Egypt. Poult. Sci. Vol (37)(III): (907-925)(2017) **(1755)**

Egyptian Poultry Science Journal

http://www.epsaegypt.com

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

IMPACT OF USING ORGANIC ACIDS ON GROWTH PERFORMANCE,BLOOD BIOCHEMICAL AND HEMATOLOGICAL TRAITS AND IMMUNE RESPONSE OF DUCKS(CAIRINA MOSCHATA).

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Received: 25/08/2017 Accepted: 06/09/2017

ABSTRACT: The main objective of the study was to investigate the effect of two types of organic acids (formic acid, FA and citric acid CA) on performance, blood parameters, immune response and bacterial count. A total number of 250 unsexed 7 d old ducklings (Cairina Moschata) were randomly divided into five dietary treatment groups, 50 birds each in five equal replicates. The first group was fed a commercial basal diet without supplementation (control), the 2nd and 3rd groups were fed basal diet supplemented with 0.5 and 1.0 % of FA, while the 4th and 5th groups were fed basal diet supplemented with 2.0 and 3.0% CA. Body weight (BW), body weight gain (BWG), feed conversion, some carcass characteristics and economic efficiency were determined. At the end of the experiment (70 d), blood samples were collected to determine some blood constituents. In addition, bacterial counts of the digestive system were measured. Results showed that duckling fed the basal diet supplemented with organic acids had significantly greater BW, BWG, economical efficiency and better feed conversion as compared to control. All dietary supplements decreased serum AST, ALT, urea, creatinine, total lipids, triglycerides, cholesterol, LDL and increased T_3, T_4, TAC, GSH, GPX, SOD, glucose, total protein, globulin, γ-globulin, IgA, IgM, IgG, LA, BA, LTT, phagocytic activity, phagocytic index, RBCs and hemoglobin as compared to control. Dietary supplementation of organic acids increased dressing percentage and total edible parts compared to control. Moreover, supplementation of either formic or citric decreased total bacterial count, Salmonella, E.Coli and proteus spp. compared to control group. In conclusion, either formic or citric acid could be used safely as natural growth promoters to improve growth and immune response of duckling.

Key words: Duckling, Formic, Citric, Performance, Blood profiles, Immune response

INTRODUCTION

The increased pressure on livestock industry to minimize the use of prophylactic dosages of antibacterial growth promoters in has directed nutritionists and poultry producers to look for alternative growth promoters because of microbial resistance in humans and the imminent to do same in different parts of the world (Kopecký,et al., 2012).One of these alternatives is the utilization of organic acids as feed additives in the animal production(Sheikh et al., 2010). Organic acids and their salts are generally considered as safe and have been affirmed to be used as natural feed additives in animal production.(Kamal and Ragaa, 2014).As alternatives to antibiotic growth promoters, organic acids (OA) have demonstrated positive results in poultry production, due to their potential to lower the intestinal pH and enhance the bacterial development against pH changes (Pirgozliev et al., 2008; Ao et al., 2009), thus providing better intestinal health for the bird to maximize its nutrient absorption.The inclusion of organic acids, e.g. formic and citric acids, in the poultry feed has been appeared to enhance poultry performance (Helen and Christian, 2010; Tolebi et al., 2010; Hassan et al., 2016). Additionally, organic acids feeding were reported to have several beneficial effects on feed conversion ratio, growth performance and enhancing mineral absorption (Král et al., 2011; Gálik and Rolinec, 2011 and Petruška et al., 2012). An important objective of dietary fermentation is the inhibition of intestinal microbes competing with the host for available nutrients, and a decrease of possible toxic bacterial metabolites. In such manner, various studies have recommended that organic acids may influence the concentration of microorganisms in the ceca and small intestine (Vogt et al. 1982), and that they are bactericidal for Salmonellae in the crop (Hinton and Linton, 1988; Thompson and Hinton, 1997). Moreover, organic acids work in creatures, as a development promoter and may have a vital role in controlling certain characteristic microorganisms (Naidu, 2000 and Wolfenden et al., 2007).

There are few studies on the use of organic acids in ducks (Cairina Moschata) feeding. Therefore, this study was designed to investigate the growth performance, carcass traits, some blood parameters, bacterial count, antioxidant status and the immune response of growing ducks fed organic acids-supplemented diets.

MATERIALS AND METHODS:

This study was conducted at the Poultry Research Unit (El-Bostan Farm), Department of Animal and Poultry Production, Faculty of Agriculture, Damanhour University, Damanhour, Egypt, from June to August 2015. The main objective was to evaluate the efficacy of using organic acids (formic and citric acids) as natural growth promoters in diets of ducks from 7 to 70 days of age.

