM: Standard error of mean.

Table (5): Effect of including different dietary levels of grape pomace (GP) levels on hematological parameters of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P Value*
		2.5	5.0	7.5		
RBCs, (10^6/cmm^3)	3.87^c	4.98^a	4.65^a	4.73^a	0.765	0.002
Hb, (g/100 ml)	9.48^b	10.45^a	9.98^a	10.87^a	0.987	0.001
PCV, %	26.98^b	32.56^a	33.17^a	34.09^a	3.09	0.002
WBCs, (10^3/cmm^3)	26.98^b	29.09^a	30.02^a	28.98^a	4.09	0.001
Lymphocytes, (%)	60.09^b	65.98^a	70.09^a	67.98^a	3.98	0.002
Heterophils, (%)	25.87^b	29.98^a	28.87^a	27.89^a	2.24	0.003

^{a,b,c} Means in the same row followed by different letters are significantly different at ($p<0.05$), SEM: Standard error of mean, RBCs: red blood cells count, Hgb: hemoglobin, PCV: packed cell volume, WBCs: white blood cell count.

Table (6): Effect of different dietary inclusion levels of grape pomace (GP) on biochemical blood constituents and some immunological indices of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P value*
		2.5	5.0	7.5		
Total protein (g/100 ml)	5.87^b	6.26^a	6.34^a	6.12^a	0.128	0.001
Albumin (g/100 ml)	3.21	3.28	3.61	3.28	0.230	0.076
Globulin (g/100 ml)	2.66^b	2.98^a	2.73^a	2.84^a	0.765	0.002
α–globulin, (µg/dl)	0.671	0.612	0.601	0.603	0.114	0.087
β -globulin, (µg/dl)	0.712	0.509	0.612	0.598	0.176	0.089
γ -globulin, (µg/dl)	1.277^b	1.859^a	1.517^a	1.639^a	0.001	0.001
Total lipid (mg/100 ml)	389.9^a	265.9^c	287.7^c	350.6^b	23.9	0.002
TG. (mg/100 ml)	80.92^c	99.87^a	93.87^a	89.98^b	5.98	0.001
Chol. (mg/100 ml)	220.98^a	176.54^c	166.98^c	198.54^b	11.98	0.0001
HDL (mg/100 ml)	37.91^b	41.89^a	44.87^a	45.89^a	2.09	0.001
LDL (mg/100 ml)	166.88^a	114.67^b	103.33^b	134.65^b	12.87	0.0002
AST (U/L)	62.14^a	58.87^b	59.32^b	60.21^b	2.89	0.002
ALT (U/L)	64.55	65.90	61.67	59.91	3.01	0.098
Alk P, (U/100ml)	11.93	12.77	13.98	13.89	2.98	0.087
Uric acid (mg/100 ml)	2.32^a	1.97^b	1.67^b	1.79^b	0.087	0.002
Creatinine (mg/dl)	1.05^a	0.788^b	0.976^b	0.887^b	0.098	0.003
Glucose (mg/100 ml)	190.8^b	230.4^a	225.8^a	230.7^a	12.98	0.001
T_3 (ng / 100 ml)	2.65^c	4.01^a	4.11^a	3.67^b	0.098	0.001
T_4 (ng / 100 ml)	5.89^c	8.98^a	9.01^a	7.98^b	0.876	0.002

^{a,b,c} Means in the same row followed by different letters are significantly different at ($p<0.05$), SEM: Standard error of the mean, TG: triglycerides, Chol.: total cholesterol, HDL: high-density lipoprotein, LDL: low-density lipoprotein, AST: aspartate aminotransferase, ALT: alanine aminotransferase, Alk. P =Alkaline phosphatase; T3: triiodothyronine,T4:Thyroxine.

