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Research Article

Effect of Organic Acids Supplementation on Some Productive Performances of Growing Japanese Quails

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Abstract

This study was conducted to evaluate the effect of using different sources of organic acids such as citric, malic, fumaric and their mixture at the level (0.6%) of each (as feed supplementation) in Japanese quail diets on some productive performance and carcass characteristics. Three hundred seventy five, one day old, unsexed Japanese quail chicks were divided into 5 groups (25 birds each) according to the source of organic acids supplemented. Live body weight was recorded each week through the experimental period from one day to 6 weeks of age. Body weight gain, feed intake and feed conversation were calculated. At the end of the experiment (6 weeks of age) 15 birds from all treatment groups were slaughtered for some carcass characteristics determination. The data revealed that, birds fed dietary 0.6% malic acids supplementation recorded a slight numerically improved ($P \geq 0.05$) in body weight at 4^{th} and 6^{th} weeks of ages followed by birds fed dietary 0.6% fumaric acids in compered with other treatments. Hence, the greatest numerically body gain and feed intake were recorded for birds fed dietary 0.6% malic followed by birds fed dietary 0.6% fumaric for body gain or birds fed 0.6% mixture of organic acids for feed intake. The greatest values ($P \leq 0.05$) carcass and carcass and edible weights were recorded for birds fed dietary fumaric acids supplementation followed by the control diet compared with other treatments of organic acids supplementation. The highest ($P \leq 0.05$) edible proportions was calculated for birds fed diet contain mixture of organic acids. Moreover a numerically improvement in dressing percentage (carcass% or carcass% and edible%) for birds fed diets contain citric, malic or fumaric acid supplementation compared with mixture or control diets.

Keywords: Organic Acids; Productive; Performances; Japanese Quails; Carcass Characteristics

Introduction

Growth promoters as feed supplementation have been used extensively in animal feeds and water all over the world, especially in the poultry industries [1]. Antibiotic as feed additions in poultry industry has been excluded because of its harmful effects on human health. These products detected by the development of microbial resistance [2,3]. Therefore, other natural products such as herbs, spices, and various plant extracts have established increased care as possible feed additives as antibiotic growth proalter replacements [4].

Several alternatives to these feed supplementation as growth promoters have been proposed such as organic acids and medicinal plants as natural feed. Dietary organic acids and their salts inhibit microorganism growth in feed, and keep the microbial balance in the gastrointestinal tract [5]. Citric acid makes an acidic environment (pH 3.5 to 4.0) in the gut that favors the development of *lactobacilli* and inhibits the replication of *Escherichia coli, Salmonella*, and other gram-negative bacteria [6]. Malic acid exhibited antimicrobial activity [7]. Moreover, malic acid is a middle in metabolic cycles of organisms for energy production, and could help digestion and absorption by chelating various cations and enhancing the activities of some digestive enzymes [8]. Fumaric acid is a chiefly created by the oxidation of succinate and then transformed to malic acid in the tricarboxlic cycle [9].

The use of organic acids has been stated to defend the young chicks by competitive prohibiting [10], improvement of nutrient utilization and growth and feed conversion efficiency [11]. Lactic, acetic, tannic, fumaric, propionic, caprylic acids, etc. as an organic acids, have been shown to display useful effects on the intestinal health and performance of birds [12,13]. Broiler chicks fed diets contain, 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 [14]. No difference in the cumulative feed intake between the groups fed organic acids and the control group. Birds fed the diets supplemented with organic acids exhibited a significant ($P < 0.05$) enhancement in feed conversion as against the chicks fed the control diet [15]. Weights and percentages of liver, gizzard were significantly affected by dietary levels of organic acids, 2% citric acid, 1% acetic acid and their mixture at 42 days of age [16].

The aim of this study was carried out to evaluate the effect of using different sources of organic acids such as citric, malic, fumaric and their mixture at the level (0.6%) of each in Japanese quail diets on some productive performance and carcass characteristics.

