EFFECT DIETARY CITRIC ACID ON SOME PRODUCTIVE AND REPRODUCTIVE PERFORMANCE, OF LOCAL LAYING HENS

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Abstract: *This study was performed to evaluate the effect of dietary citric acid on some productive and reproductive performances in Matrough laying hens. A total number of 144 chickens at the middle production season(10month of age) were equally divided into four groups each group contain 36 birds (30femals and 6 males). Birds in group one fed the basal diet (T_1). However birds in groups fed diet containing 0.3% citric acid (T_2), the 3rd group fed diet containing 0.6% citric acid (T_3). And the 4th group fed diet containing 0.9% citric acid (T_4). All birds were kept on floor and raised under the same environmental conditions. The experiment was continu for 3 months of age. Obtained results indicated that addition 0.9% citric acid to Matrough diets improved($p< o.o5$) egg number, egg mass, egg production rate, egg weight, hatchability percent, immune response, economic efficiency, feed conversion and reduced ($p<o.o5$) mortality rate. While slightly improved egg ($p>o.o5$) in surface area, yolk weight%, albumen index specific gravity, shell density, SWUSA, egg shell volume and Haugh unit was recorded for birds fed dietary 0.09% citric acid as compared to the all other treatments.*

This study recommended use 0.9% citric acid as feed addition to improved increase the layer productive and reproductive performance.

INTRODUCTION

Growth promoters for poultry are classified in to three main groups: Probiotics, pre-probiotics and pro-probiotics. Probiotics are divided into three ways.

Micorbial probiotics: (Strains, lanctobacilli, Streptococci and Bacilli, and products: Lacto- Sacc, Lactifrom, Paciflor… / (Marionnet and Lebas. 1990 and De Blas et al., 1991). Acidifiers: Organic acids: Citric, fumaric, acetic, propionic acids and compound products: Acid-pak4-way (Karmauner 1994). Yeast culture: strains: Sacchromyces and candida and products: yea-

Sacc, thepax, Baker and Brewer (Lyons. 1992 and Gerendia et al, 1992). Sakomura et al, (1998 reported that, there was no effect on laying performance due to fumaric acid inclusion into layer diets. Falkowski and Aherne (1984), and Radecki et al, (1988) reported that, feed intake was depressed by high inclusion levels of citric acid. Furuse and Okumura (1989) showed that, feed intake can be depressed as a result of low palatability of acidic diets due to organic acid inclusions.

Burnell et al, (1988) reported that, citric acid supplementation lowered the pH value of coron-soy diet. Lower dietary pH, tended to decrease pH value in small intestine.

Haddading et al, (1996) who suggested that, increasing lactic acid concentration in the thickness, egg shell strength clearly increased by feeding different levels of dietary citric acid. The effect of organic acid as growth stimulants for chicken has been reported by (Genetesse et al, (1994)) found that, calcium metabolizability increased by adding citric acid into broiler diets. Similar results were obtained by Ibardo laza et al, (1993) who found that, feeding dietary propionic acid increased calcium absorption.

Moreover Afifi and Alaily (2001) indicated that, there were non-significant improvement in egg production percentage and feed conversion ratio due to feeding 0.8% 1.2% and 1.6% dietary citric acid containing diet. Average egg weight and daily feed consumption were not affected by feeding different levels of citric acid except for 1.6% level which reducded average egg weight and feed consumption compared to other treatments. Both of calcium retetion percentage and serum calcium significantly increased by feeding dietary citric acid. Egg shell quality in terms of egg shell percentage, egg shell thickness and egg shell strength was significantly improved by feeding different levels of citric acid. Afifi et al, (2001) showed that feeding dietary citric acid led to increasing average body gain and no significant effects was noted on feed consumption or feed efficiency ratio, total proteins, total lipids or cholesterol level, bursa or spleen weight, small intestine thickness and relative weight of liver. Feeding dietary citric acid led to sharp reduction in ileal content of coliforms bacteria and bacterial total count, but, the number of lactobacilli bacteria was slightly increased. Patten and Waldroup (1988) observed significant improvements in performance of broilers fed diets supplemented with fumaric acid; also the same results were obtained with proponic acid (vogt et al., 1981). Brown and lee (1985) found that 1% addition of citric acid did not affect rate of feed efficiency. Jin et al., (1997) stated that, organic acids inhibit the growth of bacteria and their action depends on reducing gut pH value.

