# Effect of Dietary Supplementation of Organic Acids on Performance and Serum Biochemistry of Broiler Chicken

Azza M. Kamal[1] and Naela M. Ragaa[2]

[1] Biochemistry Dept, Animal Health Research Institute, Dokki 12618,Gizza,Egypt.
[2]Nutrition and Clinical Nutrition Dept., Fac. Vet. Med., Cairo University, 12211 Giza, Egypt.
nalamohamed@gmail.com

**Abstract:** This study was conducted to compare the effects of dietary supplementation of different types of organic acids on the performance and blood biochemistry of broiler chicken. Two hundred of commercial (Arbor acres) broiler chicks were randomly divided into 4 main groups (50 birds) of each. The control (T 1) group were fed the basal diet whereas in other treatment groups basal diet was supplemented with 3% butyric acid (T 2), 3% fumaric acid (T 3) and 3% lactic acid (T 4). The experiment was lasted when chicks were 42d old. Growth performance and some biochemical blood parameters were measured. Results obtained could be summarized as follow 1.Broiler chicken fed diets supplemented with organic acids had significantly ($p < 0.\ 0\ 5$) improved body weight gains and feed conversion ratio. No effect ($p < 0.\ 0\ 5$) on cumulative feed consumption was observed. 2. Broiler chicken fed acidified diets had better immune response as indicated by a higher serum globulin level than the control. On the other hand, significant reduction in serum level of cholesterol, total lipid or low density lipoprotein (LDL) was achieved due to dietary acidification. While, serum calcium, phosphorus and magnesium concentrations were significantly increased. At the same time, dietary acidification significantly elevated, triiodotyrosin (T3) concentration as well as T3:T4 ratio, but thyroxin (T4) level was not significantly affected. Moreover, liver and kidney functions did not adversely affected, while the activity of alkaline phosphatase was recorded to be significantly decreased in response to addition of organic acids. The results indicated that the organic acid supplementation, irrespective of type and level of acid used, had a beneficial effect on the performance of broiler chicken.

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**Key words:** Organic acids, broiler performance, serum biochemistry, immunity

**Abbreviations:** Alanine amino trasferase (ALT), Albumin globulin ratio (A/G ratio), Antibacterial growth promoters (AGP) Aspartate amino trasferase (AST), Gastro intestinal tract (GI-tact), High density lipoprotein (HdL) Low density lipoprotein (LDL), Thyroxin (T4), Triiodotyrosin (T3)

## 1.Introduction

A new challenge in the poultry production is to take advantage of the use of specific dietary supplements to achieve better poultry performance and feed conversion.

The increased pressure on livestock industry to phase out the use of prophylactic dosages of antibacterial growth promoters (AGP) in the European Union due to microbial resistance in animals and human and the prospective to do same in other parts of world has stimulated increased interest in alternative natural growth promoters (Ján, *et al.,* 2012). One such non therapeutic alternative was the use of organic acids as feed additives in the animal production, (Sheikh *et al.,* 2010).

Organic acids and their salts are generally considered as safe (GRAS) and have been approved by most member states of EU to be used as the feed additives in animal production.

Organic acids work in animals, not only as a growth promoter but also as a significant tool of controlling all intrinsic bacteria, both pathogenic and non pathogenic (Naidu, 2000 and Wolfenden *et al*., 2007). Organic acids in non dissociated (non-ionised, more lipophilic) form can penetrate the bacteria cell wall and disrupt the normal physiology of certain types of bacteria (Dhawale, 2005). Acidification with various organic acids has been reported to reduce the production of toxic components by the bacteria and colonization of pathogens on the intestinal wall, thus preventing the damage to epithelial cells (Langhout, 2000).

Apart from the antimicrobial activity, they reduce the pH of digesta, increase the pancreatic secretion, and have trophic effects on the mucosa of gastro-intestinal tract (Dibner and Buttin,2002). Afsharmanesh and Pourreza (2005) suggested that the reduction in gastric pH which occurs following organic acid feeding may increase pepsin activity.

