Influence of some organic acids supplementation on growth performance and some biochemical parameters in growing Rabbits

By

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SUMMARY

Fifty apparently healthy male New Zealand White (NZW) rabbits (4 weeks old) were divided randomly into 5 equal groups. The first group was served as a control and fed on the basal diet. While, the other four groups were received the basal diet supplemented with either 0.5% citric acid, 0.5% fumaric acid, 0.5% malic acid or a mixture of citric, fumaric and malic acids (C+ F+M) respectively. The experiment was extended to significant 13 weeks of age. Rabbits receiving dietary organic acids had improvement in live body weight (LBW), body weight gain (BWG) and feed conversion ratio (FCR) as compared to those fed unsupplemented diet.

Rabbits 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 acid and acidifiers.

Key words: Organic acids, Rabbits, Growth performance and biochemical parameters of Rabbits

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INTRODUCTION

Organic acids are routinely included in diets for monogastric animals in Europe in order to replace antibiotics as growth promoters, (Leticia, et al., 2005). The main effects of dietary organic acids in weaned piglets have been...
extensively reviewed, (Partanen and Mroz, 1999; Ravindran and Kornegay; 1993), consisting primarily of improved diet digestibility and growth performance, but (Cromwell, 2001) revealed that improvements in growth can be lower than those obtained with antibiotics as growth promoters. The action mechanisms of organic acids are mainly involved in balancing the microbial population in the small intestine and/or to stimulating the activity of digestive enzymes, (Knarreborg et al, 2002).

Acidifiers have also been assayed for intensive rabbit production diets, either as organic acids or their salts with research being focused mainly on both health and productive performances, (Leticia et al., 2005). However, (Cromwell, 2001) stated that as the fermentation in hindgut of rabbits is important in feed utilization than in young pigs, the possible effect of organic acids on the caecal environment cannot be neglected. Also, their correct use along with nutritional, managerial and biosecurity measures, could be a powerful tool in maintaining the health of the GI-tract of animal, thus improving their zootechnical performances, (Abdel-Fattah et al., 2008).

Organic acids work in animals, not only as a growth promoter but also as a meaningful tool of controlling all entritic bacteria, both pathogenic and non-pathogenic (Naidu, 2000 and Wolfenden et al., 2007). 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 (Abdo, 2004 and Abdel-Fattah et al., 2008).

Contrary to antibiotics, organic acids have other properties like; lowering of the chyme pH, consequently enhancing protein digestion (Gauthier, 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). Therefore, the acid anion has been shown to complex with Ca, P, Mg and Zn, which results in an improved digestibility of these minerals (Kishi et al., 1999).

The objective of this experiment was to evaluate how citric acid, fumaric acid, malic acid or a mixture in diets of growing rabbits may affect growth performance and some blood metabolites of NZW rabbits.
MATERIAL AND METHODS

Animals and experimental diets:
Fifty apparently healthy male New Zealand White (NZW) rabbits (4 weeks old) with an average live body weight 550 – 600 g were divided randomly into 5 equal groups. Group(1) kept as a control and fed on a basal diet. The other four groups were given a basal diet supplemented with either 0.5% citric acid, 0.5% fumaric acid, 0.5% malic acid or a mixture of (0.166% of citric , 0.166% fumaric and 0.166% malic acids) (C+F+M), respectively.

The organic acids were obtained as powders from the Egyptian Company for laboratory Services, Cairo, Egypt. Rabbits were housed in metallic cages, reared under similar environmental and hygienic conditions and fed on iso-caloric iso-nitrogenous experimentally formulated diets , (Table 1). During the growth period of rabbits (4-12 weeks of age) live body weight and feed consumption were recorded in table (2).

The rations were given to animals in mixed form and were formulated to satisfy the nutrient requirements of the intensively reared rabbit according to NRC (1989) and Lebas et al. (1998) recommendations, for 8 weeks experimental period. At the end of experimental period, animals were slaughtered and blood samples were taken into dry, clean glass tube for separation of serum. Serum was separated by centrifugation of blood sample at 3000 r.p.m for 15 minutes, and 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 (McGowan et al., 1983), Total 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, 1982) and (Albertini and Ekins, 1982), respectively.