Table (7): Effect of different dietary inclusion levels of grape pomace (GP) on indicators of antioxidative status of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P value*
		2.5	5.0	7.5		
TAC, (Mmol/dl)	355.9[b]	430.9[a]	448.5[a]	450.1[a]	12.09	0.002
GSH-Px, (Mmol/dl)	834.8[b]	945. 3[a]	990.2[a]	987.5[a]	23.90	0.001
GSH, (Mmol/dl)	0.311[b]	0.876[a]	0.911[a]	0.789[a]	0.098	0.001
SOD, (U/L)	167.9[b]	189.9[a]	199.2[a]	193.5[a]	11.98	0.002
MDA (Mmol/dl)	198.9[a]	156.9[b]	145.9[b]	150.1[b]	24.91	0.002

[a,b,c] Means in the same row followed by different letters are significantly different at ($p<0.05$), SEM: Standard error of mean, TAC: total antioxidant capacity, GSH-Px: glutathione peroxidase, GSH: glutathione SOD: superoxide dismutase, MDA: malondialdehyde.

Table (8): Effect of different dietary inclusion levels of grape pomace (GP) on some immunological indices of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P Value*
		2.5	5.0	7.5		
IgG (mg/100 ml)	39.76[b]	44.89[a]	46.94[a]	42.98[a]	2.89	0.001
IgM (mg/100 ml)	18.09[b]	22.87[a]	23.91[a]	24.11[a]	1.99	0.002
IgA (mg/100 ml)	15.94[c]	18.56[a]	19.01[a]	18.76[a]	0.987	0.001
PA, (%)	13.87[b]	16.98[a]	17.76[a]	18.16[a]	1.98	0.002
PI, (%)	1.09[b]	1.28[a]	1.22[a]	1.26[a]	0.098	0.001
BA	7.98b	12.96a	13.03a	12.99a	1.08	0.002
LA	23.98[b]	28.77[a]	27.84[a]	26.94[a]	2.98	0.003
LTT	20.76[c]	29.76[a]	28.65[a]	24.78[b]	2.76	0.001

[a,b,c] Means in the same row followed by different letters are significantly different at ($p<0.05$), SEM: Standard error of mean, IgG: immunoglobulin G, IgM: immunoglobulin M. IgA: immunoglobulin A; PA: phagocytic activity, PI: phagocytic index, BA: bactericidal activity, LA: lysozyme activity, LTT: lymphocyte transformation test.

Table (9): Effect of different dietary inclusion levels of grape pomace (GP) on carcass characteristics, relative weight of immune organs of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P Value*
		2.5	5.0	7.5		
Dressing	61.78[c]	73.87[a]	70.89[a]	66.65[b]	8.96	0.001
Total edible parts	64.87[c]	69.83[a]	69.09[a]	67.43[b]	3.09	0.008
Liver	2.08	1.99	2.11	2.01	0.098	0.092
Gizzard	2.44	2.05	2.35	2.41	0.097	0.087
Pancreas	0.278	0.298	0.301	0.303	0.098	0.067
Abdominal Fat	0.998[a]	0.691b	0.560b	0.422b	0.0345	0.002
Lymphoid organs (%)						
Spleen	0.411	0.390	0.404	0.412	0.012	0.087
Thymus	0.023	0.045	0.021	0.018	0.045	0.098
Busa	0.031	0.039	0.026	0.025	0.023	0.078

[a,b] Means in the same row followed by different letters are significantly different at ($p<0.05$); SEM, Standard error of mean.

Table (10): Effect of different dietary inclusion levels of grape pomace (GP) on intestinal bacterial count of Muscovy ducklings.

Items	0.0	Grape Pomace (GP) levels %			SEM	*P Value*
		2.5	5.0	7.5		
Intestinal bacterial count						
TBC (cfu x10^6)	3.98[a]	2.09[b]	2.11[b]	2.19[b]	0.987	0.001
E. Coli (cfu x10^3)	1.55[a]	0.987[b]	0.876[b]	0.801[b]	0.065	0.002
Proteus (cfu x10^3)	0.993[a]	0.411[b]	0.409[b]	0.398[b]	0.087	0.003
Lactobacillus spp. (cfu x10^3)	1.28[b]	2.87[a]	2.98[a]	2.76[a]	0.098	0.001