Peptides arising from pepsin proteolysis trigger the release of hormones, including gastrin and cholecystokinin, which regulate the digestion and absorption of protein (Hersey, 1987, Dibner and Buttin,2002). Therefore, the acid anion has been shown to complex with Ca, P, Mg, and Zn, which results in an improved digestibility of these minerals and serve as substrates in the intermediary metabolism (Kishi *et al*., 1999).

Moreover, organic acids feeding is believed to have several beneficial effects such as improving feed conversion ratio, growth performance, enhancing mineral absorption and speeding recovery from fatigue (Král *et al.,* 2011, Gálik, and Rolinec, 2011 and Petruška *et al.,* 2012).

The present study was conducted with the objectives to evaluate the effect of dietary supplementation of organic acids on the performance and serum biochemistry of the broiler chicken.

**2. Material and methods**

The experimental work of this study was carried out at a commercial poultry farm at Giza city, Egypt, at winter. A total of 200, commercial one day old broiler chicks (Arbor acres). On arrival, the chicks were provided with 8% sugar solution and ground maize for the first 12 hours. To avoid stress, the water soluble vitamins and electrolytes were added to the drinking water for the first 3 days. At 7 days of age, the birds were individually weighed and randomly assigned into the four groups (50 chicks/ group). The first group was kept as a control(T1) and given the basal diet while, second (T2),third (T3) and fourth (T4) groups given a 3% butyric acid,3% fumeric acid and 3% lactic acid respectively in the diet. The dose of organic acids were determined according to (Sheikh *et al.,*2010) who found that Broiler chicken fed diets supplemented with 2% butyric acid, 3% butyric acid, 2% fumaric acid,3% fumaric acid, 2% lactic acid, and 3% lactic acid improved body weight gains and feed conversion ratio irrespective of type and level of acid used.

Basal diets were formulated to meet the nutrient requirements of arbor acres broiler at starter (1-21d) and grower finisher (22-42) periods. The ingredients and composition of the control diet are listed in (Table 1). The chemical analysis was done as per AOAC (1996).

The feed ingredients were always properly mixed and prepared in lots of 60 kg for each treatment. The organic acids were obtained as powders from the Egyptian Company for laboratory Services, Cairo, Egypt. The organic acids powder was mixed thoroughly in above-mentioned quantities to a small amount of feed (1 kg) in a premixer.

The chicks were floor reared in an electrically heated experimental room bedded by a layer of chaffed wheat straw with a 24 hours consistent lighting schedule. The temperature was gradually reduced from 32 to $20^0$C on day 42. The birds were provided with clean water and fed ad-libitum during the experimental period (6 weeks) on iso -caloric iso-nitrogenous experimentally formulated diets, (Table 1). The feeding program consisted of a starter diet until 21 days and a finisher diet until 42 days of age. Proper ventilation was ensured by means of the exhaust fans. All birds were kept under standard hygienic conditions and were subjected to a prophylactic vaccination and pharmacological program against viral and bacterial diseases. The birds were vaccinated against New castle, Gumboro's and Avian influnza diseases.

The body weight of birds per group was recorded on the individual basis at weekly intervals. The cumulative feed consumption per group was also recorded on the weekly basis. Feed conversion ratio per group was worked out at weekly intervals by taking into consideration the weekly body weight gain and the feed consumption of respective group.

At the end of the feeding trial, five birds per treatment were selected at random and utilized for the carcass evaluation study. Each bird was weighed immediately before severing the jugular vein at the atlantooccipital joint and then allowed to bleed. The shanks were cut off at the hock joint, and carcass was subjected to the scalding process at60 ° C for 30 seconds. The feathers were removed completely by hand picking leaving the skin intact. Thereafter, the abdominal cavity was opened to expose the visceral organs, and the carcass characteristics were evaluated.

Blood samples were collected from the slaughtered birds in non heparinised tubes. The samples were centrifuged at 3000 rpm for 15 minutes, and the serum obtained was stored at −20 °C until analysis.