Material and Methods, Discussion and Conclusion

This study was carried out in the Poultry research unit, Department of Animal Production, Faculty of Agriculture, Minia University.

Experimental birds and management

Three hundred seventy five, one day old, unsexed Japanese quail chicks were kept in electrically heated battery cages, housed in light and temperature controlled room. Feed and water were available all time. Quails were divided into 5 groups (25 birds each) according to source of organic acids such as citric acids, malic acids, fumaric acids and their mixture at the level of 0.6% each. Every treatment group contained 3 replicates of 25 birds. The basal diet contained suitable levels of nutrients for growing Japanese quail as recommended by the National Research Council [17], with no supplementation representing in the control diet. Four experimental diets were achieved by incorporating three sources of organic acids and their mixture at the level of 0.6% each in Japanese quail diet. The sequence of the 5 dietary treatments were as follow:- control diet without any supplementation, diet contain 0.6% citric acid, diet contain 0.6% malic acid, diet contain 0.6% Fumeric acid and diet contain 0.6% mixture (of citric, malic and fumeric acids by a level 0.2% of each acid.

Ingredient	%
Ground,yellow corn	52.20
Broiler Concentrate(52%CP)	10.00
Soybean meal	35.00
Poultry fat	2.00
Vitamins minerals mixture*	0.50
Dl-Methionin	0.30
Total	100.00
Calculated analysis and chemicals analysis	
Metabolizable energy Kcal/Kg	3011.00
Crude protein, **	24.05
Crude fiber, **	3.37
Ether extract, **	3.20
Calcium,	1.15
Available phosphorus,	0.51
Methionine and cysteine,	0.80
Lysine ,	1.03

Table 1: The Ingredients and Proximate chemical analysis of the basal diet.

*Each 2.5 kg of vitamin and minerals mixture contains: 12000.000 IU vitamin A acetate; 2000.000 IU vitamin D3; 10.000 mg Vitamin E acetate; 2000 mg vitamin K3; 100 mg vitamin B1; 4000 mg vitamin B2; 1500 mg vitamin B6; 10 mg vitamin B12; 10.000 mg pantothenic acid; 20.00 mg Nicotinic acid; 1000 mg folic acid; 50 Biotin; 500 mg Iron; 55.000 mg Manganese; 55.000 mg Zinc, and 100 mg selenium.

**estimated value

Growth performance

Live body weight and body weight gain

The live body weight of each replicate recorded to the nearest gram each week through the experimental period from one day to 6 weeks of age. Body weight gain/bird/period was calculated as follow:-Body weight for each replicate (g) at the end of each period - body weight for each replicate (g) at the beginning of each period/number of live chicks in the same replicate at the end of each period.

Feed intake and feed conversion ratio

Amounts of feed intake for each replicate during starting, growing and at the whole experimental periods were recorded. Averages feed intake (g/bird) during each period were calculated as follow.

Feed intake for each replicate (g)/number of live chicks in the same replicate.

Feed conversion ratio was calculated during the periods 0-2, 2-4, 4-6 and 0-6 weeks as follow:

Period, feed consumption

Feed conversion ratio = ...

Period, body weight gain pe

Mortality rate

Throughout, the experimental period mortality rates were weekly recorded for each replicate.

Note:-no bird died as a result of dietary treatments.

Carcass traits

At 6 weeks of age (the end of the experiment), representative samples of birds (3 birds from each treatment) around average treatment body weight mean, fasted for about 12 hours, then individually weighed. A total number of 15 birds from all treatment groups were slaughtered and after complete bleeding, the birds were scalded and feathers were removed. Eviscerated carcasses were weighed and dressing percentage was calculated (weight of carcass × 100/live weight). Percentage of giblets (liver + gizzard + heart) and offal's were calculated in relation to live weight.

Statistical analysis

Microsoft® Excel 2010 (10.2614.2625) Microsoft Egypt, mssupport@gbrands.com were used for summarized data then data transferred to analysis of variance using the General Linear Model, SAS software [18]. Mean values were separated, when significance is present, using Duncans Multiple Range Test [19].

