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EFFECT OF ADDING CITRIC AND LACTIC ACIDS TO BROILER DIETS DIFFERENT IN THEIR PROTEIN CONTENT ON PRODUCTIVE PERFORMANCE, BACTERIAL COUNT AND SOME BLOOD PARAMETERS.

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SUMMARY

The experimental work of the present study was carried out during the period from January to February 2012. Chickens were initially fed a control diet for three days. A total number of 192 three-day old unsexed broilers (Cobb strain) were divided into eight treatments (24 birds each). Each treatment contained three replicates of eight birds. *The experimental (4x2 factorial) treatments were as follows: 1. Chicks were fed the control diet (C). 2. C - 2% crude protein (CP). 3. C +2% citric acid (CA). 4. C - 2% CP +2% CA. 5. C +2% lactic acid (LA). 6. C - 2% CP +2% LA. 7. C +1% CA +1% LA. 8. C - 2% CP +1% CA +1% LA.* Results obtained could be summarized in the following:

1- Productive performance: The results indicated that LBW, LBWG, GR and PI significantly decrease with reduction CP contents of the diet. Chicks fed diets containing recommended level of CP had the best FC, CPC and CCR during the overall period studied. Chicks fed diet supplemented with organic acids (OA) had significantly lower FI during the period from 4 to 38 days of age. Dietary CP level had insignificantly affected FI during the period from 4 to 38 days of age. Chicks fed diet containing recommended level of CP supplemented with 1% CA + 1% LA had significantly lower FI during the period from 4 to 38 days.

2- Slaughter parameters % and intestinal microflora count: Organic acids supplementation to broiler diets decrease total microflora count, while, insignificant effects were observed in slaughter parameters %, colibacillus and lactobacillus. Chicks fed diet containing recommended level of CP had significantly higher intestinal pH (lower total microflora count). No significant differences due to interaction between types of addition with level of CP were observed on slaughter parameters % and intestinal microflora count.

3- Blood constituents: Chicks fed diet containing sub-optimal CP level un-supplemented with OA had higher RBCs value, while, those fed diet containing sub-optimal CP level supplemented with 2% LA had lower RBCs value (higher MCV value).

4- Chemical composition of broiler meat and tibia parameters: The highest fat% (the lowest protein and ash%) were observed for chicks fed diet containing sub-optimal CP level. No significant differences due to interaction between types of addition with level of CP on chemical composition of broiler meat. Organic acids supplementation to broiler diets significantly increase calcium (Ca) and phosphorous% (P) compared with those fed un-supplemented diet. The highest density, ash, Ca and P values were observed for chicks fed diets containing optimal CP level. The results indicated no significant differences due to interaction between types of addition with level of CP on tibia parameters.

5- Economical efficiency value during the period from 4 to 38 days of age was improved of chicks fed diet containing recommended level of CP supplemented with 2% CA and chicks fed diet containing recommended level of CP supplemented with 1% CA +1% LA, as compared with those fed the control diet and other treatments.

It could be concluded that, Cobb broiler chicks fed low protein diets supplemented with OA maintain the same performance and economical efficiency as that obtained from chicks fed diets containing recommended level of CP. On the other hand, it can be concluded that CP can be reduced from the recommended level by 2% and supplement these diets with OA (i.e., CA and LA) without affecting performance. However, using such diets reduces feed cost and nitrogen pollution.