Sera were used for determination of total proteins (Armstrong and Carr,1964), Total albumin (Doumas *et al.,* 1971), total globulin (Rehulka (1993). Serum transaminases ALT and AST were determined according to Reitman and Frankel (1957). Total Lipids (Frings *et al.,* 1970), Total cholesterol and HdL-cholesterol (Burtis and Ashwood, 1994), Triglycerides (Mc Gowan *et al.,* 1983), LDL cholesterol according to,Friedewald *et al.* (1972). Serum levels of Phosphorus (Goodwin,1970), Calcium, (Gindler and King,1972), Magnesium (Gindler, 1971), Urea (Patton and Crouch, 1977), Uric acid (Tietz,1986) and Creatinine (Husdan, 1968) and Alkaline phosphatase according to (Kind and King,1954) were also determined. In addition, serum concentration of T3 and T4 were also measured based on solid phase radioimmunoassay technique based on antibody coated tubes according to (Burger *et al.,* 1982) and (Albertini & Ekins,1982) respectively.

**Table 1: Ingredient and chemical composition of experimental basal diets.**

| Ingredients (%) | Starter | Grower |
|---|---|---|
| Yellow corn | 53.86 | 57.30 |
| Soya bean meal (44%) | 35.6 | 32.10 |
| Fish meal (herring 72%) | 2.50 | 2.10 |
| Limestone | 1.30 | 1.25 |
| DCP | 1.80 | 1.30 |
| vitamin premix* | 0.19 | 0.19 |
| Trace mineral mixture** | 0.23 | 0.23 |
| Salt | 0.30 | 0.30 |
| L-lysine | 0.08 | 0.03 |
| DL-methionine | 0.18 | 0.10 |
| Vegetable oil | 3.96 | 5.10 |
| Analyzed Values: | | |
| Crude protein % | 22.04 | 20.51 |
| Crude fiber % | 4.915 | 4.997 |
| Ether extract % | 7.235 | 8.614 |
| Total ash % | 4.013 | 3.731 |
| Calculated Values: | | |
| Metabolizable energy (Kcal/Kg diet) | 3026.42 | 3151.17 |
| Calcium % | 1.048 | 0.901 |
| Available phosphorus % | 0.505 | 0.402 |
| Lysine % | 1.292 | 1.073 |
| Methionine % | 0.581 | 0.460 |

*Vitamin premix (per 2.5 kg of diet): vitamin A 15.000 IU, vitamin D3 1.500 IU, vitamin E 20 mg, vitamin K3 5 mg, vitamin B1 3 mg, vitamin B2 6 mg, niacin 25 mg, vitamin B6 5 mg, vitamin B12 0.03 mg, folic acid 1 mg, D-biotin 0.05 mg, Ca-D-pantothenate 12 mg, carophyll-yellow 25 mg, and cholinechloride400 mg.

