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THE ADDITION OF CITRIC AND LACTIC ACIDS AND THEIR MIXTURE TO THE PRODUCTIVE PERFORMANCE AND EGGS QUALITATIVE TRAITS OF THE LAYING HENS.

Ammar Taleb Dhiab

Department of Animal production, College of Agriculture, University of Diyala, Iraq

Abstract

This experiment is conducted for the period from 2-1-2016 to 26-2-2016 in the field of poultry at the Department of Animal Wealth/ college of Agriculture/ University of Diyala. The experiment is designed using 120 egg laying brown lohmann hens, aged 37 weeks, distributed over four different treatments, with 3 replicates per treatment, each contains ten hens. The treatments are distributed in the following way: 1. Controlled treatment with no addition; 2. Adding 4.0% lactic acid; 3. Adding 4.0% citric acid; 4. Adding 8.0 % of the mixture of both lactic and citric acids. The findings show a significant primacy ($p > 0.01$) and ($p > 0.05$) of the treatments with the addition of the organic acids (citric and lactic) and their mixture on the cumulative eggs production based on the (hen day production) H.D.%, as well as eggs mass and feed conversion coefficient compared with the controlled treatment. Furthermore, the findings show no differences in the average of eggs weight among the treatments with the organic acids compared with the controlled treatment.

Key words: Citric Acid, Lactic Acid, Eggs Qualitative.

Introduction

Because of their supporting role in the growth, health and performance of the chickens, the use of organic acids becomes necessary and encouraging to have better results (Gauthier, 2005; AlYasseen and Abid Al-Abbas, 2010). Organic acids are formed naturally in plants as a result of metabolic processes and accumulate in different cells and in varying amounts. For example, lemon fruits have almost 2.5 pH because of citric acid (58 mg/ml). The acidity of most fruits is caused by the accumulation of the organic acids (Pennistion *et al.*, 2008). Remarkably, shikimic, Quinic and Ascorbic acids are a few of the most common acids found in plants. The first two belong to the carboxylic ring acids with hexagonal carbon atoms which are important as the basis for forming the aromatic compounds in plants. Besides, some of the organic acids are formed in animals and humans in the form of intermediate metabolic compounds in citric acid cycle which is known as Kreps cycle to decompose some proteins (Lehninger *et al.*, 1982).

The results of the erroneous and undifferentiating use of antibiotics and their intensive use in poultry fodders lead to the emergence of some bacterial strains resistant to these antibiotics (WHO, 1997). Relatedly, Roy *et al.*, (2002) states that 99% of the samples of salmonella are isolated from the living chickens and they are resistant to erythromycin, lincomycin and penicillin. Moreover, antibiotic residues in animal products like meat and eggs consumed by the consumer have negative effects on human health and safety (Naji *et al.*, 2009) and most antibiotics destroy both the pathogenic and beneficial bacteria. Closely related, Kemin, (1993) states that the existence of antifungal and yeast reduces the number of microflora of the intestines that compete with the pathogenic bacteria which disturb the microbial community in the intestines. In addition, people who eat animal products that absorbed these antibiotics might suffer from some allergies (Jin *et al.*, 1997a; Jin *et al.*, 1997b; Naji *et al.*, 2009).

Therefore, instead of antibiotics, specialists seek alternative methods such as using bioenergy and biomass or organic acids as stimulators for growth and supportive to health. The current study aims at knowing the effect of adding the organic acids (lactic and citric) and their mixture to egg laying hens and the productive performance and some of the qualitative traits of produced eggs.

***Author for correspondence :** E-mail: dr.ammaraltememey@gmail.com

Materials and Methods

Design of the experiment

This experiment is conducted during the period from 2-1-2016 to 26-2-2016 in the field of poultry at the Department of Animal Wealth/ college of Agriculture/ University of Diyala. The experiment is designed using 120 egg laying brown lohmann hens, aged 37 weeks, distributed over four different treatments, with 3 replicates per treatment, each containing ten hens. The treatments are distributed in the following way:

1. Control treatment with no addition.
2. Adding 4.0% lactic acid.
3. Adding 4.0% citric acid.
4. Adding 8.0% of the mixture of both lactic and citric acids.