Two hundred and fifty unsexed day-old ducklings obtained from a commercial hatchery, were randomly distributed into five groups, each group contain 5 replicates, 10 birds each**.** Ducks were reared in floor pens (1.5*1.5m), and were allocated to the following dietary treatments: the first group was fed a commercial basal diet without supplementation (control), the 2nd and 3rd groups were fed basal diets supplemented with 0.5 and 1.0 % of formic acid, and the

4th and 5th groups were fed same basal diets supplemented with 2.0 and 3.0% citric acid. The experimental diets were formulated to meet the nutrient requirements of ducklings according to NRC (1994). Ducklings in all treatments were reared under similar hygienic and managerial conditions. They were housed in well-ventilated brooders and feed and water were provided ad-libitum throughout the experimental period during the starter (1-35 d of age) and grower, finisher period (36-70 d of age). Birds in each replicate were weighed (g) weekly between 7 and 70 d of age, and the body weight gain (g/bird) was calculated. Feed intake was recorded for each replicate (g/bird) and thereby feed conversion ratio (g feed/g gain) was easily calculated. Economical evaluation (EE) was estimated during all period of experiment. EE was calculated as 100 times net revenue divided by total feed costs. While net revenue was calculated as total revenue minus total feed costs. European production efficiency index (EPEI) was measured throughout the experimental period (7-70d of age), according to Hubbard broiler management guide (1999).

$$EPEI = \frac{BW\ (kg) \times SR}{PP \times FCR} \times 100$$ Where:

EPEI = European Production Efficiency Index. BW = Body weight (kg)

SR = Survival rate (100% - mortality)

PP = Production Period (days)

FCR = Feed conversion (kg feed / kg gain)

At 70 d of age, ten blood samples were collected randomly in heparinized test tubes from each treatment to determine red blood cells (RBCs) and white blood cells (WBCs) counts and different types of leukocytes according to Hepler (1966). Packed cell volume (PCV %), hemoglobin (Hb) concentration and red blood cell indices were determined as described by Jain (1986):

Mean Corpuscular Hemoglobin (MCH) (Pg) = Hbx10/ RBC's

Mean Corpuscular Hemoglobin Concentration (MCHC) (g/dl) = Hbx100/PCV

Additional fifteen serum samples were obtained also from each treatment at 70 d of age for biochemical analysis using commercial kits. Such biochemical determinations include glucose concentration (mg/dl) according to Trinder (1969) , total protein (g/dl) according to Henry et al. (1974), albumin (g/dl) according to Doumas (1971), and different types of globulin (α-globulin, β-globulin and γ-globulin) according to Bossuytet al.(2003), besides, serum globulin concentration was calculated by difference. Moreover, serum levels of creatinine and urea were also determined using method of Bartles et al.(1972), triglycerides according to Fossati and Prencipe (1982), total cholesterol according to Stein (1986), HDL-cholesterol according to Lopez-Virella et al.,(1977), LDL-cholesterol according to Friedewald et al.(1972) and Alkaline phosphatase (ALP) concentration according to the colorimetric method of Bauer (1982).

Besides, the activity of serum aspartate aminotransferase (AST), and serum alanine aminotransferase (ALT), were estimated according to Reitman and Frankel (1957) using commercial kits. Serum samples were assigned also for determination of total antioxidant capacity (TAC) according to Koracevicet al. (2001), superoxide dismutase (SOD) activity according to Misra and Fridovich

(1972), glutathione peroxidase (GPX) activity according to Paglia and Valentine (1967) and blood reduced glutathione (GSH) concentration according to Ellman, 1959. Phagocytic activity and index were determined according to Kawahara et al. (1991). Phagocytic activity (PA) = Percentage of phagocytic cells containing yeast cells, while Phagocytic index (PI) = Number of yeast cell phagocytized/ Number of phagocytic cells. Serum immunoglobulin (IgY, IgM and IgA) were determined using commercial ELISA kits (Kamiya Biomedical Company, USA) according to Bianchi et al.(1995).

Lymphocyte transformation test was done following the method described by Balhaa et al.(1985). Serum bactericidal activity to Aeromonashydrophila strain was determined according to Rainger and Rowley (1993). Serum lysozyme activity was measured with the turbidimetric method described by Engstad et al.(1992) and the results are expressed as one unit of lysozyme activity that defined as a reduction in absorbance at 0.001/min.