Keywords: *citric acid; lactic acid; crude protein; broiler performance; bacterial count; blood serum parameters.*

INTRODUCTION

Poultry production in Egypt has become one of the biggest agriculture industries and its improvement is one of the main objectives of both private and public sectors. Moreover, feeding cost for poultry is usually considered the most expensive item, especially dietary protein sources. Efforts to reduce dietary protein level have been the subject of numerous investigators. Further, poultry production increased from just over 118.8 million birds at the end of 2000 to over 137.2 million birds by the end of 2010 in Egypt (FAO, 2012); this increase in production resulted in an increase in poultry litter available for land application. Abd El-Gawad *et al.* (2004) concluded that lowering crude protein (CP) level lowered broiler chicks performance. Hence, it is expected that great efforts will be directed to maximize the utilization of low protein diets. Supplementing low protein diets with growth promoters may an be alternative way to improve broiler chicks performance and economical efficiency. Low protein diets supplemented with the requirements of essential amino acids (EAA) are recommended for poultry reared in normal and heat stress conditions. Not only because they are economical diets but also they contribute in reducing nitrogen pollution through reducing nitrogen excretion by the birds, although some investigators believed they do not maintain the same performance as high protein diets (Edmonds *et al.*, 1985). Also, Colonago *et al.* (1991) concluded that optimal performance of starter and grower periods could not be achieved with low protein diets supplemented with crystalline amino acids (AA). Broiler chicks fed on optimum level of CP showed significantly ($P \leq 0.05$) higher live body weight (LBW) and live body weight gain (LBWG) value during the experimental periods, when compared with sub-optimum level of CP, while, supplementing low protein diets with growth promoters improved total LBWG when compared with the control diet (Abd El-Gawad *et al.*, 2004).

Acidifiers have been used by the poultry industry for several years. In recent years, there has been an increase in the use of acidifiers as substitutes of growth promoters due to the concern about the consequences of feeding antibiotics to livestock on both human and animal health (Martin and Williams, 2002). Various organic acids (OA) have been used in poultry nutrition with inclusion rates between zero and 2% (Moran, 2005). Their supplementation in the diet of broilers enhanced nutrient utilization, growth and feed efficiency (Denil *et al*., 2003). The poultry response to OA supplementation depends on type and level of the acids, composition of the diet, age and health status of the animals (Jensen *et al.*, 2003). Studies have suggested that the addition of OA influences concentration of bacteria in the ceca and small intestine (Vogt *et al.*, 1981).

Citric acids (CA) is a commodity chemical, and more than a million tonnes are produced every year by fermentation. It is used mainly as an acidifier, as a flavoring, and as a chelating agent. Brown and Southern (1985) reported that CA addition did not affect chick growth performance and intestinal pH. Either no effects or negative effects on growth performance of broiler chicks by supplementing CA and fumaric acid were observed (Cantor, 2005).

Organic acids have been evaluated for their efficacy in improving performance in chicks (Rafacz *et al.*, 2005). The use of certain lactic acids (LA) bacteria as probiotics has been proposed for many years. These probiotics bacteria have been shown to prevent enteric disease, as well as, improve the overall health of poultry (Tellez *et al.*, 2006). The pH of OA solutions are directly related to microbial killing because pH affects the concentration of undissociated acid formed (Ricke, 2003). It is believed that undissociated forms of OA can easily penetrate the lipid membrane layer of the bacterial cell, and once internalized into the neutral pH of the cell protoplasm, they can dissociate into anions and protons (Ricke, 2003). This dissociation inside the cell potentially causes problems for bacteria as the organism must maintain a specific internal pH. Thus, OA sometimes cause cell death through depletion of energy through the ATP-driven proton pump. The end result can be impaired bacterial cell function and/or lysis. The potential targets of biocidal compounds such as OA include the cell wall, cytoplasmic membrane, and specific metabolic functions in the cytoplasm associated with replication, protein synthesis, and function (Ricke, 2003). In another study, Russell and Diez (1998) observed a strong bactericidal effect of OA without significantly decreasing the pH value in the GI tract. However, Cantor (2005) have observed that dietary addition of OA significantly lowered the pH of the diets and the crop content but did not change the pH of the gizzard and the small intestine. Improved mineral utilization may be accomplished through the reduction of dietary pH, producing an environment conducive to phytase activity (Boling *et al.*, 2001a). Alternatively, improved mineral utilization may occur though the binding of calcium (Ca) with CA, rendering it unavailable for chelation with phytate and thus increasing phytate solubility in the small intestine (Afsharmanesh and Pourreza, 2005).