Bird management

The hens are received at the 37-week of age. They have received full veterinary care during the growth and production phase. They are housed in a hall made up of 33 ground pens of 2×1.5 m for each. The treatments are distributed randomly on the pens with 3 replicates for each treatment. In the hall, twelve pens are used and each took 10 hens which means 30 hens for each different treatment. Each pen contains hanging cylindrical feeder and an automatic water softener and two nests to lay eggs. Feed is provided according the guideline which highlights the needs of this species. Water is always provided.

All conditions for farming layer hens are provided in the hall starting with the light (16 hours lights: 8 hours dark/day) and suitable temperature. The hens are fed on one fodder for a whole week and it is considered as the exemplary fodder, then the rest of the treatments are added after the first week. The experiment lasts 8 weeks, the eggs are collected on daily basis as shown in table 1, that illustrates the percentage of the primary materials included in the fodders used in the experiment and the calculated chemical composition.

Table 1: The proportion and components of feed materials included in the fodder used for the experiment.

Feeding material	Percentage %
Yellow corn	63.4
Soybean crisp 44% protein	26
Protein concentrate (1)	2.5
Limestone	7.5
Dicalcium phosphate	0.4
Food salt	0.3
Total mean	100
Calculated chemical analysis (2)	
Energy represented (kilo calorie/ kilogram)	2740
Raw protein	17
Lysine	0.92
Methionine	0.41
Methionine + cysteine	0.70
Calcium	3.45
Phosphorus	0.36

1. As a protein concentrate, Max care, Trouw nutrition product is used. It contains 50% raw protein, 2.3% lysine, 5.4 methionine, 5.8% methionine, 5.8% Methionine + cysteine, 2685 kilo calorie of energy represented, 2% raw fibers, 26.3% calcium, 9.5% available phosphorus, 5.5% sodium, 400000 international unit/ kilogram vitamin A, 100000 international unit/ kg vitamin D3, 800 mg/kg vitamin E, 60 mg /kg vitamin K3, 20 mg/kg vitamin B1, 160 mg/kg Vitamin B2, 220 mg vitamin B3, 20 mg/kg vitamin B6, 600 mg/kg vitamin pp, 12 mg/kg Folic acid, 1200 mircogram/ kg biotin.

2. According to the chemical analysis based on analyzing feed materials cited in NRC, (1994).

The Source of Organic Acids

The organic acids (Lactic and citric) are obtained from one of the scientific agencies in Baghdad, which is from an English source with a concentration of 98%.

Studied traits

• Productive traits:

Eggs production: The average of eggs production is calculated based on the number of living hens found in each pen HD (Hen day production) on varied periods. The length of each is 28 days. Al-Fayadh and Naji, (1989) formula is used:

$$\text{H.D.}(\%) = \frac{\text{The number of the eggs produced in a specific period of time}}{\text{The number of living hens at the end of the period} \times \text{The number of days}} \times 100$$

Eggs weight

Eggs weight are recorded on weekly basis for each egg while using a sensitive scale that reads to the nearest two decimal places.

Eggs mass

The mass of the produced Eggs are measured by gram/day for each bird according to Naji *et al* (2009) formula:

Mass of the produced eggs **(**gm egg/bird/day) = percentage of produced egg during the period × the average of eggs weight during the period.

The Cumulative Number of Eggs

The cumulative number of eggs is measured according to Naji *et al.*, (2009) formula:

$$\text{The cumulative number of egges} = \frac{\text{Production average}}{100} \times \text{The length of the period in days}$$

The Consumed Feed

The consumed feed is measured according to Al-Fayadh and Naji, (1989) formula:

$$\text{The average of daily consumed feed (gm feed/ bird)} = \frac{\text{The weekly amount of the consumed feed by the birds of each replicate}}{\text{The number of birds in each replicate} \times 7 \text{ days}}$$

As the amount of feed consumed weekly by the birds in each replicate = weekly share of feed - the residue amount of feed at the end of the week.