Lysozyme activity = (A0 - A) / A.

The effect of dietary treatments on the microbial activity of the digestive system was evaluated through measuring total bacterial aount and also counting some pathogenic bacteria harboring the intestine such as salmonella, E.coli and proteus spp. according to methods described by ICMSF (1980).

Data obtained were analyzed using the GLM procedure (Statistical Analysis System (SAS, 2002) , using one-way ANOVA using the following model: $Y_{ik}= \mu+ T_i + e_{ik}$.

Where, Y is the dependent variable; μ is the general mean; T is the effect of experimental treatments; and e is the experimental random error. Before analysis ,all percentages were subjected to logarithmic transformation (log10x+1) to normalize data distribution. The differences among means were determined using Duncan's new multiple range test (Duncan , 1955).

RESULTS

The production performance, economical efficiency and production index of ducks fed basal diet supplemented with formic and citric acids during days 7-70 of age are shown in Table 2. Ducks fed basal diet supplemented with either formic or citric acids at different levels had significantly ($p\leq0.05$) greater body weight (BW) and Body weight gain (BWG) than the control group. Groups fed 0.5% formic acids and 3% citric acids had significantly ($p\leq0.05$) higher BW and BWG during 7-70d of age as compared to the other groups.

Ducks fed the basal diet supplemented with formic and citric acids at different levels recorded lower FI and better FCR during 7-70d of age as compared to the control group. Furthermore, ducks fed the basal diet supplemented with 3% citric acid had significantly lower FI and better FCR than other groups. Ducks fed the basal diet supplemented with different supplements at different levels had significantly better values of economical efficiency and production index compared to the control group. However, ducks fed the basal diet supplemented with 0.5% formic acid and 3% citric acid recorded the best economical efficiency and production index compared to the other groups.

The biochemical blood constituents of ducks are shown in Table 3. All feed supplements, used herein decreased serum levels of urea, creatinine and

activity of AST and ALT and increased serum activity of alkaline phosphatase, urea/creatinine ratio as compared to control group. Furthermore, ducks fed basal diet supplemented with 0.5% formic acid and 3% citric acid had significantly decreased serum concentrations of urea, creatinine than other groups. While, birds fed the basal diet supplemented with the two levels of citric acid had significantly lower ALT than other groups however, ducks fed the basal diet supplemented with the two levels of formic acid had significantly, lower serum AST than other groups.

In addition, all dietary supplements increased serum glucose and decreased serum total lipids, triglycerides, cholesterol and LDL as compared to control group. Furthermore, ducks fed the basal diet supplemented with 0.5% formic acid and 3% citric acid had significantly lower total lipids and triglycerides than other groups.

Moreover, ducks fed the basal diet supplemented with either formic or citric acids at different levels had significantly higher serum concentration of T_3 and T_4 than the control group, with the highest values for groups that were fed the basal diet supplemented with the two levels of citric acid.

On the other hand, serum antioxidants indices and enzymes including TAC, GSH, GPX and SOD were higher in ducks fed the basal diet supplemented with either formic or citric acids at different levels as compared to the control group. However, no significant effects of different supplements levels were detected on TAC, GPX but, birds fed the basal diet supplemented with 0.5% formic acid and 3% citric acid had significantly higher GSH and SOD than other groups (Table 4).

Feeding diet with different supplements increased RBCs, hemoglobin, PCV, MCV, MCH, WBCs, lymphocyte and monocytes as compared to control group. Moreover, ducks fed the basal diet supplemented with 3% citric acid had significantly higher RBCs, hemoglobin, PCV and MCH than other groups (Table 5).

Feeding diet with different supplements increased serum total protein, globulin, α–globulin, γ-globulin, IgA, IgM, IgG, LA, BA, LTT, phagocytic activity and phagocytic index as compared to the control group. Ducks fed diet supplemented with 0.5% formic acid and 3% citric acid had significantly higher globulin, α–globulin, γ-globulin, BA, LTT, IgG and IgM than other groups. However, no significant effect of different levels of supplements was found on LA, phagocytic activity, phagocytic index and IgA (Table 6).

Dietary supplementation of either formic or citric at the tested levels increased significantly percentage of dressing and total edible parts and decreased abdominal fat compared with the controls. Furthermore, ducks fed the basal diet supplemented with 0.5% formic acid and 3% citric acid had significantly higher percentages of dressing and total edible parts and lower abdominal fat than other groups, but feed supplements had no significant effect on percentages of spleen and thyme (Table 7).