The results were presented as mean values ± standard error for groups were compared using one-way analysis of variance (ANOVA) according to Perrie and Watson (1999).
Table 1: Composition of the experimental diets.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>%</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>-yellow corn</td>
<td>13</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>-Wheat bran</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>-Clover hay</td>
<td>28.6</td>
<td>30.6</td>
<td>30.6</td>
<td>30.6</td>
<td>30.6</td>
<td></td>
</tr>
<tr>
<td>-Soybean (44%)</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>-Citric acid</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-Fumaric acid</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-Malic acid</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C+F+M</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>-Lime stone</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>-Common salt</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>-Vitamin/mineral mix</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>-Methionine</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

Calculated analysis (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>87.75</td>
<td>87.50</td>
<td>87.55</td>
<td>87.50</td>
<td>87.70</td>
<td></td>
</tr>
<tr>
<td>Crude protein</td>
<td>16.84</td>
<td>16.84</td>
<td>16.84</td>
<td>16.84</td>
<td>16.84</td>
<td></td>
</tr>
<tr>
<td>Ether extract</td>
<td>2.94</td>
<td>2.90</td>
<td>2.91</td>
<td>2.92</td>
<td>2.92</td>
<td></td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>53.30</td>
<td>53.29</td>
<td>53.31</td>
<td>53.26</td>
<td>53.27</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>5.90</td>
<td>6.12</td>
<td>6.05</td>
<td>5.95</td>
<td>6.08</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>0.90</td>
<td>0.88</td>
<td>0.87</td>
<td>0.87</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>phosphorus</td>
<td>0.60</td>
<td>0.56</td>
<td>0.57</td>
<td>0.59</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>K cal/kg / (digestible energy) not less than.</td>
<td>2700</td>
<td>2700</td>
<td>2700</td>
<td>2700</td>
<td>2700</td>
<td></td>
</tr>
</tbody>
</table>

Mineral and vitamin composition (per kilogram of premix): S, 69 g; Mg, 52.2 g; Mn, 3.9 g; Zn, 11.75 g; I, 0.25 g; Fe, 21.55 g; Cu, 2.2 g; Co, 0.14 g; thiamine 0.2 g; riboflavin, 0.38 g; pyridoxine, 0.2 g; nicotinic acid, 4 g; choline, 52 g; menadione, 0.2 g; dl-tocopheryl acetate, 3.33 g; retinol, 0.55 g; cholecalciferol, 3.25 m
RESULTS

Table (2): Effect of dietary supplementation of organic acids on average growth performances of the grower rabbits.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial / g</td>
<td>550.00 ± 45.20a</td>
<td>552.00 ± 48.25a</td>
<td>551.00 ± 49.23a</td>
<td>555.00 ± 50.20a</td>
<td>550.00 ± 48.20a</td>
</tr>
<tr>
<td>Final / g</td>
<td>1324.00 ± 0.31a</td>
<td>1380.00 ± 0.14b</td>
<td>1385.00 ± 0.80b</td>
<td>1450.00 ± 0.18c</td>
<td>1370.00 ± 0.85b</td>
</tr>
<tr>
<td>Weight gain / g</td>
<td>774.00 ± 65.15a</td>
<td>828.00 ± 74.20a</td>
<td>834.00 ± 92.15b</td>
<td>895.00 ± 95.12c</td>
<td>820.00 ± 85.75a</td>
</tr>
<tr>
<td>Feed consumption/ g</td>
<td>3885.60a</td>
<td>3780.00b</td>
<td>3680.60b</td>
<td>3591.20b</td>
<td>3650.25b</td>
</tr>
<tr>
<td>Feed conversion</td>
<td>5.020a</td>
<td>4.565b</td>
<td>4.413b</td>
<td>4.013b</td>
<td>4.452b</td>
</tr>
</tbody>
</table>

Table (3): Effect of dietary organic acids supplementation on serum total protein, albumin and globulin in growing rabbits.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Protein (g/dl)</td>
<td>5.679± 0.42a</td>
<td>5.734± 0.35a</td>
<td>5.825± 0.50a</td>
<td>5.852± 0.41a</td>
<td>5.775± 0.38a</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>3.967± 0.22a</td>
<td>3.762± 0.25a</td>
<td>3.852± 0.19a</td>
<td>3.771± 0.24a</td>
<td>3.645± 0.31a</td>
</tr>
<tr>
<td>Globulin (g/dl)</td>
<td>1.712± 0.21a</td>
<td>1.972± 0.15b</td>
<td>1.973± 0.14b</td>
<td>2.081± 0.18c</td>
<td>2.130± 0.25c</td>
</tr>
</tbody>
</table>