Feed Conversion coefficient (gm feed/ gm eggs mass)

Feed Conversion coefficient is measured based on the amount of feed (gm) necessary to produce one gram of eggs according to Ibrahim, (2000) formula:

$$\text{Feed Conversion coefficient (gm feed / gm eggs)} = \frac{\text{The average of daily consumed feed (gm/bird)}}{\text{The average of the produced eggs mass (gm/day)}}$$

Eggs Qualitative Characteristics

Samples of eggs are taken from each replicate over several periods. Each period is 4 weeks for each treatment. The qualitative traits of the eggs shell, yolk, albumen are measured according to Al-Fayadh and Naji, (1989) methods and then the average is considered.

Shell Thickness (Mm)

Shell thickness is measured with the internal membranes after being dried from both sides, the pointed and convex, for each egg. It is measured by using Micrometer and consider the average of both readings.

$$\text{The average of shell thickness (Mm)} = \frac{\text{Shell thickness from the convex side}}{2}$$

Shell Weight

After fully drying the shell for 48 hours and calculating the qualitative measurements for the eggs, the weight of the shell is measured by using a sensitive scale made for this purpose which reads to the nearest two decimal places. The measurement unit is the gram.

Albumen Height (Mm)

This trait is measured by a special tri-bore micrometer from two opposite points of the thick albumen and consider the average of both readings for the albumen of each egg.

Haugh unit

Haugh's unit is calculated according to the following formula cited by Al-Fayadh and Naji, (1989):

Haugh unit = 100 logarithm

$$H = \left\{ \frac{\sqrt{G\ (30\ W0.37 - 100)}}{100} + 1.9 \right\}$$

H= albumen height

Yolk height

It is measured by using a tri-bore micrometer.

Egg Shape Index

The shape index is calculated according to the formula cited by Al-fayadh and Naji, (1989):

$$\text{Egg shape index} = \frac{\text{Egg diameter}}{\text{Egg height}} \times 100$$

Statistical Analysis

The statistical analysis of the data is conducted by using the completely randomized design to study the effect of the different treatments on the studied characteristics. Through the process, the statistical analysis system SAS, (2004) is used. The significant differences among the averages are tested by using Duncan test, (1955) and according to the following mathematical model:

$Yij = Yij = \mu + Ti + eij$

That is :

Yij = represents the value of observing j of the studied trait (of the treatment i)

μ = represents the average of the trait

Ti = represents the effect of treatment i

eij = represents the random error of the observation

Result and discussion

Productive characteristics

• Eggs production:

Table 2 illustrates the significant differences in the average of eggs production calculated based on H.D. % among the different treatments. The treatment with the mixture of lactic and citric acids (T4) shows a significant primacy ($p>0.05$) of 0.8% over the controlled treatment with no addition (T1) during the period of the experiment. No significant differences are shown among the other treatments with the addition until the third week when the treatment (T4) shows supremacy over the rest of the treatments in the average of eggs production.

The total cumulative average of the egg production during 56 days period of the experiment shows a significant primacy ($p>0.01$) of the treatments with the addition of organic acids and their mixture added to the fodder over the controlled treatment. On the one hand, the treatment (T4), which is a mixture of the two acids (citric and lactic) of 0.08%, ranks the highest in eggs production compared with the controlled treatment with

Table 2: The effect of adding the organic acids (lactic and citric) and their mixture on eggs production average (HD%) (the average ± standard error) for brown Lohmann hens.

Treatments	Weeks								Total mean
	1	2	3	4	5	6	7	8	
T1 Control	85.57 b ± 2.6	85.14 b ± 2.2	84.28 c ± 2.3	84.28 c ± 1.8	83.32 c ± 2.2	82.85 c ± 2.5	81.89 c ± 0.2	81.42 c ± 1.1	83.59 c ± 2.2
T2 0.4% Lactic acid	88.57 a ± 2.4	87.61 a ± 2.1	87.14 b ± 1.4	87.14 b ± 2.2	85.57 b ± 2.1	85.57 b ± 2.2	84.71 b ± 0.4	84.28 b ± 1.1	86.32 b ± 2.2
T3 0.4 Citric acid	88.57 a ± 2.2	88.09 a ± 2.3	87.61 b ± 1.6	87.14 b ± 1.1	86.09 ab ± 1.2	85.57 b ± 1.6	85.14 ab ± 0.2	84.71 b ± 0.8	86.61 b ± 2.4
T4 0.8% Mixture	89.04 a ± 2.2	88.57 a ± 2.3	88.57 a ± 1.4	88.57 a ± 1.8	87.14 a ± 1.2	87.14 a ± 1.4	86.61 a ± 0.2	86.61 a ± 0.9	87.78 a ± 2.3
Significance level	*	*	*	*	*	*	*	*	**