**Trace mineral premix (per kg of diet): Mn 80 mg, Fe 60 mg, Zn 60 mg, Cu 5 mg, Co 0.2 mg, I 1 mg, and Se 0.15 mg.

**Table 2: Effect of organic acid supplementation on the performance and carcass characteristics of broiler chicken.**

| Parameters | T1<br>Control | T2<br>3% butyric acid | T3<br>3% fumeric acid | T4<br>3% lactic acid | No. of observation /group | Sig |
|---|---|---|---|---|---|---|
| Initial body weight (g) | $42 \pm 3.9^{a}$ | $42 \pm 3.2^{a}$ | $42 \pm 3.9^{a}$ | $42 \pm 3.5^{a}$ | 50 | NS |
| Final body weight (g) | $1574.4 \pm 18.5^{a}$ | $1717.7 \pm 21.1^{b}$ | $1766.2 \pm 22^{b}$ | $1727 \pm 25.2^{b}$ | 50 | * |
| Final body weight gain (g) | $1532.4 \pm 23.6^{a}$ | $1675.7 \pm 22.1^{b}$ | $1724.2 \pm 26.3^{b}$ | $1685.0 \pm 26.8^{b}$ | 50 | * |
| Feed consumption (g) | 3085.3 | 3075.3 | 3115.6 | 3070.3 | | NS |
| Feed conversion ratio | 2,013 | 1.835 | 1.807 | 1.822 | | |
| Dressing percentage | $71.79 \pm 6.63^{a}$ | $72.70 \pm 6.79^{a}$ | $73.07 \pm 5.97^{a}$ | $72.30 \pm 5.38^{a}$ | 5 | NS |
| Gizzard weight (g) | $37.35 \pm 2.88^{a}$ | $39.12 \pm 3.05^{a}$ | $40.66 \pm 3.33^{a}$ | $40.46 \pm 4.43^{a}$ | 5 | NS |
| Heart weight (g) | $9.33 \pm 0.53^{a}$ | $11.21 \pm 1.55^{a}$ | $11.51 \pm 1.25^{a}$ | $10.75 \pm 1.16^{a}$ | 5 | NS |
| Liver weight (g) | $42.66 \pm 4.17^{a}$ | $45.33 \pm 4.88^{a}$ | $44.56 \pm 3.75^{a}$ | $42.33 \pm 4.05^{a}$ | 5 | NS |
| Head weight (g) | $52.12 \pm 5.75^{a}$ | $62.20 \pm 6.56^{a}$ | $55.33 \pm 5.63^{a}$ | $52.22 \pm 5.57^{a}$ | 5 | NS |
| Feather weight (g) | $189.60 \pm 54.9^{a}$ | $185.35 \pm 47.3^{a}$ | $179.63 \pm 41.4^{a}$ | $192.55 \pm 65.29^{a}$ | 5 | NS |

*Means± SE within the same row with different superscripts are significantly different (P≤.05).
NS: Non significant

**Table 3. Effect of dietary organic acids supplementation on serum total protein, albumin and globulin in broiler chicken:**

| Items | T1<br>Control | T2<br>3% butyric acid | T3<br>3% fumeric acid | T4<br>3% lactic acid | No. Of observation/group | sig |
|---|---|---|---|---|---|---|
| **Total Protein(g/dl)** | $5.679 \pm 0.42^{a}$ | $5.734 \pm 0.35^{a}$ | $5.825 \pm 0.50^{a}$ | $5.852 \pm 0.41^{a}$ | 3 | NS |
| **Albumin(g/dl)** | $3.967 \pm 0.22^{a}$ | $3.762 \pm 0.25^{a}$ | $3.852 \pm 0.19^{a}$ | $3.771 \pm 0.24^{a}$ | 3 | NS |
| **Globulin(g/dl)** | $1.712 \pm 0.21^{a}$ | $1.972 \pm 0.15^{b}$ | $1.973 \pm 0.14^{b}$ | $2.081 \pm 0.18^{c}$ | 3 | * |

*Means± SE within the same row with different superscripts are significantly different at (P≤.05).
NS: Means± SE within the same row with same superscripts are Non significantly different at (P≤.05).

**Table 4. Effect of dietary organic acids supplementation on serum lipid profile in broiler chicken:**

| tems | T1 Control | T2 3% butyric acid | T3 3% fumeric acid | T4 3% lactic acid | No. Of Observation /group | sig |
|---|---|---|---|---|---|---|
| **Total Lipid (mg/dl)** | 190.60±25.5[a] | 184.70±24.8[b] | 185.50±23.5[b] | 182.45±25.7[b] | 3 | * |
| **Cholestero (mg/dl)** | 96.68±1.90[a] | 90.50±1.45[b] | 92.75±2.1[b] | 89.50±2.2[b] | 3 | * |
| **Triglycerides (mg/dl)** | 133.50±12.25[a] | 132.50±12.50[a] | 131.50±10.50[a] | 129.75±11.50[a] | 3 | Ns |
| **LDL (mg/dl)** | 46.00 ± 4.12[a] | 41.50±3.90[b] | 39.25±3.20[b] | 40.29±3.12[b] | 3 | * |
| **HDL (mg/dl)** | 25.07 +2.92[a] | 24.50 +2.02[a] | 23.75 +2.22[a] | 24.35 +2.15[a] | 3 | Ns |

*Means± SE within the same row with different superscripts are significantly different at ($P \leq .05$).
NS: Means± SE within the same row with same superscripts are Non significantly different at ($P \leq .05$).

