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Using Organic Acids in Laying Hens' Diets to Improve Egg Production, Egg Characteristics, Nutrient Utilization, and Blood Metabolites during the Hot Season

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Abstract

THE biggest obstacle to the poultry industry is the heat. It lowers the birds' physiological potential, feed intake, and egg output. Consequently, there is a great deal of interest in minimizing the negative consequences of elevated temperatures on laying hen productivity by employing feed additives as organic acids. To ascertain the result of feeding acetic and citric acids alone or together on egg output, egg quality, nutrient digestibility, and particular serum measurements during the summer, this study employed eighty Bovans Brown laying chickens (40–54 weeks old, average=1500 kg±334.5). Four sets of 10 duplicates were randomly dispersed. The sets were C (control group), T1 (0.5ml acetic acid/kg feed), T2 (0.5g citric acid), and T3 (0.5ml acetic acid plus 0.5g citric acid). The egg output, egg mass, egg and shell weights, shell weight per unit of surface area, serum total protein, and globulin levels ($P \leq 0.01$) all increased noticeably after treatment with citric acid, then the mixed treatment. The citric acid set had the highest shell thickness ($P<0.01$). The shell surface area was substantially elevated in all sets ($P \leq 0.01$) compared to the control. Acetic acid treatment significantly minimized ($P<0.05$) blood cholesterol, triglyceride, and aspartate aminotransferase levels. Regarding the feed intake, feed conversion ratio, serum alanine transaminase, and calcium, the treatments didn't differ significantly from one another. The findings revealed that including pure forms of either citric or acetic acid, or their blend in laying hens' diets throughout the summer season boosted the egg output and improved the value of the eggshell.

Keywords: Acetic acid, Citric acid, Laying hens, Summer season.

Introduction

The most important environmental factor affecting the poultry sector throughout the summer is high temperatures. Heat stress raises the mortality rate of chickens and reduces their appetite, egg output, and quality [1]. The zone of thermo-neutrality, where laying hens can perform, ranges from 19°C to 22°C [2]. Because of increased panting, which decreased blood carbon dioxide, commercial layers subjected to 36°C "heat stress" experienced a decline in blood calcium concentration, a rise in pH, and a fall in the egg output and the value of egg shell [3]. However, heat stress alters the microbial gut makeup by boosting the pathogenic bacteria and declining the healthy ones. Heat stress significantly altered gut microbial species by lowering levels of *Bifidobacterium* and *Lactobacillus* spp. while raising those of *Escherichia coli*, *Clostridium perfringens*, and *Coliforms* spp [4]. So that, it is advised that poultry producers adopt preventative measures via adding organic acids like citric and acetic acids to their drinking water and feed, to lessen high temperature's negative effects on their flocks through the hot months [5]. Citric and acetic acids possess the ability to raise the gut's acidity which stimulates the activity of several enzymes like phytase and pepsin that need an acidic environment. These benefits enhance feed conversion efficiency, mineral absorption [6], and protein consumption [7]. Furthermore, it has demonstrated that citric acid lowers intestinal pH [8], gizzard and crop [9], and cecal digesta [10] in broiler. Additionally, it strengthened their immunity and reduced the harmful microbial load [7]. In human and animal diets, citric acid is regarded a natural ingredient [11] and acts as an intermediate in metabolic oxidation [12]. After intake, it is quickly transformed into CO_2 and H_2O, making it beneficial during heat stress. Also, it is the source of biological energy and the carbon skeleton