The following statistical model was used

Yij = μ+ Ti +Eij, Where: Yij = Experiment observations, μ = The overall mean, Ti = The effect of dietary treatment, i = 1,……..4, Eij = The experimental error.

NS = Not significant ($p > 0.05$), * = Significant ($p < 0.05$), ** = Highly significant ($p < 0.01$).

Means bearing different superscripts were significantly different at level 5%.

Results and Discussion

Effect of dietary organic acids supplementation on growth performance

The effects of dietary organic acid sources on body weight, body weight gain, feed intake and feed conversion ratio (g, feed/g, gain) are shown in tables (2-5).

Body weight

The effects of adding different sources of organic acids to growing Japanese quail diets, on body weight at different ages are shown in table 2. The data showed that, no significant ($P \geq 0.05$) difference in body weight as a result of adding organic acids sources (i.e. citric, malic, fumaric and their mixture) to Japanese quail diets compared with the control diet at all experimental ages. Hence, at the end of experiment (6 weeks of age), birds fed all sources of organic acids diets or their mixture presented numerically ($P \geq 0.05$) enhancement in body weight compared with others fed the control diets. In addition, birds fed dietary 0.6% malic acids supplementation recorded a slight numerically improved ($P \geq 0.05$) in body weight at 4^{th} and 6^{th} weeks of ages followed by birds fed dietary 0.6% fumaric acids in compered with either sources of organic acids supplementation or control diets.

The slightly improvement in body weight of the chicks due to organic acids sources additions in Japanese quail diets may be due to that the organic acids are moreover probability feed additive alternatives to antibiotic growth promoters in animal raising systems [20]. Also, organic acids maintain cellular safety of the bowels lining and increase digestive processes by serving to preserve normal bowel flora. Moreover, citric organic acid can enhance the digestibility of proteins and amino acids by increasing gastric proteolysis [21].

The previous results are agreement with the finding of [22] who did not find any positive effects of organic acids on growth performance of broiler chickens. Similarly, several studies reported that organic acids had no effects on performance of quails [23,24]. In addition [25], found that, organic acid supplementation did not affect the body weight and body weight gain.

Items	Age, WKS	Treatments					SE	Sig
		Control	Citric (0.6%)	Malic (0.6%)	Fumaric (0.6%)	Mix (0.6%)		
Body weight (g/bird)	0	7.33	7.53	7.53	7.53	7.46	0.21	N.S
	2	33.93	30.21	33.23	31.55	34.46	1.31	N.S
	4	92.36	86.65	95.06	93.81	93.22	2.80	N.S
	6	154.63	155.00	172.08	158.04	157.25	5.86	N.S

Table 2: Effect of dietary organic acids supplementation on body weight (g/bird) of growing Japanese quail

NS = Not significant; ±SE = Standard error.

Body weight gain

The effect of adding different sources of organic acids to growing Japanese quail diet on body gain at different ages intervals are displayed in table 3. The data showed that, no significant ($P \geq 0.05$) difference on body gain at studied age intervals as a result of adding different sources of organic acids to Japanese quail diet compared with the control diet. During the entire period of the experiment (0-6 weeks of age) it was noticed that adding all sources of organic acids and their mixture recorded slightly numerical ($P \geq 0.05$) enhancement in body gain compared with control diet. The greatest numerical ($P \geq 0.05$) body gain was recorded for birds fed dietary 0.6% malic followed by others fed dietary 0.6% fumaric.

The previous improvement in body gain as a result of adding different sources of organic acids to Japanese quail diet may be due to that the organic acids rise the effect of proteolytic enzymes and improve protein digestibility [26]. Moreover, organic acids also decrease the pH in the intestines and ultimately enhance the performance of birds [26]. Body weight gains were significantly ($P < 0.05$) improved by dietary supplementation of organic acids when compared with the control group. The greatest weight gains were achieved in the birds fed 3% fumaric acid, followed by the group fed diet supplemented with 3% lactic acid. The 3% inclusion levels were found better in promoting the weight gains when compared with the groups fed diets supplemented with the 2% levels [27]. Broilers chicks 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 [14]. other workers [28-30] who reported that, the supplementation of organic acids in broiler chicken improve the body weight gain when compared with the un supplemented group.