**Table 5. Effect of dietary organic acids supplementation on serum calcium, phosphorus and magnesium in broiler chicken:**

| Items | T1 Control | T2 3% butyric acid | T3 3% fumeric acid | T4 3% lactic acid | No. Of Observation /group | sig |
|---|---|---|---|---|---|---|
| **Calcium (mg%)** | 5.25±0.52[a] | 6.73±0.70[b] | 6.55±0.55[b] | 6.35±0.62[b] | 3 | * |
| **Phosphorus(mg%)** | 2.53±0.28[a] | 3.50±0.36[b] | 3.24±0.33[b] | 3.20±0.25[b] | 3 | * |
| **Magnesium(mg%)** | 3.22±0.35[a] | 3.95±0.38[b] | 3.75±0.39[b] | 3.76±0.36[b] | 3 | * |

*Means± SE within the same row with different superscripts are significantly different at ($P \leq .05$).
NS: Means± SE within the same row with same superscripts are Non significantly different at ($P \leq .05$).

**Table6: Effect of dietary organic acids supplementation on serum thyroid gland activity in broiler chicken:**

| Items | T1 Control | T2 3% butyric acid | T3 3% fumeric acid | T4 3% lactic acid | No. Of Observation /group | sig |
|---|---|---|---|---|---|---|
| **T3** (ng/ml) | 0.57 ±0.06[a] | 0.80 ±0.08[b] | 0.75±0.08[b] | 0.72±0.07[b] | 3 | * |
| **T4 (ng/ml)** | 6.824±0.71[a] | 7.02±0.75[a] | 6.24±0.63[a] | 6.70±0.65[a] | 3 | Ns |
| **T3:T4** | 0.083 ±0.003[a] | 0.113 ±.006[b] | 0.120±0.001[b] | 0.107±0.003[b] | 3 | * |

*Means± SE within the same row with different superscripts are significantly different at ($P \leq .05$).
NS: Means± SE within the same row with same superscripts are Non significantly different at ($P \leq .05$).

**Table 7: Effect of dietary organic acids supplementation on serum liver and kidney functions in broiler chicken:**

| Items | T1 Control | T2 3% butyric acid | T3 3% fumeric acid | T4 3% lactic acid | No. Of Observation/group | Sig |
|---|---|---|---|---|---|---|
| **AST (u/L)** | 64.70±5.73[a] | 63.50±4.75[a] | 63.25±5.57[a] | 65.75±6.21[a] | 3 | Ns |
| **ALT (u/L)** | 29.80 ±2.21[a] | 30.56±2.75[a] | 28.12±2.82[a] | 30.08±3.12[a] | 3 | Ns |
| **Alkaline p h. (U/dl)** | 18.77±0.89[a] | 13.25±1.08[b] | 16.33±1.73[c] | 15.13±1.62[c] | 3 | * |
| **Creatinine (mg/dl)** | 1.15±0.32[a] | 1.22±0.25[a] | 1.12±0.09[a] | 1.18±0.11[a] | 3 | Ns |
| **Uric acid (mg/dl)** | 4.32±0.45[a] | 4.20±0.52[a] | 4.26±0.44[a] | 4.28±0.44[a] | 3 | Ns |

*Means± SE within the same row with different superscripts are significantly different at ($P \leq .05$).
NS: Means± SE within the same row with same superscripts are Non significantly different at ($P \leq .05$).

The data obtained was statistically assessed by the analysis of variance (ANOVA) through General Linear Model procedure of SPSS (14.0) software. The values were expressed as means ± standard error. Duncan's,(1995) multiple range test was used to test the significance of difference between means by considering the differences significant at $p \leq 0.05$.