All dietary supplements decreased total bacterial count, Salmonella, E.Coli and proteus spp. as compared to the control group. However, ducks fed the basal diet supplemented with citric acid with the

two levels had significantly lower means of TBC, Salmonella, E.Coli and proteus spp. than the other supplemented groups (Table 8).

DISCUSSION

The present results indicate that the addition of organic acids(either formic or citric acids) to diets could improve the growth, FCR, economical efficiency, production index and decreased FI of ducklings as compared to the un-supplemented control, birds. The results of the present study are in line with those obtained by Sheikh et al., (2011); Chazalah et al., (2011); Hassan et al.,(2016) and Hossain and Nargis (2016) who indicated that dietary supplementation of organic acids improved performance of broiler chickens as compared to the un- supplemented group. The improved body weight gain of duckling, reported herein, is probably due to the beneficial effect of organic acids on the gut flora. The organic acids may affect the integrity of microbial cell membrane or cell macro molecules or interfere with the nutrient transport and energy metabolism causing the bactericidal effect (Ricke, 2003).

Organic acids in gastrointestinal tract (GIT) tend to reduce the pH value in the gastrointestinal tract, so increase effectiveness of the barrier function of the stomach against pathogens and increase the activity of digestive enzymes. The acidifiers can promote gastric acid secretion and lower pH of gastrointestinal tract, thereby enhancing the protease, lipase and amylase activity as well as improve serum calcium and phosphorus levels (Dhawale,2005). Acidifiers also can increase pancreatic secretions, and promote the absorption of minerals such as Ca, P, Cu and Zn. At the same time, intestinal acidic environment is also conductive to vitamins A and D absorption.

The beneficial microbiological and pH decreasing abilities of organic acids is mainly related in the inhibition of pathogenic intestinal bacteria leading to decreasing their metabolic needs, thereby increasing the availability of nutrients to the host. The decreased level of toxic bacterial metabolites as a result of less bacterial fermentation, causing an improvement in the protein and energy digestibility thus enhancing the weight gain and performance (Ghazalah et al., 2011). The effect of organic acids might not be due to pH reduction only. Studies have evaluated several organic acids and have shown that citric acid improved phosphorus utilization by competitively chelating Ca, reducing the formation of insoluble Ca phytate complexes in chicks (Angel et al., 2001; Snow et al., 2004).

Improvements in FCR were attributed to an encouraged group of the beneficial microflora in the GIT induced by dietary supplementation of organic acids (Jin et al., 2000). Naghmeh and Jahanian (2012) indicated that the improvement in the FCR could be possibly due to better utilization of nutrients resulting in increased body weight gain. This result may be due to the positive effect of organic acids on pathogenic bacteria (E.Coli, Salmonella) in both stomach and small intestine (Dhawale,2005).

Results revealed that dietary supplements (either formic or citric acids) increased glucose, total protein, globulin, α–globulin, γ-globulin, IgA, IgM, IgG, LA, BA, LTT, phagocytic activity, phagocytic index, RBCs, hemoglobin, PCV, MCV,

MCH, WBCs, lymphocyte and monocytes and decreased serum total lipids, triglycerides, cholesterol and LDL as compared to the control group. The present results match with those obtained in broiler chicks (Ghazalah et al., 2011), who reported that dietary organic acids exhibited relatively noticeable by higher concentration of total protein and globulin as compared to the control birds, indicating that the immune response improved by addition of organic acids which might indicate that broiler chicks fed acidifiers-supplemented diets had better immune response and disease resistance.

These results indicated that supplemental organic acid may improve the immune response, as globulin level has been used as an indicator of immune responses and source of antibody (Kamal and Ragaa, 2014). This result is in harmony with those of Rahmani and Speer(2005), who found higher percentage of gamma globulin in broilers given organic acids than the control. The enhancement of immune response associated with dietary acidification could be due to their inhibitory effects against the pathogenic microorganisms throughout the gastrointestinal tract.

The findings of serum lipid profile are in agreement with Kamal and Ragaa(2014) who reported that blood total lipids, triglycerides and cholesterol decreased significantly by dietary acidifiers. The beneficial role of organic acids in reducing the blood lipid profile may be interpreted through their influence in decreasing the microbial intracellular pH (Abdel-Fattah et al. , 2008).

All supplements of either formic or citric acids decreased serum levels of urea, creatinine and activity of AST and ALT and increased activity of Alkaline phosphatase, urea/creatinine ratio, serum concentration of T3, T4, TAC,GSH,GPX and SOD as compared to the control group. The reduced serum levels of urea, creatinine of groups supplemented with different organic acids could be an indication to a better utilization of protein and amino acid digestibility as uric acid is the major end product of protein metabolism in poultry.