The different letters found in the same column indicate there exist significant differences among the averages.
*indicate having significant differences with the probability level of ($p<0.05$) within each column.
** indicate having significant differences with the probability level of ($p>0.01$) within each column.

no addition. Relatedly, the second and third treatments T2 and T3 (with the addition of 0.4% the organic lactic acid and 0.4% the organic citric acid) successively achieve a significant primacy in the cumulative egg production compared with the controlled treatment. On the other hand, the lowest average is achieved by the controlled treatment T1 in which the cumulative average of eggs production for all the treatments (T1, T2, T3, T4) are 83.95, 86.32, 86.61, 87.78 successively.

This significant primacy ($p>0.01$) of the treatments with the addition of the organic acids whether individually or mixed compared with the addition free treatment is found due to the fact that adding organic acids to food works on reducing the pH of the digestive tract which works on providing a proper environment for the pepsin enzyme and then to dissolve proteins into Amino acids. This leads to a better digestive process and food absorption. Also, it may be due to the increase in the numbers of the beneficial bacteria and the decrease in the numbers of the harmful ones. The lactobacilli bacteria secrete some of the enzymes like amylase that stimulates the hydrolysis of starch and beta glucanase which contributes in reducing the viscosity of the intestinal contents leading to Improve the digestive factor of the protein and organic material (Jin *et al*., 1997a). The lactobacilli bacteria also secrete lactic acid, which increases the acidity of its environment. This hinders the growth of pathogenic bacteria *E. coli* which leads to reduce the competition for the host in consuming food and detoxification which helps the host to have a larger benefit of the food (Adil *et al*., 2010).

These findings are consistent with that of Gama *et al*., (2000) and Yesilbag and Colpan, (2006). However, Park *et al*., (2009) don't consider any significant difference in eggs production average on adding the produced lactic acid (a mixture of 5% Ca-propionate,

Table 3: The effect of adding the organic acids (lactic and citric) and their mixture on Eggs Weight (the average ± the standard error) for brown Lohmann hens.

Treatments	Weeks								Total mean
	1	2	3	4	5	6	7	8	
T1 Control	64.56 a ± 0.3	65.12 a ± 0.4	65.68 a ± 0.3	65.77 a ± 0.8	67.82 a ± 0.4	66.62 a ± 0.3	66.91 a ± 0.8	67.13 a ± 0.2	66.02 a ± 0.2
T2 0.4% Lactic acid	64.08 ab ± 0.4	63.67 a ± 0.1	66.16 a ± 0.4	67.06 a ± 0.2	66.85 a ± 0.1	67.17 a ± 0.4	67.15 a ± 0.2	67.41 a ± 0.1	66.19 a ± 0.2
T3 0.4 Citric acid	62.09 b ± 0.2	65.84 a ± 0.3	65.98 a ± 0.2	66.84 a ± 0.1	67.85 a ± 0.3	67.04 a ± 0.2	67.25 a ± 0.1	67.66 a ± 0.2	66.31 a ± 0.4
T4 0.8% Mixture	64.03 ab ± 0.2	63.45 a ± 0.3	65.48 a ± 0.4	66.93 a ± 0.4	67.41 a ± 0.3	67.54 a ± 0.4	67.50 a ± 0.4	68.50 a ± 0.2	66.35 a ± 0.3
Significance level	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

The different letters found in the same column indicate there exist significant differences among the averages; *indicate having significant differences with the probability level of ($p<0.05$) within each column; N.S. indicate the nonexistence of any significant differences.

17% Ca-formate, 15% Ca-Lactate, 27% Citric acid, 36% carrier).