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which was required for breathing cycle and additional metabolic reactions [13]. Its supplementation in animal feed is risk-free and environmentally friendly [14]. At concentrations as low as 0.5 weight percent, acetic acid, a weak organic acid, is poisonous to the majority of pathogenic bacteria. The primary reason for this harmful effect is the acetic acid's breakdown inside microbial cells that lowers the pH inside cells and disrupts the anion's metabolism. These microbial inhibitory processes allow acetic acid to be employed as a preservation substance [15]. However, an extensive array between 0.5 and 5% acetic acid added to chicken diets predominantly prevented the growth of numerous pathogenic intestinal bacteria, Consequently, the intestinal mucosa's inflammatory processes were lessened, which enhanced the height of villus and the mucosa's capacity to produce, digest, and absorb nutrients [16]. In comparison with the control, treatments including organic acids and/or their mixture produced a rise in egg output and the mass of eggs together with a decline in the consumed feed and an improvement in feed conversion ratio [17]. When citric and other acids are mixed, chicken production and shell strength are improved [18]. Following treatment with an acid mixture, there was existed a considerable rise in the proportion of crude protein from albumen, egg mass, egg output, and estradiol hormone [19]. During the hot season, drinking water containing acetic acid at concentrations of 200, 400, and 600 ppm produced an enhancement in the egg production via approximately 10%, 15%, and 20% in contrast with the command group [20]. The aim of this research is to look into the efficacy of adding citric acid and acetic acid alone or together in the pure form and low concentrations to laying hens' diet aged 40–54 weeks throughout the summer months on egg quantity and quality.

Material and Methods

The trial's design and hens' housing

In the summer (July–October) in Egypt, this experiment was completed in the experimental station of South Sinai (Ras-Sedr City) that is a part of the DRC (Desert Research Center). Ras-Sedr has a desert climate; it indicates that temperatures range from extremely hot in the summer to pleasant in the cooler months. Eighty Bovans Brown laying chickens 40-54 weeks old (around 1500 kg ± 334.5) were placed into four experimental groups at random. Each group had ten repetitions, each with two hens. The control (C), T1 (0.5 ml acetic acid/kg diet), T2 (0.5 g citric acid/kg), T3 (0.5 ml acetic acid plus 0.5 g citric acid/kg) were the trial units used in this research. These acids are cheap and available in their pure form. The concentrations of these acids are 99.8% and 99% for acetic acid and citric acid, respectively. The hens received 16 hours of constant light while being raised in three-deck wire batteries. The constituents of the diet were displayed in Table 1 [21]. The diet contains 18.52% crude protein and 2620.85 Kcal ME/Kg. Additionally, availability of feed and water during the trial.

Internal climatic conditions

The ambient temperature (maximum, minimum, average, and THI), and relative humidity (maximum, minimum, and average) were determined by the thermohygrometer and were represented in Table 2. The THI (temperature-humidity index) was computed by the method of Zulovich and DeShazer [22].

$$THI = 0.60T_{db} + 0.40T_{wb}$$

Where, T_{db} = dry-bulb temperature (maximum temperature), T_{wb} = wet-bulb temperature (minimum temperature).

Experimental measurements

Weekly feed intake (FI) records were kept. Daily mass of eggs (g/hen/day) was computed by weight and quantity of eggs. The feed conversion ratio (g FI/g egg mass) is computed by dividing the quantity of FI by the egg mass. In order to gauge the qualities of the egg and shell (weights of egg and shell, the indices of egg shape, albumen, and yolk, the proportions of shell, yolk, and albumen, Haugh unit, shell thickness, density, shell weight per unit of surface area, and surface area), 10 eggs were removed out of each group at the final of the field work. The index of egg shape was deduced by Panda's methodology [23].

$$ESI = (ED / EL) * 100$$

Where: ESI = Egg shape index, ED = Egg width,

EL = Egg length

Haugh [24] computed the Haugh unit's formula as follows:

$$\text{Haugh unit} = \log(\text{Albumen height} + 7.57 - 1.7 \times W^{0.37}) \times 100$$

Where: W= Egg weight

The shell thickness (ST) of the shell was identified using a micrometer. SWUSA (shell weight per unit of surface area) and SA (shell surface area) were computed in compliance with Nordstrom and Qusterhout [25]:

$$SWUSA\ (mg/cm^2) = SW\ (mg) / SA\ (cm^2)$$

$$SA\ (cm^2) = 3.9782 \times EW^{0.7056}$$

Where: SW= shell weight, EW = egg weight (g), 3.9782 = constant factor.

The next formula [26] calculated the shell density (SD) in g/cm^3:

$$SD = SW\ (g)/SA\ (cm^2) \times ST\ (cm)$$

Trial of digestion

Five chickens from each group had fresh feces samples collected every 24 hours over the final three days of field work. After measuring the feces and feed consumption, the feces specimens were dehydrated at 70ºC until they reached a constant weight and were kept for laboratory analysis (dry matter, organic matter, crude protein, and ether extract) in conformity with the Association of Official Analytical Chemists, AOAC [27].