Items	Age, WKS	Treatments					SE	Sig
		Control	Citric (0.6%)	Malic (0.6%)	Fumaric (0.6%)	Mix (0.6%)		
Body weight gain (g/bird)	0-2	26.60	22.67	25.70	24.02	27.00	1.35	N.S
	2-4	58.42	56.44	61.82	62.25	58.75	2.43	N.S
	4-6	62.27	68.35	77.02	64.23	64.03	5.11	N.S
	0-6	147.30	147.47	164.55	150.50	149.78	5.77	N.S

Table 3: Effect of dietary organic acids supplementation on body weight gain (g/bird) of growing Japanese quail.

NS = Not significant; ±SE = Standard error.

Feed intake

The effects of adding different sources of organic acids and their mixture to growing Japanese quail diets on feed intake at different ages intervals are shown in table 4. The data revealed that, there was no significant difference ($P \geq 0.05$) between dietary treatments in feed intake during all experimental periods except the interval (2 to 4) weeks of age. During the whole period of the experiment (0 to 6 weeks of age), the greatest numerical ($P \leq 0.05$) feed intake was recorded for birds fed 0.6% malic diets followed by other birds fed dietary 0.6% mixture of organic acids.

A slightly positive effect of using some organic acids such as malic or organic acid mixture at the level of 0.6% of each was statement with the finding of the present results are in agreement with [15] who found no difference in the cumulative feed consumption between the groups fed organic acids and the control group. In addition [31], who reported no effect in feed intake by organic acid additions to broiler chicks diet. Similarly [32], who reported that, there was no significant effect on feed intake in broiler chicks fed a diet supplemented with citric acid.

In generally [27], they stated that the feed consumption was found statistically non-significant ($P > 0.05$) among all the treatment groups when they fed broiler chicken on different sources of organic acids (control, 2% butyric acid, 3% butyric acid, 2% fumaric acid, 3% fumaric acid, 2% lactic acid, and 3% lactic acid). [33,34] who reported that, adding different levels of citric acid and acetic acid to broilers did not have any effect on feed intake.

On the other hand [12,35,36] found that, organic acids increase the availability of nutrients from the feed which in turn decrease the feed consumption. Feed consumption was found non-significant decrease among all the treatment groups in comparing to control one when they fed broilers chicks dietary contain (0.3% butyric acid, 0.3% fumeric acid and 0.3% lactic acid) (hicks fed diets supplemented citric acid(CA) and acetic acid (AC) significantly consumed less feed ($P \leq 0.05$) compared to control group. It was observed that the lowest ($P \leq 0.05$) amount of feed intake was recorded for birds fed diets containing (1.61 and 1.70) of CA and (1.98 and 2.30) of AC [37].

Items	Age, WKS	Treatments					SE	Sig
		Control	Citric (0.6%)	Malic (0.6%)	Fumaric (0.6%)	Mix (0.6%)		
Feed intake g/bird	0-2	21.21	17.48	17.70	12.63	18.06	3.96	N.S
	2-4	169.49^{b}	173.02^{ab}	207.85^{a}	187.26^{ab}	175.38^{ab}	10.80	*
	4-6	155.94	155.70	216.52	203.58	240.79	29.73	N.S
	0-6	346.63	346.21	442.08	430.49	434.24	30.95	N.S

Table 4: Effect of dietary organic acids supplementation on feed intake (g/bird) of growing Japanese quail.

Values within rows no common superscripts are significantly different ($p < 0.05$).

NS=Not significant, * = ($p < 0.05$), ** = ($p < 0.01$) ±SE = Standard error.