**3. Results:**

**3.1. Performance and carcass characteristics:**

The effects of dietary supplementation of organic acids on growth performance of broiler chickens were summarized in table 2. At the end of feeding trial, the groups fed on (0.3% butyric acid, 0.3% fumeric acid and 0.3% lactic acid) showed significant increase in live body weight gain by 9.4%, 12.5% and 9.9% ($P \leq 0.05$) respectively compared with control group.

The feed consumption was found statistically non-significant decrease among all the treatment groups in comparing to control one (Table 2).

The carcass characteristics of broiler chicken fed diets supplemented with the organic acids showed no significant differences between various treatment groups (Table 2).

**3.2. Effect of organic acids on serum parameters:**

Data presented in (Table.3) showed that, the organic acids supplemented groups exhibited relatively remarkable increase; although insignificant in the serum concentration of total protein compared with control one. But there is a significant increase in serum globulin. Hence, serum albumin values showed no significant difference among all groups including the control.

Results of serum lipid profile represented in (Table.4) revealed that, broilers fed organic acids supplemented diets were exhibited a lowest level of serum total lipids, serum cholesterol and low density lipoproteins (LDL) compared with non supplemented control group.

Broilers fed on supplemental organic acids had significantly ($p<0.05$) higher blood Ca, P and Mg concentrations, (Table 5) than those given un-supplemented diet. The results recorded in (Table 6) showed that, organic acidification of broiler diets leads to elevated serum triiodothyronine (T3) concentration, than control group, Abdel-Fattah *et al.*(2008), revealed that, any obvious alteration in thyroid function (hyperthyroidism or hypothyroidism) is reflected as altered metabolic rate. Actually, the influence was more pronounced with the addition of either butyric, fumaric or lactic acids. Similar trend was nearly observed for T3: T 4 ratio, However, serum T4 level was not significantly affected.

Data of table (7) represented that, a non-significant difference was found among all experimental groups including the control one for both ALT and AST activity. Data of uric acid showed a slight insignificant reduction in uric acid concentration.

## 4. Discussion:

### 4.1. Performance and carcass characteristics:

The results of the present study regarding weight gains agree with Owens *et al.* (2008), Sheikh *et al.*(2011) and Ghazalah, *et al.* (2011) who reported that the supplementation of organic acids in broiler chicken improved the body weight gain when compared with the un supplemented group. The improved body weight gain 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 macromolecules or interfere with the nutrient transport and energy metabolism causing the bactericidal effect, (Ricke, 2003).

Use of organic acid mixture decreases the total bacterial and gram negative bacterial counts significantly in the broiler chicken, Gunal *et al.*, 2006. Besides, the butyric acid has been reported to reduce the virulent gene expression and invasiveness in *Salmonella* Enteritidis, leading to its decreased colonization in the caeca of broiler chicken,Van Immerseel *et al.* (2004).

Furthermore, organic acids supplementation has pH reducing property, although no significant, in various gastrointestinal segments of the broiler chicken Abdel-Fattah *et al.* (2008). The reduced pH is conducive for the growth of favourable bacteria simultaneously hampering the growth of pathogenic bacteria which grow at a relatively higher pH. However, it is worth mentioning that the effects of organic acids down the digestive tract diminish because of the reduction in concentration of acids as a result of absorption and metabolism, Bolton and Dewar (1964).

Thus, it can be hypothesized that the effect of organic acids in the distal segments of gastro-intestinal tract could be due to the reduced entry of pathogenic bacteria from the upper parts of gastro-intestinal tract as a compensatory mechanism but no valid literature regarding such mechanism was found. The beneficial microbiological and pH-decreasing abilities of organic acids might have had resulted in the inhibition of intestinal bacteria leading to the reduced metabolic needs, thereby increasing the availability of nutrients to the host. This also had decreased the level of toxic bacterial metabolites as a result of decrease bacterial fermentation, causing an improvement in the protein and energy digestibility, thus improves the weight gain and performance of experimental birds. Facilitating the nutrient absorption to a greater extent and, thus boosted the growth promoting effect of organic acid supplementation, Sheikh *et al.*, 2010.