Particular blood profiles

Five chickens were chosen at random from each group at the final of the trial to have their brachial wing veins blood drawn (without anesthesia or euthanasia). The serum was then kept for additional examination at -20ºC after the blood specimens were promptly centrifuged for 20 minutes at 3000 rpm. Calcium, malondialdehyde (MDA), alanine transaminase (ALT), aspartate aminotransferase (AST), total protein, albumin, cholesterol, and triglycerides were colorimetrically determined by Biodiagnostic kits (Diagnostic and Research Reagents, Egypt). To get globulin, albumin was subtracted from total protein.

Statistical analysis

The SAS program [28] used a straightforward ANOVA to examine the data. The Duncan test was chosen to separate the means [29].

Results

Productive performance

Table 3 represented the utility of acetic acid and citric acid separately or together on egg mass, egg weight, hen-day egg production percentage, feed intake, feed conversion ratio, and mortality rate percentage during the summer season. Although the productive performance and the consumed feed in all treatments were lower than normal because of the hot climate during summer months, the egg production ($P<0.05$) and the mass of eggs ($P<0.01$) significantly enhanced with the citric acid (T2) and mixture treatment (T3). Egg weight was greatly raised ($P<0.05$) with all groups as opposed to the basic group. The variations among treatments regarding feed intake were non-significant. The improvement of feed conversion ratio was numerical. Mixture treatment exhibited no mortality percent followed by citric acid treatment (20%) as opposed to the others (35%).

Attributes of eggs

Table 4 illustrates the utility of acetic acid and citric acid separately or together on egg quality attributes in the summer. Citric acid and mixture groups exhibited a valuable ($P<0.01$) increase in egg weight in contrast to the basic group. The acetic acid treatment (T1) possessed the least yolk index and Haugh unit values ($P<0.001$), while the low value of yolk percentage ($P<0.05$) was seen with the mixture treatment (T3). Concerning albumen percentage, ESI, and albumen index, they were not affected by the trial treatments.

Attributes of egg shell

The utility of acetic acid and citric acid separately or together on attributes of egg shell in the summer was displayed in Table 5. Shell weight and SWUSA were significantly ($P<0.01$) elevated by citric acid (T2) and the mixture (T3) treatments. However, the citric acid group displayed a statistically significant higher value of shell thickness ($P<0.01$) opposed to the others. The experimental groups showed a considerable ($P<0.01$) improvement in shell surface area opposed to the basic group. There were no appreciable variations between the groups concerning the shell percentage or shell density.

Trial of digestion

The utility of acetic acid and citric acid separately or in a blend on digestibility of nutrients in the summer was displayed in Table 6. There were no appreciable variations between the groups regarding the retained percent of dry matter, organic matter, ether extract, and crude protein. The improvement of the retained crude protein was numerically in the group of citric acid in comparison with the others.

Practical blood profiles

The findings of Table 7 proved that the mixture treatment (T3), which came after the citric acid treatment (T2), significantly raised serum globulin and total protein ($P<0.05$). In contrast to the remaining treatments, the acetic acid group (T1) significantly ($P<0.05$) reduced the amounts of serum cholesterol, triglycerides, and AST. The implications of all additives on serum albumin, ALT, malondialdehyde, and calcium weren't statistically different.