Eggs weight

The data of table 3, illustrate the primacy of the controlled treatment T1 over the rest of the treatments in eggs weight in the first week of the experiment. At the same time, there are no significant differences among the treatments during the periods of the experiment. The same table indicates no significant differences in the total average of the cumulative eggs weight among the treatments of the organic acids and their mixture compared with controlled treatment. Successively, the total mean of the cumulative eggs weight of the treatments (T1, T2, T3, T4) are 66.02, 66.16, 66.31, 66.35 gm.

These findings are consistent with what Gama *et al*., (2000) have found. They use the product Lynex which contains a mixture of formic, lactic and citric acids. Furthermore, these findings are consistent with what Yesilbag and Colpan, (2006) have found. They use the product Biotronic and it is a mixture of formic and propionic acids and their salts. They are also consistent with what Soltan, (2008) has found. The latter used Provi mix product and it is a mixture of Formic, calcium butyrate, propionic, lactic acids. However, the findings are inconsistent with what Kadhim *et al*., (2008) have found. They use citric acids at different levels in which there is a significant primacy in the eggs weight average in the acids addition treatments compared with controlled treatment.

Eggs Mass

Table 4, shows significant differences (p>0.05) in eggs mass averages among the different treatments in which all treatments with the addition show primacy in eggs mass averages through the period of the experiment compared with controlled treatment. Relatedly, treatment T4, which is the one with the addition of the mixture of lactic and citric acids, shows primacy over the rest of the treatments during the production period. As for the eighth period, the treatments with the addition of acids and their mixture to the fodder show significant supremacy (p > 0.01) compared with the free addition controlled treatment. During the (56 days) of the production period, the total average of the cumulative eggs mass shows a significant supremacy (p >0.01) of the treatments with the addition of organic acids and their mixture to the fodder compared with the controlled treatment.

The treatment T4 with the addition of lactic and citric acids achieves a significant primacy of 0.8% in the cumulative eggs mass over the rest of the treatments of 58.18 gm/bird/day. Successively followed are the treatments T3 in which the value of eggs mass is 57.20 gm/bird/day, then T2 in which the cumulative eggs mass is 57.15 compared with the controlled treatment. The latter recorded the lowest average of the cumulative eggs mass of 55.33 gm/bird/day.

This result is natural and estimated as these treatments are superior in the eggs production average. The egg mass is a natural reflection of the number and weight of the produced eggs. These findings are consistent with those obtained by Soltan, (2008) while they are inconsistent with the those of Swiatkiewicz *et al*., (2010).

Cumulative Number of Eggs

Table 5, shows significant differences (p >0.05) in the averages of the cumulative number of eggs among the different treatments. Treatment (T4) shows a significant primacy over T1, T2, T3 during the periods of the experiment. Noticeably, the table also shows a

Table 4: The effect of adding the organic acids (lactic and citric) and their mixture on eggs mass (the average ± standard error) for brown Lohmann hens.

Treatments	Weeks								Total mean
	1	2	3	4	5	6	7	8	
T1 Control	55.28 c ± 1.6	55.43 b ± 1.2	55.36 b ± 1.4	55.43 b ± 2.8	56.50 b ± 2.2	55.19 b ± 2.4	54.80 b ± 1.4	54.65 c ± 2.4	55.33 c ± 2.3
T2 0.4% Lactic acid	56.75 bc ± 1.4	55.78 ab ± 1.4	57.88 a ± 1.8	58.43 a ± 2.6	57.20 ab ± 2.4	57.47 b ± 2.8	56.88 ab ± 1.8	56.81 b ± 2.8	57.15 b ± 2.4
T3 0.4 Citric acid	54.98 ab ± 0.2	57.98 a ± 0.8	57.80 a ± 1.8	56.57 ab ± 1.8	58.42 a ± 1.2	57.36 b ± 1.6	57.24 ab ± 1.0	57.31 ab ± 1.6	57.20 b ± 1.6
T4 0.8% Mixture	57.00 a ± 0.8	56.19 ab ± 0.5	57.99 a ± 1.6	59.27 a ± 1.6	58.74 a ± 1.5	58.85 a ± 1.4	58.46 a ± 1.2	58.97 a ± 1.9	58.18 a ± 1.5
Significance level	*	*	*	*	*	*	*	**	**

The different letters found in the same column indicate there exist significant differences among the averages.
*indicate having significant differences with the probability level of (p<0.05) within each column.
** indicate having significant differences with the probability level of (p>0.01) within each column.