Means with difference superscripts in the same row means significantly differ (P < 0.05) than control group
Means with the same superscripts in the same row means non significantly differ (P <0.05) than control group
Table (4): Effect of dietary organic acids supplementation on serum lipid profile of rabbit in different groups.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Lipids mg/dl</td>
<td>195.50±25.5a</td>
<td>186.70±24.8b</td>
<td>183.50±23.5b</td>
<td>180.50±25.7b</td>
<td>182.70±23.6c</td>
</tr>
<tr>
<td>Cholesterol mg/dl</td>
<td>97.48±1.90a</td>
<td>92.50±1.45b</td>
<td>90.75±2.1b</td>
<td>88.50±2.2b</td>
<td>90.50±1.90b</td>
</tr>
<tr>
<td>Triglycerides mg/dl</td>
<td>123.50±12.25a</td>
<td>122.50±12.50a</td>
<td>120.50±10.50a</td>
<td>121.75±11.50a</td>
<td>120.50±12.30a</td>
</tr>
<tr>
<td>LDL (mg/dl)</td>
<td>44.00±4.12a</td>
<td>42.50±3.90b</td>
<td>39.22±3.20b</td>
<td>40.25±3.12b</td>
<td>39.54±3.24b</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>24.00±2.92a</td>
<td>23.50±2.02a</td>
<td>23.45±2.22a</td>
<td>24.05±2.15a</td>
<td>24.12±2.30a</td>
</tr>
</tbody>
</table>

Means with difference superscripts in the same row means significantly differ (P < 0.05) than control group
Means with the same superscripts in the same row means non significantly differ (P <0.05) than control group

Table (5): Effect of dietary organic acids supplementation on serum calcium, phosphorus and magnesium in growing rabbits.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg%)</td>
<td>5.15±0.25a</td>
<td>6.23±0.50b</td>
<td>6.15±0.55b</td>
<td>6.25±0.42b</td>
<td>6.14±0.54b</td>
</tr>
<tr>
<td>Phosphorus (mg%)</td>
<td>2.53±0.18a</td>
<td>3.50±0.26b</td>
<td>3.24±0.33b</td>
<td>3.20±0.25b</td>
<td>3.28±0.28b</td>
</tr>
<tr>
<td>Magnesium (mg%)</td>
<td>3.22±0.25a</td>
<td>3.95±0.38b</td>
<td>3.75±0.29b</td>
<td>3.76±0.33b</td>
<td>3.66±0.40b</td>
</tr>
</tbody>
</table>

Means with difference superscripts in the same row means significantly differ (P < 0.05) than control group
Means with the same superscripts in the same row means non significantly differ (P <0.05) than control group
Table (6): Effect of dietary organic acids supplementation on serum thyroid gland activity in growing rabbits.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3 (ng/ml)</td>
<td>0.57 ± 0.02a</td>
<td>0.80 ± 0.03b</td>
<td>0.75 ± 0.02b</td>
<td>0.72 ± 0.02b</td>
<td>0.64 ± 0.04b</td>
</tr>
<tr>
<td>T4 (ng/ml)</td>
<td>6.824 ± 0.11a</td>
<td>7.02 ± 0.05a</td>
<td>6.24 ± 0.33a</td>
<td>6.70 ± 0.25a</td>
<td>6.28 ± 0.28a</td>
</tr>
<tr>
<td>T3:T4</td>
<td>0.083 ± 0.003a</td>
<td>0.113 ± 0.006b</td>
<td>0.120 ± 0.001b</td>
<td>0.107 ± 0.003b</td>
<td>0.102 ± 0.002b</td>
</tr>
</tbody>
</table>