The results of feed consumption be through with Hernandez *et al.* (2006) and Sheikh, *et al.* (2011) who found no difference in the cumulative feed consumption between the groups fed organic acids and the control group. Chicks fed the diets supplemented with organic acids showed a significant improvement in the FCR as against the chicks fed the control diet (Table 2). The improvement in the FCR could be possibly due to better utilization of nutrients resulting in increased body weight gain (Table 2) in the birds fed organic acids in the diet. These results are coincide with the reports of (Vogt *et al.*,1981, Runho, *et al.*, 1997 and Ghazalah, *et al.*, 2011) who reported that the supplementation of organic acids improved the feed conversion ratio in broiler chicken.

The results of carcass characteristics confirming the earlier findings, Thirumeignanam *et al.*, 2006.

### 4.2. Effect of organic acids on serum parameters:

The non significant increase in total protein could be due to the achieved significant increase in the serum concentration of globulin level by the supplemented groups. The present results match with those obtained in broiler chicks (Abdo, 2004) due to citric acid and acetic acid inclusion, respectively. These results indicated that supplemental organic acids may improve the immune response. Globulin level has been used as indicator of immune responses and source of antibody production. El-Kerdawy, (1996) stated that high globulin level and low A/G ratio signify better disease resistance and immune response. 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 ones. The enhancement of immune response associated with dietary acidification could be due to their inhibitory effects against the pathogenic microorganisms throughout the GI-tract.

The findings of serum lipid profile are in agreement with Abdo and Zeinb, (2004), who reported that blood total lipids 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. Thus, inhibits the action of important microbial enzymes and forces the bacterial cell to use energy to release the acid protons, leading to an intracellular accumulation of acid anions (Young and Foegeding, 1993). Also, Abdel-Fattah *et al.* (2008), show that, the observed lower feed consumption (Table. 2), during the period of growth and consequently lower fat intake that resulted in fat depletion may also contribute in reducing blood lipid content. Moreover, the observed hyperthyroidism (Table 6) associated with dietary organic acidification could also explain the observed reduction in serum lipid profile.

The increase of Ca and P levels in blood serum produced by addition of organic acids may be attributed to the lowering of GI-tact pH by using these acids, which increases the absorption of such minerals from the gut into the blood stream. Improving the utilization of calcium and phosphorus by organic acids supplementation was revealed by Boling *et al.*(2001). Also, Abdo and Zeinb (2004). observed an increase in blood calcium of broiler chicks fed on dietary acidifier. In this respect, Abdel - Azeem *et al.* (2000) and Edwards and Baker (1999), found that, the acidic anion has been shown to complex with Ca, P, Mg and Zn, which results in an improved digestibility of these minerals. Furthermore, (Kishi *et al.*,1999) reported that dietary acetic acid prevented osteoporosis, through reducing the bone turnover, as it enhanced intestinal Ca absorption by improving Ca solubility in ovariectomized rats.

The result of ALT and AST means that broilers could tolerate the addition of 3% organic acids without any deleterious effects on liver functions. These results are in full agreement with those of El-Kerdawy (1996). While, Abdel-Azeem *et al.* (2000) showed that level of AST was reduced although ALT was not significantly affected.

The findings of uric acid are coincide with Sturkie (1986)who revealed that dietary addition of organic acid slightly reduced serum concentration of uric acid. This result could be referred to the better utilization of protein and amino acid digestibility. As uric acid is the major end product of protein metabolism

In conclusion, this study outstanding the importance of using organic acid as feed additives to improve the growth performance of broilers through their physiological action in inducing the growth and activities of some endogenous mechanisms and their beneficial antimicrobial effect which may be responsible for better performance. Further studies are needed to throw more light on the developmental effects of those organic acids on the broilers physiological functions, with the consideration of using different levels and combinations.

**Corresponding author**
Naela M. Ragaa
Nutrition and Clinical Nutrition Dept., Fac. Vet. Med., Cairo Uni., 12211 Giza, Egypt.
nalamohamed@gmail.com

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