Table 5: The effect of adding the organic acids (lactic and citric) and their mixture on the cumulative numbers of eggs (mean ± standard error) for brown Lohmann hens.

Treatments	Weeks								Total mean
	1	2	3	4	5	6	7	8	
T1 Control	5.98 [c] ± 0.6	5.98 [b] ± 0.2	5.89 [c] ± 0.4	5.89 [c] ± 0.8	5.81 [c] ± 0.2	5.77 [c] ± 0.4	5.71 [c] ± 0.4	5.69 [c] ± 0.4	5.84 [c] ± 0.3
T2 0.4% Lactic acid	6.19 [b] ± 0.4	6.12 [a] ± 0.4	6.09 [b] ± 0.8	6.09 [b] ± 0.6	5.98 [b] ± 0.4	5.98 [b] ± 0.8	5.92 [b] ± 0.8	5.89 [b] ± 0.8	6.03 [b] ± 0.4
T3 0.4 Citric acid	6.19 [b] ± 0.2	6.15 [a] ± 0.8	6.12 [b] ± 0.8	6.09 [b] ± 0.8	6.01 [ab] ± 0.2	5.98 [b] ± 0.6	5.98 [ab] ± 0.6	5.92 [b] ± 0.6	6.05 [b] ± 0.6
T4 0.8% Mixture	6.22 [a] ± 0.8	6.19 [a] ± 0.5	6.19 [a] ± 0.6	6.19 [a] ± 0.6	6.09 [a] ± 0.5	6.09 [a] ± 0.9	6.05 [a] ± 0.9	6.01 [a] ± 0.9	6.12 [a] ± 0.5
Significance level	*	*	*	*	*	*	**	**	**

The different letters found in the same column indicate there exist significant differences among the averages.
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** indicate having significant differences with the probability level of ($p>0.01$) within each column.

significant primacy of all the treatments with the addition compared with the controlled treatment.

Treatment (T4), which a mixture of the two organic acids (lactic & citric of 0.8%), shows primacy over the rest of treatments during the production periods. As for the seventh and eighth periods, there has been a significant supremacy (p >0.01) of the treatments with the addition of organic acids and their mixture over the controlled treatment with no addition. During the productive period of (56 days), the total mean of the cumulative number of eggs shows the primacy of the treatments with the addition of the mixture of the organic acids (lactic and citric) to the fodder over the rest of treatments. Treatment T4 (lactic and citric acids of 0.8%) achieves a significant primacy (p >0.01) over the rest of the treatments in the cumulative number of eggs. The cumulative number of T4 is 6.12 eggs/bird/week followed by T3 and its cumulative number is 6.05 egg/bird/week, while T2 is 6.02. As for the controlled treatment, the cumulative number is 5.84 egg/bird/week.

The rise in the cumulative number of eggs of the treatments with the addition of organic acids at different proportions may be due to the use of nutrients and the growing production of eggs as well as the enlargement of the egg size due to providing a proper environment which facilitates the work of enzymes on the food and leads to increase its availability in the intestines (Hinton and Linton, 1988; Boling *et al*., 2001; Ghazalah *et al*., 2011).

The increase in the number of beneficial bacteria in the intestines of birds and the reduction of the numbers of harmful ones participate in providing the proper environmental and health conditions for utilizing the food. The increase in the numbers of E.coli bacteria and CI – perfringeness harms the chickens and weakens the process of its growth. Additionally, the growing length of intestinal glands is a complementary factor to increase nutrients absorption and utilization whether in the growth of meat chickens or eggs production of each layer hen (Adil *et al*., 2010). These findings are consistent with that of Kadim *et al*., (2008) when they use different levels of citric acids, while they are inconsistent with what Gama *et al*., (2000) have found. The latter have used the product Lynex which contains fumeric, lactic and citric acids. The findings are also inconsistent with what Soltan, (2008) has found when he uses the product provi mix which is a mixture of formic acid, calcium butyrate, propionic and lactic acids.