Therefore the objective of this study was aimed to evaluate the effect of dietary citric acid (0.3,0.6,and 0.9%) on the layer performance, and egg parameters for Matrough hens under upper Egypt climatic.

MATERIALS AND METHODS

This study arried out at Poultry research unit Animal production department AL-Azhar University Assiut Branch. Egypt. Laboratory work of determining the immune response for New-Castle disease was done at the poultry services center in Faculty of Agriculture , Cairo University.

Birds and management:

One hundred and forty four Matrough layers at the middle laying season (10 month age) were reared on floor in open side house under the same managerial conditions. Birds were distributed into four treatments each 30 hens and 6 cocks. Each group contained 3 replicates (10 hens and 2 cocks as a replicate). Birds in group one were served as a control and fed basal ditet. While birds in groups 1,2,3 and 4 were fed dietary citric acid at levels of 0.3,0.6, and 0.9% respectively Food and water were provided ad-libitum. The basel diet was formulated to meet the nutrient requirement of laying hens according to NRC (1994) and reported in (Table 1). Lighting hours were scheduled to be 16 hours per day. The experiment was started at November and terminated at February(3month). Intial body weight at the beginning of the experiment was recorded. The maximum and minimum temperatures and relative humidity of chicks house were daily recorded at the morning and afternoon throughout the experimental period and summarized monthly in (Table 2).

Performance traits:

Egg number and egg weight (to the nearest1g) were daily recorded by dividing total egg number or total egg weight for each replect by the total number of hens in each cages respectively. Both egg mass and egg production rate were calculated. Mortality number for each treatment were recorded daily to count the mortality percent every month. Feed consumption (hen\day) was recorded and feed conversion was calculated every period. At the end of first,second,third months of laying period. Eggs from each treatment were collected throughout successive days and incubated in an automatic incubator. Eggs were examined at 7 days of incubation period to determine fertile and in fertile egg, fertility was calculate as follows:

Fertility% = (Number of fertile eggs/ Number of total set eggs) x100

Hatched chicks and unhatched eggs were counted to calculate hatchability percentage A total hatching eggs for Matrough = 30 eggs x 4 treatments x 3 months = 360 eggs .

Hatchability % = (Number of hatched chicks / Number of fertile eggs) x 100

Birds were immunized against New Castle Disease virus (NDV) with vaccine la Sota at the end of the experimental period. Blood samples were collected after 10 days from immunization and the serum antibody titre were determined by hemagglutination Inhibition (HI) test (Hitchner et al., 1980).

Some egg contents:

Six eggs were collected from each treatment were individually weighed then broken out individually on a flat glass plate to calculated egg dimensions (Length and width), diameter and height of albumen and yolk were measured in mm using a digital caliper to calcuted the shell, albumen and yolk weight percentage of egg weight..

Some egg quality measurements:

Then calculated the egg shape index according to Roman off and Romanoff (1949)

Yolk and shape index % =egg width (cm) /egg length (cm) x % .

Albumen index was calculated according to Funk et al, (1958) as yolk and albumen height divided by yolk and albumen diameter, respectively.

Haugh unit was calculation according to Eisen, et al (1962) based on the height of a albumen determined by micrometer and egg weight .Egg specific gravity (SP.gr) was calculated by Harms et al, (1990) using the following equation:

SP.gr = EW/0.968 (EW.SH.W) + (0.4921 X SH.w)

Were EW = egg weight, SH.w = shell weight.