Supplementation of either formic or citric acids at the tested levels increased significantly percentages of dressing and total edible parts and decreased abdominal fat compared with controls. The results of carcass characteristics agree with Talebi et al. (2010), who reported that the added organic acids improved in the relative weights of carcass, giblets and dressing of birds fed citric acid compared to the control group. In addition, Ghazalah et al.(2011), reported that added dietary organic acid improved the relative weights of carcass, giblets and dressing of birds fed citric acid at 2 g/kg as compared to the control group.

Results reported herein showed that all dietary supplements decreased total bacterial count, Salmonella, E.Coli and proteus spp. compared to control group. Use of organic acids decreases the total bacterial and gram negative bacterial counts significantly in the broiler chicken (Gunal et al.,2006). Abdel-Fattah et al.(2008), reported that the reduced pH is conductive for the growth of favorable bacteria simultaneously hampering the growth of pathogenic bacteria which grow at a relatively higher pH.

IN CONCLUSION

under such experimental conditions, both formic and citric acids are shown to be effective in improving productive performance, immune response and general health of ducklings, especially formic acid at 0.5% and citric at 3% being the best

Table (1): Composition and nutrient contents of the basal diets of growing ducks from 7 to 70 days of age

Ingredients (%)	**Starter (7-35 d)**	**Grower (36- 70d)**
Yellow corn	56.40	68.00
Soybean meal (44%)	38.30	26.70
Limestone	1.00	1.00
Dicalcium phosphate	2.00	2.00
Salt (NaCl)	0.30	0.30
Vit+Min.premix1	0.30	0.30
DL-Methionine	0.10	0.10
Sunflower oil	1.50	1.50
Antifungal	0.10	0.10
Total	100.0	100.0
Calculated analysis (NRC, 1994)		
ME,kcal/Kg	2877	3007
Crude protein, %	21.7	17.59
Crude fiber, %	3.92	3.37
Ether extract, %	3.95	4.30
Lysine, %	1.18	0.90
Methionine %	0.44	0.39
Meth. + Cyst., %	0.79	0.69
Calcium, %	0.92	1.60
Total phosphorus, %	0.45	0.43
Available phosphorus%	0.52	0.31
Determined analysis: on DM basis (AOAC, 2000)		
Dry matter, %	92.60	91.42
Organic matter, %	91.75	91.67
Crude protein, %	23.46	19.24
Crude fiber, %	4.24	3.65
Ether extract, %	4.27	4.40
Ash, %	8.25	8.33
Nitrogen free extract,%	59.78	64.38

[1]Vit+Min mix. Provided per kilogram of the diet Vit. A: 6000 IU, vit. E (dl-α-tocopherylacetate: 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. $B_{12:}$ 4 μg, vit. B_6: 5 mg, thiamine: 3 mg, folic acid: 0.50 mg,and biotin: 0.02 mg. Trace mineral (mg/ kg of diet: Mn: 80 mg, Zn: 60 mg, Fe: 35 mg, Cu: 8 mg and Se: 0.1 mg).

Table (2): Performance of growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

Items	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	Sig.
Live body weight (g)							
7d	130.00	129.06	127.19	128.25	128.28	0.47	NS
35d	1297^{c}	1472^{a}	1351^{cb}	1385^{b}	1430^{ab}	11.6	*
70d	2306^{c}	2707^{a}	2561^{b}	2520^{b}	2771^{a}	17.3	*
Body weight gain (g)							
7-35 d	1167^{d}	1343^{a}	1224^{c}	1257^{b}	1302^{ab}	10.7	*
36-70d	1009^{c}	1235^{b}	1209^{b}	1135^{b}	1340^{a}	55.1	*
7-70d	2176^{c}	2578^{a}	2433^{b}	2392^{b}	2642^{a}	81.3	**
Feed intake (g):							
7-35d	2756^{a}	2385^{c}	2457^{b}	2488^{b}	2263^{d}	31.3	**
36-70d	5572^{a}	5042^{c}	5239^{b}	4872^{d}	4931^{d}	53.7	**
7-70d	8328^{a}	7427^{c}	7696^{b}	7360^{d}	7194^{d}	64.2	*
Feed conversion ratio (g feed/g gain).							
7-35d	2.362^{a}	1.775^{c}	2.007^{b}	1.979^{b}	1.738^{c}	0.139	*
36-70d	5.522^{a}	4.083^{bc}	4.333^{b}	4.293^{b}	3.679^{c}	0.315	*
7-70d	3.827^{a}	2.881^{c}	3.163^{b}	3.077^{b}	2.723^{d}	0.285	*
Economical efficiency and production index							
EE	0.149^{c}	0.414^{a}	0.357^{b}	0.365^{b}	0.490^{a}	0.0138	**
REE , %	100	277.8	239.6	245.0	328.8	9.26	**
EPEI , %	66.8^{c}	100^{a}	86.9^{b}	87.2^{b}	107^{a}	1.63	**