Feed Conversion Coefficient

Table 6, shows significant differences (p >0.01) among the different treatments in the feed conversion coefficient. During the first to second productive periods, significant differences are found among the treatments in the feed conversion coefficient. In this table, significant differences (p >0.01) are noted among the treatments with the addition of the organic acids and their mixture to the fodder during the rest of the periods of the experiment compared with the controlled treatment. As for the total average of the cumulative feed conversion coefficient, significant differences (p >0.01) are found among the different treatments. All the treatments with the addition of the organic acids and their mixture show primacy over the controlled treatment. Treatment T4 shows primacy over T2 and T3. The average value of the feed conversion coefficient of the birds in the treatments T1, T2, T3, T4 are 2.14, 2.06, 2.07, 2.03 gm feed/ gm eggs successively.

The statistical analysis shows the effect of the productive periods on the feed conversion coefficient.

Table 6: The effect of adding the organic acids (lactic and citric) and their mixture on the feed conversion coefficient (the average ± standard error) for brown Lohmann hens.

Treatments	Weeks								Total mean
	1	2	3	4	5	6	7	8	
T1 Control	2.09 [ab] ± 0.04	2.16 [a] ± 0.03	2.15 [a] ± 0.06	2.14 [a] ± 0.08	2.10 [a] ± 0.02	2.17 [a] ± 0.05	2.18 [a] ± 0.02	2.19 [a] ± 0.02	2.14 [a] ± 0.04
T2 0.4% Lactic acid	2.03 [b] ± 0.04	2.09 [ab] ± 0.03	2.03 [a] ± 0.04	2.03 [b] ± 0.08	2.08 [a] ± 0.01	2.08 [ab] ± 0.06	2.10 [b] ± 0.04	2.10 [b] ± 0.02	2.06 [b] ± 0.04
T3 0.4 Citric acid	2.13 [a] ± 0.02	2. 02 [b] ± 0.02	2.06 [a] ± 0.05	2.05 [ab] ± 0.02	2.05 [a] ± 0.02	2.08 [ab] ± 0.02	2.09 [b] ± 0.02	2.09[b] ± 0.01	2.07 [b] ± 0.03
T4 0.8% Mixture	2.03 [b] ± 0.02	2.05 [b] ± 0.02	2.03 [a] ± 0.03	1.99 [c] ± 0.01	2.03 [a] ± 0.02	2.04 [b] ± 0.04	2.05 [b] ± 0.02	2.03 [b] ± 0.01	2.03[c] ± 0.03
Significance level	*	*	N.S.	**	N.S.	**	**	**	**

The different letters found in the same column indicate there exist significant differences among the averages; *indicate having significant differences with the probability level of (p>0.01) within each column; N.S. indicate the nonexistence of any significant differences.

The same table shows a significant difference (p >0.01) in the averages of the treatments in the fourth, fifth, sixth, seventh and eighth periods compared with the first and seconds periods. Furthermore, the table also shows no significant differences in the third and fifth periods in the feed conversion coefficient among the addition treatments and the controlled treatment. This improvement in the efficiency of feed conversion is an indication of the extent to which birds intake from the feed consumed to produce eggs and that is by increasing egg production average or increasing the weight of produced eggs. This result is a natural reflection and an outcome of the achieved improvement in the conditions of the internal environment due to the reduced internal pH which stimulates the secretion of digestive enzymes and pancreatic enzymes that work on generally digesting food and particularly proteins (Ghazalah *et al*., 2011).

The reduction of the intestinal pH and its effect in reducing the number of harmful bacteria which feeds basically over proteins will enhance the readiness of the protein in the intestines of the bird. Moreover, it will reduce the risks of converting protein into harmful ammonia as a result of the fermentation process caused by pathogenic bacteria. (Naji *et al*., 2007; Adil *et al*., 2011) On the one hand, reducing the number of harmful bacteria that rely on protein as a basic nutrient will increase the benefit of amino acids and nitrogen stored in the body. On the other hand, the increasing numbers of the lactic acid bacteria under study, which produces lactic acid as a final product of the process of fermentation, lead to reduce the pH and to provide an improper environment for the growth of harmful bacteria which lessens its numbers.