Table (7): Effect of dietary organic acids supplementation on serum liver and kidney functions in growing rabbits.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control</th>
<th>Citric</th>
<th>Fumaric</th>
<th>Malic</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST (u/L)</td>
<td>64.70 ± 5.73a</td>
<td>63.50 ± 4.75a</td>
<td>63.25 ± 2.57a</td>
<td>65.75 ± 6.21a</td>
<td>63.95 ± 5.09a</td>
</tr>
<tr>
<td>ALT (u/L)</td>
<td>29.80 ± 2.21a</td>
<td>30.56 ± 1.75a</td>
<td>28.12 ± 1.82a</td>
<td>30.08 ± 2.12a</td>
<td>29.66 ± 2.33a</td>
</tr>
<tr>
<td>Alkaline phos. (U/dl)</td>
<td>18.77 ± 0.89a</td>
<td>13.25 ± 0.08b</td>
<td>16.33 ± 0.03c</td>
<td>15.13 ± 0.02c</td>
<td>14.75 ± 0.07b</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.15 ± 0.32a</td>
<td>1.22 ± 0.25a</td>
<td>1.12 ± 0.09a</td>
<td>1.18 ± 0.11a</td>
<td>1.25 ± 0.23a</td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>10.61 ± 0.77a</td>
<td>9.85 ± 0.04a</td>
<td>10.12 ± 0.05a</td>
<td>9.77 ± 0.03a</td>
<td>9.92 ± 0.06a</td>
</tr>
<tr>
<td>Uric acid (mg/dl)</td>
<td>4.26 ± 0.04a</td>
<td>4.20 ± 0.02a</td>
<td>4.32 ± 0.05a</td>
<td>4.28 ± 0.04a</td>
<td>4.30 ± 0.02a</td>
</tr>
</tbody>
</table>

Means with difference superscripts in the same row means significantly differ (P <0.05) than control group
Means with the same superscripts in the same row means non significantly differ (P <0.05) than control group
RESULTS AND DISCUSSION

1-Growth performance:

Growth performance for growing NZW rabbits as affected by organic acids supplementation are shown in table (2). Results showed that rabbits fed on the commercial diet supplemented with 0.5% malic acid gave the highest weight gain and show the best performance followed by those supplemented with fumaric acid then citric and a mixture of (C+F+M) acids respectively. This result show that rabbits may become more adapted to these acids and utilize the ration more efficiently at the period (4-13 weeks of age). In general, results clarified that supplementation of growing rabbit diets with either 0.5% malic, fumaric or citric from (4-12 weeks of age) increased weight gain and total weight gain significantly \((p<0.05)\), feed conversion was improved in group which received malic, fumaric, citric then mixture acids respectively, however feed consumption was decreased significantly in those groups than control group, this result agree with El-Kerdawy (1996). The effects of fumaric and citric acids supplementation agreed with the findings of Radecki et al., (1988) who observed beneficial effect of citric acid on body gain during the first 4 weeks of trial with pigs supplemented with 1.5% citric. However, the general results throughout the experimental period extended from 4-12 weeks of age were in accordance with the findings of Pallauf et al., 1990 and Grella and Lipiec, 1992 who observed an increase in weaned pigs growth when supplemented their diets with 1.5% or 2.5 g citric acid per kg feed in the works respectively. Castrovilli (1991) found that feed conversion efficiency by rabbits was improved with addition of 0.15 or 0.3% mixture of organic acids. On the other hand, Thacker et al. (1992) reported no differences in growth, feed intake or feed efficiency when pigs fed on barley based diets supplemented with 2% fumaric acid, while, Hohler and Pallauf (1993) found that feed intake, live weight gain and feed conversion efficiency were insignificantly affected when pigs were supplemented with 1.5% citric acid. Leticia et al. (2005), revealed that the importance of the effects of acidifiers in the small intestine for nutrient utilisation, either as antimicrobials or through an enhancement of enzymatic or absorption capabilities, has been pointed out. In rabbits, the microbial population in the caecum contributes to an important extent to total tract digestion and nutrient utilisation. Therefore, despite the measurement of diet digestibility, a quantitative and qualitative evaluation of the caecal environment would give an idea of any effect
that acidifiers may have in rabbit nutrition.

2-Biochemical parameters :-

Data presented in (table.3) showed that, dietary supplementation of organic acids exhibited relatively noticeable increase, although insignificant in the serum concentration of total protein compared with unsupplemented control. This could be due to the achieved significant increase in the serum concentration of globulin level by the supplemented groups. Hence, serum albumin values showed no significant difference among all groups including the control. The present results coincided with those obtained in growing rabbits (El-Kerdawy, 1996) and 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. This established enhancement of immune response associated with dietary acidification could account for their inhibitory effects against the pathogenic microorganisms throughout the GI-tract.