Considering the above statements, the purpose of the present work was to determine the effect of using citric and lactic acids in broiler diets varying in their protein content on growth performance, mortality rate, carcass parameters, bacterial count, intestinal pH, blood serum parameters and economical efficiency.

MATERIALS AND METHODS

The experimental work of the present study was carried out at El-Azab Poultry Research Station, Fayoum, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Egypt during the period from January to February 2012. Chemical analyses were performed in the laboratories of the Poultry Production Department, Faculty of Agriculture, Fayoum University according to the procedures outlined by A.O.A.C. (1990).

Chickens were initially fed a control diet for three days. A total number of 192 three-day old unsexed broiler chicks (Cobb strain) were divided into eight treatments (24 birds each). Each treatment contained three replicates of eight birds, so that all groups and replicates had equal average body weights (84.51±0.37g). The experimental (factorial 4x2) treatments were as follows:

1. Chicks were fed the control diet (C). 2. C - 2% CP. 3. C +2% CA. 4. C - 2% CP +2% CA. 5. C +2% LA. 6. C - 2% CP +2% LA. 7. C +1% CA +1% LA. 8. C - 2% CP +1% CA+1% LA.

The experimental diets were supplemented with minerals and vitamins mixture DL-methionine and L-Lysine HCl to cover the recommended requirements according to the strain catalog recommendations and were formulated to iso-caloric (Table1).

Citric acid and LA used in this study were purchased from Sigma Chemical Co. (St. Louis, MO). De Man, Rogosa, and Sharpe (MRS). Citric acid was supplied as monohydrate citric acid with 92% purity.

Chicks were individually weighed to the nearest gram at the start of experiment, wing-banded and randomly allotted to the dietary treatments. Chicks were raised in electrically heated batteries with raised wire mesh floors and had a free access to the feed and fresh water from nipple drinkers (2 nipples/cage) throughout the experiment. Light was provided for 23h/d. Room temperature on zero day was 33ºC and decreased approximately 3ºC per week until 20ºC was reached, according to standard poultry rearing practices. Batteries were placed into a room provided with continuous fans for ventilation. The chicks were fed with broiler starter diets between four and 14 days, broiler grower diets between 15 and 25 days and broiler finisher diets between 26 and 38 days. At the same time, feed consumption was recorded and feed conversion (FC,g feed/g gain) and live body weight gain (LBWG) were calculated. Crude protein conversion (CPC), caloric conversion ratio (CCR) and growth rate (GR) were also calculated. Performance index (PI) was calculated according to the equation described by North (1981) as follows: PI = (LBW, Kg/FC) x100.

At the end of the finishing period (38 days of age), slaughter tests were performed using three chicks around the average LBW of each treatment. The birds were on feed withdrawal overnight (approximately 12h), then individually weighed to the nearest gram, and slaughtered by severing the jugular vein (Islamic method). After four minutes bleeding time, each bird was dipped in a water bath for two minutes, and feathers were removed. After the removal of head, carcasses were manually eviscerated to determine some carcass traits, dressing% (eviscerated carcass without head, neck and legs) and total giblets% (gizzard empty, liver, heart and spleen). The eviscerated weight included the front part with wing and rear part. The bone of front and rear were separated and weighed to calculate meat percentage. The meat from each part was weighed and blended using a kitchen blender.

At the time of slaughter test, three samples of ileum content for each treatment were taken. Total microflora, colibacillus and lactobacillus of ileum content were enumerated. The pH of intestinal contents was directly determined by pH-meter. At the end of the experimental period (38 days), individual blood samples were taken from 3 birds of each treatment. The blood samples were collected into dry clean centrifuge tubes and centrifuged at 3000 rpm for 20 minutes. The clear serum samples were carefully drawn and transferred to dry, clean, small glass bottles, and stored at –20Ċ in a deep freezer until the time of chemical determinations. The biochemical characteristics of blood were determined colorimetrically, using commercial kits.