Feed conversion

The influence of using different sources of organic acids in growing Japanese quail diet on feed conversion at different ages interval are stated in table 5. The data indicated that, during all experimental periods there was no significant difference ($P \geq 0.05$) between dietary treatments in feed conversion. Whereas, the best numerical feed conversion efficiency was noticed for birds fed dietary citric acids and control diets compared with other treatments. As a result of increasing feed intake of birds fed dietary mixture of examined organic acids (table 4) without the same enhancement in body gain (table 3), the feed conversion of these birds was in the lowest value compared with other treatments.

The present results are parallel in the finding of [31] showed negative effect ($P \geq 0.05$) on FCR by organic acid. Also [38], they found when female Japanese quails fed diets contain basal diet (BD) with a supplement of acetic acid (AA), lactic acid (LA) and butyric acid (BA) diets containing BD+LA, BD+AA, and BD+BA, respectively had significantly decrease FCR as compared with another diet in female Japanese quail ($p < 0.01$).

On the other hand, these results are in opposite trend with the findings of [39,40] who stated that, the addition of organic acids improved the feed conversion ratio in broiler chicken. Also [32], who reported that, the addition of citric acid to a broiler diet improved feed efficiency. Moreover [41] who also stated positive result on FCR by organic acids supplementation. Also [16], revealed that, FCR was significantly improved by the supplementation broiler chicks diet with organic acids supplementation as follows: 2% citric acid (CA), 1% acetic acid (AC) and % citric acid + 0.5% acetic acid, during the experimental period (1- 42 days of age).

Items	Age, WKS	Treatments					SE	Sig
		Control	Citric (0.6%)	Malic (0.6%)	Fumaric (0.6%)	Mix (0.6%)		
Feed conversion g/, feed/g, gain)	0	0.80	0.76	0.69	0.51	0.67	0.15	N.S
	2	2.91	3.07	3.38	3.01	2.99	0.22	N.S
	4	2.43	2.32	2.85	3.67	3.78	0.52	N.S
	6	2.35	2.35	2.69	2.88	2.90	0.22	N.S

Table 5: Effect of dietary organic acids supplementation on feed conversion (g, feed/g, gain) of growing Japanese quail.

Values within rows no common superscripts are significantly different ($p < 0.05$).

NS = Not significant, * = ($p < 0.05$), ** = ($p < 0.01$) ±SE = Standard error

Slaughter traits

The absolute weight of some carcass parts

The effects of dietary organic acids sources on the absolute weight of carcass, edible giblets, and offals are reported in table 6. The result displayed that there is a significant differences ($P \leq 0.05$) between dietary treatment in carcass and carcass and edible giblets weight. While, no significant differences ($P \geq 0.05$) was detected between dietary treatments on edible or offals weight. Birds fed dietary fumaric acids supplementation recorded the greatest ($P \leq 0.05$) carcass and carcass and edible weights followed by the control diet compared with other treatments of organic acids supplementation.

The positive effect of adding fumaric acid supplementation to Japans quail diet on absolute weights of carcass and carcass and edible may be due to the beneficial effect of fumaric acid in increasing metabolizable energy of the diets [42]. Moreover, the intestinal protective effects of FUA, which enhance the pH in meals, gut microbial, and digestive enzyme activities, could explain why FUA improves growth performance [12-43]. FUA is also a byproduct of carbohydrate metabolism (the citric acid cycle), which is a major source of intercellular energy in the form of ATP. Furthermore, dietary fumaric acid supplementation considerably increased broiler chick growth performance [44-46].

In the same trend of present results [47], who found no effect on the carcass characteristics of broiler chicken fed organic acid based diets. Also [14], showed that, when broilers chicks fed dietary contain (0.3% butyric acid, 0.3% fumeric acid and 0.3% lactic acid) the carcass characteristics had no significant differences between various treatment groups.