Discussion

Although high summer temperatures diminish laying hens' egg production because of lower reproductive efficiency, this study discovered that treating laying hens using acids that are organic in the summer increased their output. This improvement might be ascribed to citric acid's reaction to high temperatures by functioning primarily as an antioxidant and a mediator in respiratory metabolisms that include defensive mechanisms for temperature adaptation [30]. Additionally, acetic acid is toxic to most pathogenic bacteria. This toxic impact is primarily brought on by the breakdown of acetic acid in microbial cells that lowers pH inside cells and causes metabolic disturbance because of the anion. Because acetic acid inhibits microbiological development, it can serve as a preservative [15]. The combined actions of acetic and citric acids led to a synergistic impact that increased egg quantity and improved egg attributes. Additionally, several blood metabolites, while decreasing mortality rates. According to several studies, citric acid changes the intestine pH and stimulates the act of specific enzymes, like phytase and pepsin, which need an acidic environment to function. Additionally, supplementing using citric acid boosted the activity of digestive enzymes, including lipase and amylase [31]. This enhances the way that certain minerals and proteins are used and improves feed conversion efficiency [6, 7]. Additionally, the gut's pH [8], gizzard and crop [9], and cecal digesta [10] were lowered by citric acid. These results align with other reports that fed laying chickens a diet rich in organic acids, either separately or in a blend, dramatically increased the quantity of the produced eggs, their weight, and their mass in comparison with the basic group [17]. Furthermore, utilizing citric acid, lactic acid, or their blend led to a considerable enhance in egg quantity and mass and improves the feed conversion ratio [32]. There are various aspects that determine the egg quality as judged in Haugh units. In a review of research on the diminution in the quality of eggs, Sharp [33] discovered that the following variables affected the degeneration of egg albumen: time, temperature, pH, and CO_2. According to Cotterill et al. [34], as the temperature rises, more CO_2 is released from an egg. Retaining CO_2 in an egg reduced the pH from rising and the egg's quality from declining [35]. According to Cotterill's [36] findings, exposing eggs to CO_2 or blocking carbon dioxide leakage from the egg contents slowed the degeneration of the egg's thick albumen. Also, increased panting through the hot months elevates blood pH (alkalosis) and reduces blood carbon dioxide levels; this prevents blood bicarbonate from being available for the mineralization of egg shell. Citric acid (CA) is a key element in the metabolic conversion of proteins, lipids, and carbohydrates to water and CO_2 may account for the enhancement in egg shell characteristics when it comes to CA and combination treatments. The present results align with earlier research that has shown the combination of organic acids containing citric acid improved the productive performance of hens and shell strength and quality [18]. Additionally, the detrimental influence on the egg shell thickness and weight caused by high ambient temperatures has been considerably mitigated with the inclusion of acidifiers [37]. Acetic acid treatment caused the HU and yolk% to drop; this might be because acetic acid, unlike citric acid, failed to mitigate the impact of carbon dioxide reduction during the panting process on egg quality, or we require a higher dose of this acid than the one utilized in this research. The high doses of acetic acid (400–600 ppm) significantly improved albumen height and HU in eggs compared to low dose (200 ppm) and control treatments during the hot season [20]. The findings of the digestibility trial are in line with recent research [8] showing no significant rise in crude protein digestibility with citric acid (30 g /kg diet). Conversely, the outcomes of earlier research proved that citric acid in lime juice improved broiler chickens' nutritional digestibility [38]. The factors that account for the variations in the studies' results and determine the efficacy of citric and acetic acids on poultry performance, production, and intestinal development include the product type, degree of inclusion, age and type of bird, feed composition, technique, length of the trial, and environmental stress. The serum globulin level is an excellent indication of immunological responses and, consequently, greater disease resistance due to it is a supply of antibody formation [39]. Comparable to the present results, the citric acid-supplemented groups of Japanese quails had increased globulin content than the basic group [31]. Moreover, dietary citric acid supplementation at 2 to 3% significantly enhanced the amounts of blood globulin and total protein in ducks [40]. Supplementing broiler chicks' diets alongside a blend of 1% citric acid and 0.5% acetic acid boosted globulin and total protein [41]. However, various acetic acid concentrations had no discernible effects on blood total protein or globulin [42]. Organic acids are able to reduce plasma cholesterol concentrations via inducing the production of bile acid [43] and inhibiting the production of liver cholesterol [44]. Organic acids may stimulate protein production, which improves lipoprotein production in liver and transfers triglycerides from the bloodstream into the hepatic cells [45], which could be in charge of the fall in blood triglycerides and cholesterol in the current research. Furthermore, acetic acid stops fatty acid synthase, ATP citrate lyase, and acetyl-CoA carboxylase gene expression by sterol regulatory element-binding protein-1, lowering blood triglyceride concentration [46]. Additionally, acetic acid affects the microbial population and may boost positive bacteria, lowering blood cholesterol. There are multiple methods by which lactic acid bacteria, including *Bifidobacterium*, *Enterococcus*, and *Lactobacillus* have been proven to lower cholesterol levels [47]. Moreover, the female Japanese quail' serum triglyceride level was significantly declined with acetic acid treatment [48]. Adding an amalgam of citric and acetic acids to broiler chick diets considerably declined blood cholesterol concentration [41]. The liver enzymes (ALT and AST) are important indicators for liver health [49]. Acetic acid had no impact on the ALT enzyme in Japanese quail of varying ages [42] or by citric and acetic acids in broiler [50]. The blend of 5% citric acid, 70% propionic acid, and 25% soft acid increased the serum values containing albumin and ALT remained unchanged [51]. Alongside, Abou-Ashour *et al*. [41] found that while cholesterol and total lipid concentrations sharply decreased the inclusion of an amalgam of acetic and citric acids significantly increased certain blood biochemical components (globulin and total protein). In contrast to the present results, while the AST enzyme, globulin, and total protein were unaffected, the blood content of calcium was considerably greater in broiler chicks fed a diet supplemented with citric acid and acetic acid at 3.0% and 1.5 levels [50]. Organic acid mixture showed no changes in serum cholesterol, triglyceride, total protein, or AST [51]. Malondialdehyde is a biomarker for measuring oxidative stress [52]. According to Hashemi *et al*. [53], broiler hens that were fed organic acids had lower serum malondialdehyde levels than the hens in the current study. Serum malondialdehyde levels were greater in ducks fed an amalgam of organic acids [54].