Shell quality:

Shell weight was measured to the nearest 0.1gm and shell thickness (cm) by micrometer was recorded

Egg surface area (ESA) was calculated according to Paganel et al, (1974) by the equation as follows:-

Egg surface area = $4.835\ W^{0.662}\ cm^2$

where W= egg weight. in gram.

Shell weight per unit surface area (SWUSA)= shell weight, mg/ESAcm^2

While egg shell volume was calculated according to Rahn (1981)

= ESA cm^2 X shell thickness cm.

Morwover was shell density calculated according to Nordstrom and Qusterhant (1982).

Shell density = shell weight, mg/SSA.

Where SSA = $3.978XW^{0.7056}$

W = egg weight,gm

Economic efficiency:

The total feed cost (L.E) at the end of the experiment for each treatment, was calculated depending upon the local market prices of the ingredients (during 2007 year) used in formulating the experimental diets. Also, the total income (L.E) was calculated depending upon the local market prices of 1 Kg egg weight. Economic efficiency was determined by comparing the net revenue (L.E) and the total feed cost, for each treatment. It was calculated as follows:

$$\text{Economic efficiency} = \frac{\text{Net revenue (L.E)}}{\text{Total feed cost (L.E)}}$$

Statistical analysis:

Data were statistically analyzed according to **SAS (1996).** Significant differences among individual means were analyzed by Ducans multiple range tests **(Duncan 1955).** Pooled standard error for each trait was calculated.

RESULTS AND DISCUSSION

Productive performance:

The effect of dietary treatments on some Productive performances are recorded in (Table 3) the data revealed that layer fed diets contain 0.9 % citric acid increased ($P \leq 0.05$) egg number, egg mass, egg production rate, egg weight, hatchability percentage, reduced ($P \leq o.o5$) mortality rate improved ($P \leq o.o5$) immune response، feed conversation and reduced feed consumption as compared to the all other treatments.The improvement in egg production ،as a results of adding 0.9% citric acid to laying diet،may be due to increase in calcium retention and absorption associated whit high citric acid inclusion level (EL-Afifi and Alaily (2001) Also، organic acids supplementation inhibited the growth of bacteria and their action depends

are reducing gut pH value Jit et al., (1997). Moreover, Patten and Waldroup (1988) observed significant improvements in performance of broilers fed diets supplemented with Fumaric acid, also the similar results were obtained with proponic acid Vogt et al., (1981).In the present study, addition 0.6% (T_3) citric acid to layer diet increased ($P \leq 0.05$) the egg number, egg mass, egg production rate, egg weight, hatchability percent, immune response and reduced mortality rate and improved ($P \leq 0.05$) feed conversion as compared to the control group and treatments of 0.3% level citric acid (T_2). This finding are disagrees with those reported by Falkowsk, and Aherne (1984) and Radecki et al., (1988) who reported that, feed intake was depressed by high inclusion levels of citric acid, also Brown and lee (1985) found that,1%, addition of citric acid did not affect rate of feed efficiency. Furthermore, Furns and Okumura (1989) showed that feed intake can be depressed as a results of low palatability of acid diets due to organic acid inclusion.

Egg quality:

The effect of dietary citric acid on some egg quality measurements were recorded in Table (4) that layer diets supplemented with 0.9% citric acid increased ($P \geq 0.05$) the albumen index and Haugh unit as compared to all other treatments, while, surpassed with in specific gravity rather than that, control or group of 0.6% citric acid. In the meanwhile level 0.3% citric acid (T_2) increased ($P \geq 0.05$) yolk index and specific gravity as compared to the other treatments. These results are in accordance with those of Afifi and Alaily, (2001) who noticed that, average egg weight was not affected by feeding different levels of citric acid except that of 1.6% level which reduced average egg weight as compared to other treatments.