Results of serum cholesterol levels, (table.4) showed that, rabbits fed on basal diet were exhibited a highest level compared with all supplemented groups. Additionally, the lowest levels were recorded in rabbits received either malic, fumaric or organic acids mixture followed by those fed on citric acid. Similar trend was almost observed for serum concentration of total lipids. These findings are in agreement with (El-Kerdawy, 1996 and Abdo, 2004), they 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 associated with dietary organic acidification could also explain the observed reduction in serum lipid profile, (Abdel-Fattah et al. 2008).

Rabbits fed on supplemental organic acids had significantly (P<0.05) higher blood Ca, P and Mg concentrations, (table, 5) than those given unsupplemented diet. 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 due to provision of organic acids was approved by (Boling et al., 2001). Also, (Abdo, 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) concluded 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 results observed here in (Table.6) showed that, organic acidification of rabbit diets elevated serum triiodothyronine (T3) concentration, than control group, Abdel-Fattah et al. (2008), revealed that, any pronounced alteration in thyroid function (hyperthyroidism or hypothyroidism) is reflected as altered metabolic rate. Indeed, the influence was more pronounced with the addition of either citric, fumaric, malic or mixture of them. Similar trend was nearly observed for T3 : T 4 ratio. However, serum T4 level was not significantly affected.

These results pointed out an improved metabolic and growth rate due to the addition of acidifiers into rabbits diet.

From table (7), it is clearly notable that insignificant differences were found among all experimental groups including the control one for both ALT and AST activity. This result pointed out that rabbits could tolerate the addition of organic acids up to 3% 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 in growing rabbits fed citric acid, although ALT was not significantly affected. On the other hand, Grassmann and Klasna (1986) reported that dietary addition of 3%citric acid significantly increased the activities of both AST and ALT enzymes. Data of uric acid, which is
the major end product of protein metabolism, (Sturkie, 1986 and Tawfeek et al., 1994) 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. Zaghini et al. (1986) found that urea and creatinine levels in the blood of rabbits were unaffected significantly by feeding diets containing 1.5% citric or fumaric acid.

In conclusion, this study pointed out the importance of using organic acid as feed additives to promote the growth performance of rabbits through their physiological action in inducing the growth and activities of some endogenous mechanisms responsible for better performance. Further studies are needed to throw more light on the developmental effects of those organic acids on the rabbits physiological functions, with the consideration of using different levels and combinations.

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تأثير إضافة بعض الأحماض العضوية على معدلات الأداء و بعض المؤثرات البيوكيميائية في الأرانب النامية

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الملخص العربي

أجرى هذا البحث لتقديم تأثير إضافة بعض الأحماض العضوية لعلائق الأرانب النامية من عمر القمط إلى عمر التسويق على معدلات الأداء و بعض المؤثرات البيوكيميائية. 

تم استخدام عدد 50 أرنب نيوزينديد عمر 4 أسابيع تم تقسيمه إلى 5 مجموعات متساوية. المجموعة الأولى هي المجموعة الضابطة أما الثانوية والثالثة إلى الخامسة تناولت علنيًا ضابطة مضاف إليها 0.5% حامض الإستيرك و 0.5% الفيماريك و 0.5% الفيماريك و 0.5% الفيماريك و 0.5% الفيماريك. المهم أن تأتي على النواقل.

غذيت الأرانب على هذه العلائق لمدة تقليل أسابيع (فترة التجريبية) ثم تم ذبح هذه الأرانب و أخذت عينات الدم لفحص القيمة يمكن للتحليل الكيميائي.

وقد أوضحت النتائج الأتي:

1. زيادة في وزن الأرانب و تحسن في الأداء و كذلك معدل استهلاك الفلفل و تحسن...
معامل التحويل

٢ - مع تحسن في الإستجابة المناعية و يتضح هنا في زيادة نسبة الجلوبيولين بالمصل عن مثيلتها بالكترول.

٣ - نقص معنوي في تركيز الكوليسترول والدهون الكلية والكوليسترول منخفض الكثافة.

٤ - و زيادة بتركيز الكالسيوم والصوديوم والماغنسيوم بالدم.

٥ - زيادة في تركيز هرمون التراي أنترويديروسين (T3) وهذه النتيجة أيضا تدل على تأثيرها على التحسن الواضح بمعدلات الأداء.

٦ - لا يؤثر نشاط إنزيم الكبد (AST-ALT) مع نقص نشاط إنزيم الفوسفاتيز القلوي و عدم تأثر كلا من البوريا و الكرياتينين مما يدل على عدم تغير كل من وظائف الكبد و الكلى نتيجة لهذه الأضافات.

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