Conclusion

The recent findings found that incorporating citric acid and acetic acid separately or in mix into laying hens' feed (40–54 weeks old) during the summer months improved egg output and egg attributes while having no negative effects on the chicken wellness. Furthermore, the blend of acetic acid and citric acid showed a 0% mortality rate, followed by citric acid treatment comparing to the others. We suggested that utilizing citric acid separately or in a mixture with acetic acid is an appropriate strategy to mitigate the implications of high temperatures on laying hen output during the summer months.

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Not applicable

Funding statements

This study was completed in the experimental station of South Sinai (Ras-Sedr City) that is a part of the DRC (Desert Research Center)

Declaration of Conflicts of interest

The authors declare that there is no conflict of interest.

Ethical of approval

This study follows the ethics guidelines of the Desert Research Center, Egypt. The Veterinary and Animal Care Department carried out the experimental operations after they received approval from the DRC committee's Animal and Poultry Production Division (ethics approval number; 3/12/2018).

TABLE 1. Basal diet composition [21]

Items	%
YC	57.10
SBM 44%	30.00
Ca-carbonate	7.00
Di-Ca-P	2.00
WB	3.00
DL-Methionine	0.30
Salt	0.30
Vitamins & Minerals. Premix*	0.30
Total	100
Calculated Values	
Crude protein %	18.52
Metabolizable energy (Kcal/kg)	2620.85
Calcium %	3.20
AP %	0.49
DL-Methionine %	0.59
L-Lysine %	0.97
Meth+Cys	0.90

*Vitamins and minerals premix, each 3 kg contain: Vitamin A 10000000 mg, Vitamin D3 2000000 mg, Vitamin E 10000 mg, Vitamin K 1g, Vitamin B12 10 mg, Vitamin B1 1g, Vitamin B2 5g, Vitamin B6 1500 mg, Pantothenic acid 10g, Niacin 20g, Folic acid 1g, Biotin 100 mg, Fe 30g, Mn 60g, Choline chloride 600g, Cu 4g, Zn 50g, Se 400 mg, and I 300 mg. YC=yellow corn, SBM=Soybean meal, Di-Ca-P= Di-Calcium phosphate, WB=Wheat bran, and AP=Available P.

TABLE 2. Indoor maximum, minimum, and average temperature (TºC) and humidity (RH %), and THI through the whole period of the experiment.