Egg contents:

The effect of dietary citric acid on some egg content was reported in (Table 5) it could be noticed that layer dietary fed 0.9% citric acid increased ($P \geq 0.05$) Yolk weight%. While, 0.3% citric acid improved ($P \geq 0.05$) shell weight percent as compared to other treatments. Albumen weight % was impaired with addition citric acid to layer diet . This may be due to its modification effect on microbial population in lumen and enhances the growth of lactobacilli bacteria which improves the nutrients absorption (Haddading et al. 1996) and consequently improve feed efficiency and body weight gain (Alder and Damassa (1980). On the contrary citric acid has sharply reduced number of pathogenic coliforms bacteria, which was partly responsible for the So-called melabsorption syndrome (Tortuero 1973) and consequently related the well growing of broiler

Egg shell quality:

The effect of citric acid on some egg shell quality was recorded in Table (6).Results declared that supplementation layer hens by C 9% citric acid in diet improved ($P \geq 0.05$) egg surface area, shell density, and egg shell volume as compared to low levels of citric acid, improved ($P \geq 0.05$) as compared to T_2 and T_3, while T_3 was the worst treatment. These results are in harmony with those reported by Afifi and Alaily (2001) who found that, egg shell quality in terms of egg shell percentage, egg shell thickness and egg shell strength was improved significantly by feeding different levels of citric acid. The same trend Haddading et al ., (1996) who suggested that, increasing lactic on concentration in thickness, egg shell strength clearly increased by feeding different levels of dietary citric acid. This may be due to increasing calcium metabolizability by adding citric acid in diets (Genetesse et al., (1994).

Economic efficiencies (E.ef):

The effect of dietary citric acid on economic efficiency was reported in Table (7) indicated that economical efficiency was 0.485,0.410,0.495 and 0.540 for dietary 0.0%,0.3%,0.6%and 0.9% citric acid, respectively. It seems that chicks fed on 0.9% citric acid had the best F.ef compared whit other treatments. Assuming that the relative E.ef of the control group equal 100 , the other groups recorded relatively E.ef. values of 84.52,102.06 and 11.34 for 0.3% , 0.6% and 0.9% citric acid, respectively.

The results also reveal that relative E.ef of the diet contained 0.9% citric acid was superior compared with the other treatments.

In conclusion, the present results appeared that addition excessive amount up to 0.9% citric acid in layer diets increased significantly egg number, egg mass, egg production rate, egg weight, hatchability percent, immune response, feed conversion, egg surface area, Yolk weight %, albumin index and Haugh unit ,

Table (1): Ingredient composition and calculated analysis of the basal diet.

Ingredient	%
Yellow corn	68.0
Soybean meal	14.5
Layer concentrate[a]	10.0
Limestone	7.25
Layer premix[b]	0.25
Total	100
Calculated analysis: (%)	
Crude protein	17.36
Metabolizable energy (Kcal/Kg diet)	2831
Calcium	3.46
Available P	0.85
Lysine	0.86
Methionine	0.37
Methionine + cystine	0.64

(a) Layer concentrate (50%) contain: crude protein 50%, fiber 2%, fat 4.28%, Ca 6%, P 2.85%< methionine 1.8% Methionine + cystine 2.03%, Laysine 2.75% , NaCl 2.67% and ME 2300 Kcal / Kg.

(b) Each 2.5 Kg of layer premix contain: Vit A, 10.000.I. U, Vit D, 2,250,000 C.I.U, Vit E, 10 mg, Vit K, 1 mg, Vit B_1, 1 mg, B_2 4 mg, B_6, 1.5 mg, B_{12}, 10 mg, Pantothenic acid 10 mg, Niacin 20 mg, Folic acid 1 mg, Biotin 500 mg, Choline Chloride 500 mg, Iron 30 mg, Manganese 40 mg, Zinc 45 mg. Cupper 3 mg. Cobalt 100 mg, Iodine 300 mg, Selenium 100 mg and Ca CO_3, to 2500 gm.
Accroding to NRC. 1994

Table (2): Measurements of temperature and humidity during the experimental period.