^{a,b,c,d} Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means. REE = Relative economic efficiency (REE) = (Economic efficiency/economic efficiency of the control)*100

Table (3): Some biochemical constituents of blood serum of growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

Items	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	Sig.
Urea, (mg/dl)	2.40^{a}	2.00^{c}	2.19^{b}	2.01^{c}	2.96^{b}	0.736	**
Creatinine, (mg/dl)	1.65^{a}	0.899^{c}	1.22^{b}	1.27^{b}	0.879^{c}	1.02	**
AST, (U/L)	60.4^{a}	56.3^{c}	56.6^{c}	57.4^{b}	57.3^{b}	0.731	**
ALT, (U/L)	66.4^{a}	62.2^{b}	61.7^{b}	59.8^{c}	57.7^{c}	1.12	**
ALT/AST	1.10^{c}	1.17^{a}	1.10^{a}	1.08^{d}	1.15^{b}	0.012	**
Alk. P,(U/100ml)	10.8^{b}	12.1^{a}	12.9^{a}	13.1^{a}	12.9^{a}	0.246	**
Glucose, (mg/dl)	81.4^{b}	86.1^{a}	86.8^{a}	86.6^{a}	87.6^{a}	0.401	**
T.Lipid, (mg/dl)	550^{a}	400^{c}	420^{b}	420^{b}	400^{c}	2.66	**
TRI, (mg/dl)	191^{a}	180^{d}	184^{b}	182^{c}	180^{d}	1.88	**
CHO, (mg/dl)	235^{a}	211^{b}	211^{b}	208^{c}	208^{c}	1.46	**
HDL, (mg/dl)	49.1	41.4	42.3	42.4	40.2	1.59	**
LDL, (mg/dl)	147^{a}	133^{b}	131^{b}	129^{b}	131^{b}	1.01	**

^{a,b,c,d} Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means.AST=aspartate amino transferase; ALT=alanine amino transferase; Alk. P =Alkaline phosphatase;CHO= total cholesterol; TRI= triglycerides;HDL=high-density lipoprotein; LDL=low-density lipoprotein.

Table (4): Thyroid hormones level and antioxidant statusof growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

Items	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	Sig.
T3, (ng/ml)	2.09^{c}	2.15^{b}	2.14^{b}	2.17^{a}	2.19^{a}	1.36	*
T4, (ng/ml)	11.4^{c}	14.3^{b}	14.6^{b}	15.9^{a}	15.5^{a}	0.731	**
TAC, (Mmol/dl)	407^{b}	418^{a}	419^{a}	419^{a}	422^{a}	2.11	**
GPX, (U/L)	41.0^{b}	46.5^{a}	45.6^{a}	47.6^{a}	47.4^{a}	1.17	**
GSH, (U/L)	977^{c}	990^{a}	988^{b}	984^{b}	996^{a}	2.24	**
SOD, (U/L)	241^{c}	258^{a}	250^{b}	251^{b}	256^{a}	2.25	**

^{a,b,c,d} Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$); SEM= Standard error of means. T3= triiodothyronine; T4=thyroxine; TAC=total antioxidant capacity; GPX =glutathione peroxidase; GSH= glutathione; SOD=superoxide dismutase

Table (5): Hematological traits of growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