Some types of lactic acid bacteria work on producing some low molecular weight antibiotics such as Reuterin, which has a wide spectrum and capability because of the varied numbers of harmful bacteria. In addition, it produces some vitamins like B12 and K (Naji *et al*., 2007). Therefore, the beneficial bacteria increase the availability

Table 7: The effect of adding the organic acids (lactic and citric) and their mixture on the Qualitative traits of the egg (the average ± standard error) for brown Lohmann hens.

Treatments	Shell thickness		Shell weight		Albumen height		Haugh unit		Yolk height	
	1	2	1	2	1	2	1	2	1	2
T1 Control	0.31 ± 0.01	0.34 ± 0.01	6.33 ± 0.17	6.14 ± 0.08	7.59 ± 0.42	7.60 ± 0.27	80.45 ± 0.49	81.85 ± 0.33	18.30 ± 0.22	18.25 ± 0.25
T2 0.4% Lactic acid	0.34 ± 0.02	0.35 ± 0.01	6.30 ± 0.11	6.00 ± 0.05	7.89 ± 0.21	8.13 ± 0.23	80.48 ± 0.43	81.80 ± 0.23	18.39 ± 0.08	18.31 ± 0.14
T3 0.4 Citric acid	0.32 ± 0.01	0.33 ± 0.00	6.20 ± 0.18	6.16 ± 0.15	7.80 ± 0.21	8.29 ± 0.24	80.61 ± 0.41	81.90 ± 0.24	18.37 ± 0.26	18.22 ± 0.16
T4 0.8% Mixture	0.34 ± 0.01	0.35 ± 0.01	6.33 ± 0.06	6.18 ± 0.10	8.29 ± 0.20	7.67 ± 0.15	80.63 ± 0.36	82.00 [a] ± 0.14	18.33 ± 0.16	18.35 ± 0.13
Significance level	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

The different letters found in the same column indicate there exist significant differences among the averages; N.S. indicate the nonexistence of any significant differences.

of environmental conditions to utilize the nutrients that enter the body of the bird.

At the same time, the increase in the length of the intestinal glands of the chickens under study has helped to provide large areas to absorb the digested food and then to utilize. These findings are consistent with those obtained by Senkoylu, (2007); Paul *et al*., (2007); Soltan, (2008); Chowdhury *et al*., (2009) and Tollba *et al*., (2010). While these findings are inconsistent with Park *et al*., (2004); Atapattu and Neligaswatta, (2005); Gunal *et al*., (2006); and Ghazalah *et al*., (2011).

The Qualitative Traits of the Egg

Table 7 shows significant differences among the treatments in yolk height. The table indicates no significant differences in yolk height among treatments with the addition of the organic acids and their mixture compared with the controlled treatments in the first and second periods and their total average. As for the albumen traits, which are albumen height and Haugh unit, the table indicates that there are no significant differences among treatments with addition of the two organic acids lactic and citric and their mixture compared with the controlled treatment during the first and second periods and their total averages. Noticeably, table 7, shows no significant differences among treatments with addition of organic acids and their mixture and the controlled treatment regarding the traits of shell weight and shell thickness during the first and second periods and their total average.

These findings are consistent with those obtained by Rahman *et al*., (2008); Swiatkiewicz *et al*., (2010); Kaya *et al*., (2015). These researchers have used a combination of amino acids such as formic, propionic, lactic and citric acids individually and mixed with different proportions. They receive no significant differences among the treatments with the addition of acids regarding shell thickness, shell weight and some of the yolk and albumen traits compared with the controlled treatment. At the same time, these findings are inconsistent with what Soltan, (2008) has obtained with the use of the product provi Mix, which is a mixture of Formic acid, calcium butyrate, propionic acid and Lactic acid. Relatedly, Lactacid, which is a mixture of (5% Ca-propionate, 17% Ca-formate, 15% Ca-Lactate, 27% Citric acid, 36% carrier) is used by Park *et al*. (2009) and significant differences are found in shell thickness and weight, yolk,albumen height and Haugh unit in which adding the organic acids lead to show significant primacy in some of qualitative traits of the shell, yolk, albumen of the treatments with the addition of acids compared with the controlled treatment.

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