On the other hand [16], who found that, weight and percentages of liver, gizzard were significantly affected by dietary levels of organic acids, 2% CA, 1% AC and their mixture at 42 days of age. The mixture addition of 1% citric acid with 0.5% acetic acid resulted in decreasing the level of abdominal fat percentage in carcass for group fed (1% CA + 0.5% AC) followed by for 1% AC, 2% CA and control groups, respectively at 42 days of age.

Items	Treatments					SE	Sig
	Control	Citric (0.6%)	Malic (0.6%)	Fumaric (0.6%)	Mix (0.6%)		
Live Body weight, g	213.33	188.33	193.33	223.33	210.00	10.90	N.S
Carcass Weight, g	130.66^{ab}	123.33^{b}	125.55^{b}	145.55^{a}	125.00^{b}	5.56	*

Edible weight, g*	9.00	9.00	9.00	10.00	12.00	1.03	N.S
Carcass and Edible weight, g	139.66[ab]	132.33[b]	134.55[b]	155.55[a]	137.00[b]	6.19	*
Ofals weight, g	73.67	56.00	58.78	67.78	73.00	7.76	N.S

Table 6: Effect of dietary organic acids supplementation on some carcass characteristics weights (g/bird) of growing Japanese quail.

NS = Not significant; ±SE = Standard error.

* (liver and gizzard).

The proportions of some carcass parts

The effects of dietary organic acids supplementation to growing Japanese quail diet on some carcass characteristic proportions are reported in table 7. The data showed that no significant differences (P ≥ 0.05) were observed on carcass and giblets and offalls proportions as a result of adding different sources of organic acids to growing Japanese quail diet. While, there was significant difference (P ≤ 0.05) between dietary organic acids in edible proportions. Birds fed diet contain mixture of examine organic acids recorded the greatest edible proportions followed by others fed diary citric acid supplementation compared with all treatments. Moreover it could be noticed a numerically improvement in dressing percentage (carcass% or carcass% and edible%) for birds fed diets contain citric, malic or fumaric acid supplementation compared with control diet.

The improvement in either dressing percentage (P ≥ 0.05) or edible % (P ≤ 0.05) may be 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 [48]. Furthermore, organic acids addition has pH reducing property, although no significant, in various gastrointestinal segments of the broiler chicken [35]. Moreover, organic acids enhance energy and protein digestibility by decreasing microbial completion to the host and nutrient by decreasing subclinical infection [49].

The carcass characteristics of broiler chicken fed diets supplemented with fumaric acid showed no significant (p ≥ 0.05) between various treatment groups when broiler chicks fed on dietary fumaric acid treatment groups contain, (0,0.5,1 and 1.5%) fumaric acid groups [45]. However [50], found that, supplementing formic acid at 0.5 and 1.0% in the diet of broiler chicks increased the relative weights of total edible parts, belly fat, and dressing when compared to the control group. The percentages of liver, heart, and spleen of broiler chicks were not significantly altered by dietary FUA (0, 1.25, 2.50, 3.75, 5.0, and 7.5%). Chicks fed FUA at 1.5 and 3% had no significant effect on the relative weights of dressing, giblets, and abdominal fat [51]. Similarly [52], who stated that, there were no significant differences in the relative weights of the carcass, gizzard, heart, and dressing of Japanese quail chicks between experimental groups for Japanese quail chicks fed diets supplemented with FUA (0, 5, 10, 15 and 20 g FUA/ Kg diet), in the diet.

Items	Treatments					SE	Sig
	Control	Citric (0.6%)	Malic (0.6%)	Fumaric (0.6%)	Mix (0.6%)		
Carcass, %	61.43	65.50	64.77	64.93	60.03	2.52	N.S
Edible weight, %	4.22[b]	4.77[ab]	4.62[b]	4.46[b]	5.66[a]	0.31	*
Carcass and Edible,%	65.65	70.27	69.39	69.38	65.69	2.43	N.S
Ofals, %	34.34	29.71	30.59	30.61	34.30	2.43	N.S

Table 7: Effect of dietary treatments on some carcass parts.

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