Month	Temperature ºC				Humidity%		
	Max	Min	Average	THI	Max	Min	Average
July	39.8	24.0	31.9	33.5	82.0	29.0	55.5
August	37.2	24.6	30.9	32.1	81.4	28.7	55.1
September	34.0	22.5	28.3	29.2	78.2	32.0	55.1
October	33.6	24.6	29.1	30.1	77.8	38.2	58.0
Mean (µ)	36.2	23.9	30.0	31.2	79.9	32.0	55.9

TABLE 3. Effect of acetic acid, citric acid and their combination on laying hens' productive performance aged 40-54 weeks during the summer season

	Groups					
Items	**C**	**T1**	**T2**	**T3**	**SE**	***P value***
EP%	51.48^{b}	53.68^{b}	61.15^{a}	57.20^{ab}	2.034	0.0275
EM (g)	28.75^{c}	31.76^{bc}	36.81^{a}	34.42^{ab}	1.126	0.0085
EW (g)	55.92^{b}	59.20^{a}	60.26^{a}	60.19^{a}	1.043	0.0391
FI (g/hen/day)	67.17	62.98	60.60	62.49	6.553	0.9092
FCR (g FI/g EM)	2.39	2.01	1.66	1.83	0.250	0.2786
MR%	35	35	20	0		

Means in the same row with different letters (a, b, and c) are significantly different with a probability of 0.05 and 0.01, with a standard error (SE). EP% = Hen-day egg production, EM = Egg mass, EW = Egg weight, FI = Feed intake, FCR = Feed conversion ratio, MR% = Mortality rate

TABLE 4. Effect of acetic acid, citric acid and their combination on characteristics of egg quality of laying hens aged 40-54 weeks during the summer season

	Groups					
Items	**C**	**T1**	**T2**	**T3**	**SE**	***P value***
EW (g)	52.04^{b}	57.78^{ab}	60.89^{a}	62.76^{a}	1.98	0.0017
Albumen%	63.14	60.7	59.71	62.8	2.44	0.6658
Yolk%	26.13^{a}	26.57^{a}	25.59^{ab}	22.80^{b}	0.989	0.0437
Haugh unit (HU)	89.98^{a}	78.87^{b}	92.27^{a}	89.75^{a}	1.77	0.0003
Egg shape index	80.5	77.42	82.66	81.53	2.02	0.4036
Yolk index	47.83^{a}	39.73^{b}	51.33^{a}	48.15^{a}	1.69	0.0014
Albumen index	12.75	12.22	12.67	12.79	0.756	0.9649

Means in the same row with different letters (a and b) are significantly different with a probability of 0.05 and 0.001, with a standard error (SE). EW = Egg weight.

TABLE 5. Effect of acetic acid, citric acid and their combination on shell quality traits of laying hens aged 40-54 weeks during the summer season

	Groups					
Items	**C**	**T1**	**T2**	**T3**	**SE**	***P value***
SW (g)	6.88^{b}	6.94^{b}	8.63^{a}	8.50^{a}	0.308	0.0001
Shell%	13.26	12.04	14.27	13.61	0.541	0.0796
ST (mm)	0.466^{b}	0.440^{b}	0.551^{a}	0.481^{b}	0.024	0.0141
SA (cm^2)	64.65^{b}	69.58^{a}	72.16^{a}	73.76^{a}	1.67	0.0015
SWUSA (mg/cm^2)	106.55^{bc}	99.78^{c}	119.87^{a}	115.47^{ab}	4.09	0.0110
SD (g/cm^3)	0.230	0.228	0.220	0.241	0.009	0.4397

Means in the same row with different letters (a, b, and c) are significantly different with a probability of 0.05, 0.01, and 0.001, with a standard error (SE). SW = Shell weight, ST = Shell thickness, SA = Shell surface area, SD = Shell density.

TABLE 6. Effect of acetic acid, citric acid and their combination on nutrient retention of laying hens aged 40-54 weeks during the summer season

	Groups					
Items	**C**	**T1**	**T2**	**T3**	**SE**	***P value***
Dry matter%	82.11	78.79	85.85	78.17	2.96	0.3233
Organic matter%	83.61	79.47	85.19	76.06	2.11	0.0569
Crude protein%	69.83	66.21	73.63	63.62	3.69	0.3393
Ether extract%	84.59	87.63	88.8	87.55	1.6	0.3154

SE= Standard error.