The left tibia was removed (meat was removed from the bone and the cartilage was left intact) and frozen for subsequent determination of bone density (Halliday *et al.*, 2010), bone breaking strength and bone ash percentage. Bone breaking strength was determined by using a HD 250 Texture Machine (Texture Technologies Corporation, Scarsdale, NY) fitted with a 3-point bend rig with a load cell capacity of 50 kg and a crosshead speed of 100 mm/min. After determination of bone breaking strength, fat was removed from the tibias by a 36h Soxhlet extraction in ethyl alcohol then dried at 100^{o} C for 24h. Bone ash percentage was determined by placing the bones in a muffle furnace and ashing for 36h at 550^{o} C. Ash weight was expressed as a percentage of dried tibia weight. Accumulative mortality rate was obtained by adding the number of dead birds during the experiment divided by the total number of chicks at the beginning of the experimental period (no mortality of birds were recorded during the study period).

To determine the economical efficiency for meat production, the amount of feed consumed during the entire experimental period was obtained and multiplied by the price of one Kg of each experimental diet which was estimated based upon local current prices at the experimental time, total revenue (according to the local market price at the experimental time)

Table (1): Composition and calculated analyses of the experimental diets.

Item	Starter (4-14 days)		Grower (15-25 days)		Finisher (26-38 days)	
	Control (Con.)	Con. -2% CP	Control (Con.)	Con. -2% CP	Control (Con.)	Con. -2% CP
Yellow corn, ground	60.60	64.10	63.44	69.26	63.74	71.00
Soybean meal (44%)	30.10	30.10	28.45	24.46	28.01	21.65
Corn glutein meal	3.80	0.00	1.40	0.00	0.00	0.00
Calcium carbonate	1.07	0.98	0.97	1.00	0.93	0.93
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30
Vit. and Min. premix[1]	0.30	0.30	0.30	0.30	0.30	0.30
Monocalcium phosphate	2.02	2.10	1.95	1.99	1.80	1.86
Vegetable oil[2]	1.50	1.73	2.90	2.25	4.55	3.38
DL–Methionine	0.11	0.16	0.13	0.17	0.24	0.29
L-Lysine HCl	0.20	0.23	0.16	0.27	0.13	0.29
Total	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis[3]:						
Crude protein (CP)	21.00	19.00	19.00	17.00	18.00	16.00
Ether extract	4.14	4.41	5.57	5.08	7.20	6.25
Crude fiber	3.49	3.52	3.41	3.24	3.36	3.08
Calcium (Ca)	1.03	1.00	0.96	0.96	0.90	0.90
Available phosphorus (AP)	0.50	0.51	0.48	0.48	0.45	0.45
Ca/AP ratio	2.06	1.95	1.99	2.01	1.99	1.99
Methionine	0.46	0.46	0.44	0.44	0.52	0.55
Methionine+Cystine	0.81	0.77	0.75	0.73	0.82	0.82
Lysine	1.20	1.20	1.10	1.10	1.05	1.05
ME, kCal./Kg	2988.9	2988.4	3083.3	3084.1	3182.8	3186.5
Cost (£.E./ton)[4]	2139.0	2047.9	2112.2	2014.1	2191.6	2099.8

[1]Each 3.0 Kg of the Vit. and Min. premix manufactured by Agri-Vet Company, Egypt and contains: Vit. A, 12000000 IU; Vit. D_3, 2000000 IU; Vit. E, 10 g; Vit. K_3, 2.0 g; Vit. B1, 1.0 g; Vit. B2, 5 g; Vit. B6, 1.5 g; Vit. B12,10 mg; choline chloride, 250 g; biotin, 50 mg; folic acid, 1 g; nicotinic acid, 30 g; Ca pantothenate, 10 g; Zn, 50 g; Cu,10 g; Fe, 30 g; Co, 100 mg; Se, 100 mg; I, 1 g; Mn, 60 g and anti-oxidant, 10 g, and complete to 3.0 Kg by calcium carbonate.