Items	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	Sig.
RBC's, (10^6/cmm^3)	2.26^c	3.12^b	3.32^b	3.18^b	3.56^a	0.495	**
Hb, (g/100ml)	10.1^c	13.2^b	13.5^b	13.3^b	15.9^a	0.375	**
PCV, %	25.4^c	36.3^b	39.8^b	35.5^b	41.3^a	1.81	**
MCV, (um^3)	112.4^b	116.0^a	119.9^a	111.6^b	116.0^a	0.394	*
MCH, (Pg)	44.6^a	42.31^b	40.66^c	41.82^b	44.66^a	1.13	**
MCHC, (g/100ml)	39.7	36.3	38.0	37.4	38.4	1.13	**
WBC's, (10^3/cmm^3)	25.1^b	28.8^a	27.7^a	28.7^a	26.9^a	0.491	**
Lymphocytes, (%)	41.2^b	44.6^a	46.6^a	44.9^a	44.5^a	0.801	**
Monocytes, (%)	14.8^c	16.9^b	14.9^a	16.5^b	16.7^b	0.200	**
Basophils, (%)	1.00	0.01	1.00	0.01	0.01	0.241	NS
Eosinophils, (%)	18.9	14.1	12.9	13.8	14.3	0.682	NS
Heterophils, (%)	24.1	24.4	24.5	24.9	24.5	0.604	NS
Hetero/Lympho ratio	0.584	0.545	0.521	0.477	0.545	0.025	NS

[a,b,c,d] Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means.RBC's=red blood cell; HB= Hemoglobin; PCV=packed cell volume; MCH=mean corpuscular hemoglobin; WBC's=white blood cell; MCV=Mean cell volume; MCH= Mean Corpuscular Hemoglobin; MCHC= Mean Corpuscular Hemoglobin Concentration.

Table (6): Immune indices of growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

Items	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	NS
Total protein, (g/dl)	5.90^{b}	6.65^{a}	6.50^{a}	6.65^{a}	6.55^{a}	0.20	**
Albumin, (g/dl)	3.5^{b}	3.4^{b}	3.0^{c}	3.3^{b}	3.6^{a}	0.11	**
Globulin (g/dl)	2.2^{d}	3.5^{a}	3.4^{b}	3.2^{c}	3.5^{a}	0.23	**
Albumin/globuline	1.59	0.91	0.88	1.03	1.2	0.13	NS
α–globulin, (µg/dl)	0.8^{c}	1.3^{a}	1.1^{b}	1.1^{b}	1.3^{a}	0.07	**
β -globulin, (µg/dl)	0.8^{c}	1.0^{b}	1.3^{a}	1.0^{b}	1.0^{b}	0.06	**
γ -globulin, (µg/dl)	0.5^{c}	1.4^{a}	1.0^{b}	1.0^{b}	1.2^{a}	0.06	*
LA, (IU %)	10^{b}	12^{a}	14^{a}	13^{a}	12^{a}	0.37	*
BA, (%)	31^{c}	41^{a}	38^{b}	36^{b}	40^{a}	0.75	*
LTT, (%)	21^{c}	27^{a}	24^{b}	24^{b}	26^{a}	0.98	**
PI, (%)	18^{b}	20^{a}	22^{a}	22^{a}	22^{a}	0.77	**
PA, (%)	18^{b}	22^{a}	24^{a}	23^{a}	22^{a}	1.02	**
IgA, (mg/100 ml)	71^{b}	76^{a}	79^{a}	80^{a}	80^{a}	1.05	**
IgG, (mg/100 ml)	961^{c}	977^{a}	971^{b}	975^{b}	977^{a}	3.03	*
IgM, (mg/100 ml)	231^{c}	240^{a}	236^{b}	236^{b}	241^{a}	1.79	*

^{a,b,c,d} Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means.PA: Phagocytic activity; PI= Phagocytic index;LA= lysozyme activity; BA= bactericidal activity;LTT= Lymphocyte transformation test; IgA= Immunoglobulin A; IgG= Immunoglobulin G; IgM= Immunoglobulin M.

Table (7):relative weight of carcass characteristics and lymphoid organs of growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

Items	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	NS
Carcass characteristics							
carcass yield, %	61.80^{c}	72.70^{a}	69.20^{b}	69.10^{b}	70.40^{a}	1.83	*
T.edible parts, %	66.44^{c}	78.97^{a}	75.01^{b}	75.95^{b}	76.58^{a}	0.85	*
Liver,%	1.81	2.26	1.91	2.67	2.32	0.15	NS
Gizzard,%	2.36	3.39	3.19	3.48	3.09	0.20	NS
Heart,%	0.47	0.62	0.71	0.70	0.77	0.05	NS
Fat, %	0.71^{a}	0.30^{c}	0.44^{b}	0.44^{b}	0.26^{d}	0.04	**
Lymphoid organs							
Spleen, %	0.030	0.020	0.020	0.030	0.040	0.10	NS
Thymus, %	0.27	0.35	0.25	0.15	0.33	0.07	NS