TABLE 7. Effect of acetic acid, citric acid and their combination on some serum parameters of laying hens aged 40-54 weeks during the summer season

	Groups					
Items	**C**	**T1**	**T2**	**T3**	**SE**	***P value***
TP (g/dl)	3.87^{b}	3.61^{b}	5.29^{a}	5.05^{a}	0.379	0.0158
Albumin (g/dl)	2.05	1.70	2.20	2.31	0.19	0.1799
Globulin (g/dl)	1.81^{b}	1.90^{b}	3.09^{a}	2.74^{ab}	0.295	0.0196
Cholesterol (mg/dl)	170.97^{ab}	116.59^{b}	293.88^{a}	194.10^{ab}	37.97	0.0290
Triglycerides (mg/dl)	352.19^{ab}	256.41^{b}	550.97^{a}	426.30^{ab}	66.65	0.0411
ALT (U/l)	101.47	97.54	112.57	104.28	5.91	0.3828
AST (U/l)	360.21^{a}	251.82^{b}	329.22^{a}	313.56^{ab}	20.07	0.0283
Malondialdehyde (nmol)	56.19	49.88	56.15	43.91	4.87	0.3099
Calcium (mg/dl)	9.47	9.39	9.99	9.96	0.196	0.1164

Means in the same row with different letters (a and b) are significantly different with a probability of 0.05 with a standard error (SE). TP = Total protein.

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استخدام الأحماض العضوية في علائق الدجاج البياض لتحسين إنتاج البيض وخصائصه والاستفادة من العناصر الغذائية ومستقلبات الدم خلال فصل الصيف

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الملخص

تُعدّ الحرارة العائق الأكبر أمام صناعة الدواجن، إذ تُقلّل من الإمكانات الفسيولوجية للطيور، وكمية العلف المستهلكة، وإنتاج البيض. وبالتالي، ثمة اهتمام كبير بتقليل الآثار السلبية لارتفاع درجات الحرارة على إنتاجية الدجاج البياض من خلال استخدام إضافات الأعلاف كالاحماض العضوية. وللتأكد من تأثير تغذية الدجاج البياض بحمض الخليك وحمض الستريك، كلٌّ على حدة أو معًا، على إنتاج البيض وجودته، وقابلية هضم العناصر الغذائية، وقياسات مصل الدم الخاصة خلال فصل الصيف، استخدمت هذه الدراسة ثمانين دجاجة بياضة من نوع بوفانز براون (تتراوح أعمارها بين 40 و54 أسبوعًا). وُزّعت أربع مجموعات عشوائيًا، كل منها مكونة من 10 مكررات. وكانت المجموعات هي: C (مجموعة السيطرة)، وT1 (0.5 مل من حمض الخليك/كجم من العلف)، وT2 (0.5 جم من حمض الستريك)، وT3 (0.5 مل من حمض الخليك بالإضافة إلى 0.5 جم من حمض الستريك). زاد إنتاج البيض وكتلة البيض وأوزان البيض والقشرة وSWUSA وTP في المصل ومستويات الجلوبيولين (P <0.05) بشكل ملحوظ بعد المعاملة بحمض الستريك ثم المعاملة بالمزيج. كان لمجموعة حمض الستريك أعلى سمك للقشرة (P <0.01). ارتفعت مساحة سطح القشرة بشكل كبير في جميع المجموعات (P <0.01) مقارنةً بالمجموعة الضابطة. قللت معاملة حمض الأسيتيك بشكل كبير (P <0.05) من مستويات الكوليسترول في الدم والدهون الثلاثية وAST. فيما يتعلق بـالعلف المستهلك و كفاءة التحويل الغذائى ونسبة الكالسيوم و ALT في المصل، لم تختلف المعاملات بشكل كبير عن بعضها البعض. كشفت النتائج أن تضمين أشكال نقية من حمض الستريك أو الأسيتيك، أو مزيج منهما في وجبات الدجاج البياض طوال موسم الصيف عزز إنتاج البيض وحسن قيمة قشر البيض دون المساس برفاهية الدجاج.

الكلمات الدالة: حمض الأسيتيك، حمض الستريك، دجاج بياض، فصل الصيف).