[a,b], Means in the same row followed by different letters are significantly different at ($p<0.05$), SEM: Standard error of mean, TBC = Total bacterial count

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الملخص العربى

تأثير اضافة مستويات مختلفة من تفل العنب علي الاداء الانتاجي ,خصائص الدم البيوكيمياوية والاستجابة المناعية لسلالة البط المسكوفي

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أجريت هذه الدراسة في وحدة بحوث الدواجن بمزرعه البستان، قسم الانتاج الحيواني والداجني، كلية الزراعة جامعة دمنهور. هدفت الدراسة إلى تقييم تأثيرادراج مستويات مختلفة من تفل العنب على أداء النمو،والكفاءة الاقتصادية, والصفات البيوكيميائية والهيماتولوجية للدم والاستجابة المناعية عند عمر70 يوما لسلالة البط المسكوفي *Cairina moschata*. إستخدم في هذه التجربة عدد مائتان من كتاكيت البط المسكوفي غير المجنسة عمر 7 أيام و التي وزعت عشوائيا علي خمسة معاملات بكل منها عدد 36 كتكوت موزعة علي سته مكررات بكل مكرر سته طيور. إستخدمت المجموعة الأولي للمقارنة (كنترول) بينما غذيت المعاملات رقم 2, 3 ,4 علي علائق ادرج فيها تفل العنب بمستويات 2.5 , 5.0 , 7.5 %/ كجم علف

أظهرت النتائج حدوث زيادة معنوية في وزن الجسم الحي ومعدل الزيادة الوزنية للجسم وحدوث انخفاض في استهلاك العلف وكذلك حدوث تحسن في الكفاءة الغذائية والكفاءة الاقتصادية ووزن الذبيحة في المجموعات التي غذيت علي مستويات مختلفة من تفل العنب مقارنة بمجموعة الكنترول.

أظهرت النتائج أيضا حدوث زيادة معنوية في مستوي بروتينات الدم والجلوبيولينات المناعية في المجموعات المضاف لها تفل العنب بمستوياتها المختلفة مقارنة بمجموعة الكنترول. بينما كان هناك انخفاض معنوي في مستوي الدهون الكلية في الدم و الكوليسترول وكذلك انخفاض مستوي LDL في المجموعات المغذاة علي تفل العنب مقارنة بمجموعة الكنترول. سجلت زيادة في مستوي جلوكوز الدم وكذلك زيادة في تركيزات هورمونات الغدة الدرقية وأيضا تحسن في مستوي انزيمات الاكسدة المختلفة في سيرم الدم في المجموعات المغذاة علي تفل العنب مقارنة بمجموعة الكنترول. حسنت الإضافات المستخدمة من وظائف الكبد والكلى مقارنة بالكنترول . من ناحية أخرى أدت هذه الإضافات الي زيادة معنوية في عدد كرات الدم البيضاء ، كرات الدم البيضاء الليمفاوية، زيادة جلوبيولين السيرم والجاما جلوبيولين بالمقارنة مع مجموعه الكنترول

أدت جميع الإضافات إلى زيادة مستوى انزيم (SOD) و الجلوتاثيون(GSH)والجلوتاثيون بيروكسيديز والقدرة المضادة للأكسدة والنشاط البلعمي ودليل النشاط البلعمى ومعامل تحويل الخلايا الليمفاوية ونشاط مقاومة البكتريا والنشاط الليسوسومى بالمقارنة مع مجموعه الكنترول.

أدت جميع الإضافات إلى زيادة الجلوبيولينات المناعية (IgG - IgM - IgA) بالمقارنة مع مجموعه الكنترول. كما أدت جميع الإضافات إلى حدوث انخفاض في أعداد البكتريا الممرضة في الامعاء مقارنة بالكنترول .

مما سبق يتضح أن ادراج تفل العنب إلي علائق البط المسكوفي *Cairina moschata* بمستويات 2.5, 5.0 % ادت الي تحسن في الاداء الانتاجي والاقتصادي والفسيولوجي والمناعي تحت ظروف إجراء هذه الدراسة.