^{a,b,c,d} Means in the same row followed by different superscripts are significantly different at ($p \leq 0.05$); SEM= Standard error of means

Table (8): Bacterial countsof growing ducks as affected by dietary source and level of organic acids from 7 to 70 days of age

	Control	Formic 0.5 %	Formic 1.0 %	Citric 2.0 %	Citric 3.0 %	SEM	NS
TBC	3.20^{a}	2.35^{b}	2.45^{b}	2.20^{c}	2.15^{c}	0.13	**
Salmonella	1.21^{a}	0.70^{b}	0.70^{b}	0.50^{c}	0.50^{c}	0.11	**
E.Coli	1.20^{a}	1.01^{b}	1.00^{b}	0.75^{c}	0.70^{c}	0.14	**
Proteus.	0. 90^{a}	0.50^{b}	0.60^{b}	0.40^{c}	0.40^{c}	0.09	**

^{a,b,c,d} Means in the same row followed by different superscripts are significantly different at($p \leq 0.05$); SEM= Standard error of means

TBC = Total Bacterial Count

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الملخص العربى

تأثير إستخدام الاحماض العضوية علي الاداء الانتاجي ،خصائص الدم البيوكيمياوية والهيماتولوجية والاستجابة المناعية لسلالة البط الفرنساوي (CAIRINA MOSCHATA)

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أجريت هذه الدراسة في وحدة بحوث الدواجن بمزرعه البستان، قسم الانتاج الحيواني والداجني، كلية الزراعة جامعة دمنهور. هدفت هذه الدراسة إلى تقييم تأثير إضافة الاحماض العضوية (الفورميك والستريك) على أداء النمو،والكفاءة الاقتصادية، والصفات البيوكيميائية والهيماتولوجية للدم والاستجابة المناعية عند عمر 70 يوما لسلالة البط الفرنساوي. إستخدم في هذه التجربة عدد مائتان وخمسون من كتاكيت البط الفرنساوي غير المجنسة عمر 7 أيام و التي وزعت علي خمسة معاملات بكل منها عدد 50 كتكوت موزعة علي خمسة مكررات بكل مكرر عشرة طيور. إستخدمت المجموعة الأولي للمقارنة (كنترول) غذيت المعاملات رقم 2، 3 علي علائق أضيف إليها الحامض العضوي الفورميك بمستويات 0,5 و 1 % بينما غذيت المعاملات رقم 4، 5 علي علائق أضيف إليها الحامض العضوي الستريك بمعدل 2و 3%.

أظهرت النتائج حدوث زيادة معنوية في وزن الجسم الحي ومعدل الزيادة في وزن الجسم وحدوث انخفاض في استهلاك العلف وكذلك حدوث تحسن في الكفاءة الغذائية والكفاءة الاقتصادية ووزن الذبيحة في المجموعات التي غذيت علي الاحماض العضوية مقارنة بمجموعة الكنترول. وكان افضل المعاملات تلك التي غذيت علي الحامض العضوي الفورميك 0.5% والستريك 3% مقارنة بباقي المعاملات

أظهرت النتائج أيضا حدوث زيادة معنوية في مستوي بروتينات و ألبيومينات الدم والجلوبيولينات المناعية في المجموعات المضاف لها الاحماض العضوية 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 الاحماض العضوية مقارنة بمجموعة الكنترول. سجلت زيادة في مستوي جلوكوز الدم وكذلك زيادة في تركيزات هرمونات الغدة الدرقية وأيضا تحسن في مستوي انزيمات الاكسدة المختلفة في سيرم الدم في المجموعات المغذاة علي الاحماض العضوية 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 بروتين السيرم الكلي جلوبيولين السيرم والألفا والجاما جلوبيولين بالمقارنة مع مجموعه الكنترول .

أدت جميع الإضافات إلى زيادة مستوى انزيم (SOD) و الجلوتاثيون(GSH)والجلوتاثيون بيروكسيديز والقدرة المضادة للأكسدة والنشاط البلعمى 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 في المجموعات المغذاه علي الاحماض العضوية (الفورميك- الستريك) مقارنة بالكنترول ، وكان أفضل المعاملات تلك المغذاه علي الحامض العضوي الستريك مفارنة ببقية المعاملات .

مما سبق يتضح أن إضافة الاحماض العضوية (الفورميك- الستريك) إلي علائق البط الفرنساوي بأي من المستويات المدروسة ادت الي تحسن في الاداء الانتاجي والاقتصادي والفسيولوجي والمناعي للبط الفرنساوي تحت ظروف إجراء هذه الدراسة .