3.30 PM		8.3 AM		Periods (month)
Humidity %	**Temperature C°**	**Humidity %**	**Temperature C°**	
48.97	**24.56**	**84.5**	**12.94**	**0-1**
47.06	19.85	89.23	9.61	1-2
48.73	19.33	88.87	9.15	2-3

Table (3): Effect of dietary treatments on some productive and reproductive performance of Matrough laying hens .

Measurements / Treatments	Egg number hen/30 day	Egg mass hen/gm	Egg production rate	Egg weight gm	Feed consumption gm/hen/month	Feed conversion Kg feed/kg egg mass	Hatchability %	Immunity	Mortality %
T_1 (Control) O	12.56 ± 2.94^{d}	630.80 ± 164.05^{d}	41.76 ± 9.73^{c}	49.62 ± 1.39^{b}	2832.33 ± 118.29	5.01 ± 1.04^{d}	80.33 ± 1.86^{b}	5.53 ± 0.12^{d}	$Zero^{a}$
T_2 0.3% citric acid	12.89 ± 1.01^{c}	632.11 ± 64.96^{c}	39.6 ± 6.35^{d}	48.84 ± 1.16^{c}	2902 ± 74.57	4.66 ± 0.35^{c}	85 ± 2.89^{ab}	5.63 ± 0.33^{c}	3.33 ± 1.93^{c}
T_3 0.6% citric acid	13.37 ± 1.62^{b}	684.43 ± 99.96^{b}	44.57 ± 5.41^{b}	50.86 ± 1.31^{a}	2877.67 ± 24.34	4.39 ± 0.63^{b}	85 ± 2.89^{ab}	6.00 ± 0.173^{b}	1.11 ± 1.11^{b}
T_4 0.9% citric acid	13.93 ± 1.22^{a}	709.89 ± 79.40^{a}	46.42 ± 4.07^{a}	50.77 ± 1.37^{a}	2819 ± 68.51	4.04 ± 0.37^{a}	85.67 ± 1.73^{a}	7.57 ± 0.133^{a}	$Zero^{a}$

a. b ……. Means with different superscript (S) in the same row are significantly different ($P< 0.05$).

Table (4): Effect of dietary treatments on some egg quality measurements of Matrough laying Hens .

Measurements / Treatments	Egg shape index (ES)	Yolk index (YI)	Albumen index (AI)	Haugh unit (HU)	Specific gravity (Sg)
T1 (Control) O	0.734± 0.0070	0.454± 0.0092	0.090± 0.0038	118.12± 3.7058	1.093± 0.0014
T2 (0.3%citri acid)	0.714± 0.0080	0.468±0.0099	0.088±0.0027	111.00±2.1742	1.095± 0.0013
T3 (0.6% citric acid)	0.732± 0.0099	0.457±0.0103	0.088±0.0037	115.03±2.5470	1.092± 0.0011
T4 (0.9%). citric acid)	0.720± 0.0073	0.450±0.0076	0.093±0.0037	118.19±2.4661	1.093± 0.0014

Table (5): Effect of dietary treatments on some egg contents of Matrough laying Hens.

Measurements / Treatments	Shell weight % (SWP)	Albumen weight % (AWP)	Yolk weight % (YWP)
T1 (Control) O	0.112± 0.0024	0.564± 0.0054	0.324± 0.0059
T2 (0.3% citric acid)	0.115± 0.0023	0.558±0.0042	0.326±0.0034
T3 (0.6% citric acid)	0.109± 0.0020	0.561±0.0048	0.330±0.0042
T4 (0.9% citric acid)	0.111± 0.0024	0.554±0.0054	0.334±0.0047

Table (6): Effect of dietary treatments on some egg shell quality of Matrough laying Hens.

Treatments \ Measurements	Shell density (SD)	Egg surface area (ESA)	SWUSA	Egg shell volume (ESV)
T_1 (Control)	0.090± 0.0022	66.625± 1.0292	0.088±0.0022	26.896±0.8339
T_2 (0.3% citric acid)	0.092±0.0019	64.588±0.6057	0.089±0.0018	24.872±0.6607
T_3 (0.6% citric acid)	0.087± 0.0015	65.746±0.7168	0.085±0.0015	24.476±0.8289
T_4 (0.9% citric acid)	0.090± 0.0021[a]	66.561±0.6993[a]	0.088±0.0021[a]	25.491±0.9519[a]

Table (7): In put –out put analysis and economical efficiency of different treatment of Matrough hens (L.E. in 2007) .

Items	Citric acid levels			
	Control %	0.3 % = 3 gm/ Kg feed	0.6 % = 6 gm/ Kg feed	0.9 % 9 gm/ Kg feed
Feed consumption/chick (Kg)	2.832	2.902	2.878	2.819
Price/Kg diet (L.E)	1.200	1.236	1.272	1.308
Feed cost/ chick (L.E)	3.398	3.587	3.661	3.687
Egg mass/hen/gm	630.80	632.11	684.43	709.89
Total revenue/chick (L.E)	5.046	5.057	5.475	5.679
Net revenue/chick (L.E)	1.648	1.470	1.814	1.992
Economical efficiency	0.485	0.410	0.495	0.540
Relative E.ef.	100	84.54	102.06	111.34

L.E = Egyptian pound Price of gm citric acid = 0.012 L.E.
Price of Kg egg mass = 8 L.E.
Economical efficiency = netrevenue/ feed cost.
Relative E.ef = E.ef of treatment X100 / E.ef of control.

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الملخص العربي

تأثير علائق حامض الستريك على بعض الصفات الانتاجية والتناسلية لدجاج المطروح البياض

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قسم الانتاج الحيواني – كلية الزراعة – جامعة الأزهر – أسيوط – مصر

استخدم في هذه التجربة عدد ١٤٤ دجاجة مطروح في منتصف السنة الانتاجية لها وزرعت عشوائيا على مجموعات تمثل أربع معاملات بواقع ٣ مكررات لكل معاملة ويشمل كل مكرر عشرة دجاجات بياضة و ديكان واعتبرت المجموعة الأولى هى مجموعة الكنترول (المقارنة) أما الثانية والثالثة والرابعة احتوت علائقها على ٠.٣ % و ٠.٦% و ٠.٩% من حامض الستريك وتأثيرهم على بعض القياسات الانتاجية والتناسلية لدجاج المطروح البياض وأظهرت النتائج ما يلى:

اتضح ان مستوى ٠.٩% حامض الستريك يؤدى الى زيادة معنوية (٠.٠٥%) لعدد البيض وكتلة البيض ومعدل انتاج البيض ووزن البيضة ونسبة الفقس والاستجابة المناعية لمرض النيوكاسل ونسبة الفقس والكفاءة الاقتصادية ومساحة مسطح البيضة ونسبة وزن الصفار ووحدة هيو ومعامل الالبيومين ويقلل نسبة التفوق ويحسن معامل التحويل الغذائي ويقلل استهلاك العليقة بالنسبة لباقي المعاملات ويحسن الى حد ما الكثافة النوعية وحجم عشرة البيضة ووزن القشرة لكل وحدة مساحة.

كما ان مستوى ٠.٣% حامض ستريك يحسن معامل الصفار والكثافة النوعية ووزن القشرة وكثافة القشرة، ووزن القشرة لكل وحدة مساحة فقط لاغير بالمقارنة بالمجموعة الأولى (الكنترول).

و اتضح ايضا ان مستوى ٠.٦% حامض الستريك لم يؤثر على قياسات التجربة الا انه الى حد ما حسن معامل الصفار ومعامل شكل البيضة والنسبة المئوية لوزن البياض وكذلك النسبة المئوية لوزن الصفار ووحدة مساحة البيضة بالنسبة لبقية المعاملات.

توصي هذه الدراسة باستخدام المستوى الامثل من حامض الستريك وهو اضافة ٠.٩% منه الى علائق الدجاج البياض الذى يؤدى بدورة الى تحسين كل الصفات الانتاجية والتناسلية .