[2] Mixture from 75% soybean oil and 25% sunflower oil.

*[3] According to **NRC, 1994**.*

[4] According to the local market price at the experimental time.

Statistical analysis of results was performed using the General Linear Models (GLM) procedure of the SPSS software (SPSS, 1999), two way analyses of variance model was applied according to the follow general model: $Y_{ijk}= \mu+T_i+E_j+TE_{ij}+e_{ijk}$

Where: Y_{ijk}: observed value μ: overall mean T_i: type of addition effect (i: un-supplemented, 2% CA, 2% LA and 1% CA + 1% LA). E_j: level of CP effect (i: recommended and -2% CP) TE_{ij}: interaction of type of addition effect by level of CP effect. e_{ijk}: random error.

Treatment means showing significant differences ($P \leq 0.05$ and $P \leq 0.01$) were tested using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Productive performance:

Effects of using citric and lactic acids in broiler diets varying in their protein content on productive performance of Cobb broiler chicks are presented in (Table 2). Neither type of addition nor interaction between types of addition with level of CP had any significant effect on LBW, LBWG, FC, CPC, CCR, GR and PI. Numerically, chicks fed single or combined supplementation of CA and LA had higher LBW, PI and heavier LBWG during the overall period. On the other hand, OA supplementation to broiler diets improves LBW, LBWG, FC, CCR and PI during the overall period (the improvement in LBW and LBWG may be due to the effect of OA on the utilization of minerals affecting growth) compared with those fed un-supplemented diet, but differences were not significant (Table 2).

The aforementioned results are in agreement with those of Abdel-Fattah *et al.* (2008) and Saki *et al.* (2012) who found that the addition of dietary CA or LA improved LBW and FC of broiler chicks as compared with those fed unsupplemented diets. Similar results were found by other researchers (Moghadam *et al.*, 2006 and Nezhad *et al.*, 2007). Also, several studies (Rafacz, *et al.*, 2005; Chowdhury *et al.*, 2009 and Ghazalah *et al.*, 2011) support the statement that the addition of CA to broiler diets improved LBWG. Further more, Ghazalah *et al.* (2011) found that dietary CA supplementation significantly improved FC in chicks. However, no acidifier effects on FC were detected (Daskiran *et al.*, 2004).

Likewise, inclusion of encapsulated LA significantly improved broiler performances in terms of LBWG and FC (Natsir *et al.,* 2010). The improvement in LBWG and FC due to LA might suggest that LA might reach the small intestine, enable to lower intestinal pH, increase nutrient utilization and consequently improve broiler performances.

Concerning level of CP (Table 2), the results indicated that LBW, LBWG, GR and PI significantly decrease with reduction of CP contents of the diet than those fed diets containing recommended level.

It can be seen that dietary CP level had a significant ($P \leq 0.05$ and $P \leq 0.01$) effect on FC, CPC and CCR during the period from 4 to 38 days of age. Chicks fed diets containing recommended level of CP had the best FC, CPC and CCR during the over all period studied, while, feeding the sub-optimal CP level diet resulted in the worst FC, CPC and CCR values during the same period (Table 2).

Similar results were previously observed by Abd El-Gawad *et al.* (2004) and Waldroup *et al.* (2005) who found that decreasing dietary CP resulted in a decrease in LBWG, while, supplementation with EAA partially improved the loss in LBWG (Waldroup *et al.*, 2005). However, there was no significant effect of CA on FC of broilers fed a low CP diet (Abd El-Hakim *et al.*, 2009).

Concerning to the interaction between type of addition with level of CP, chicks fed diets containing recommended level of CP supplemented with 2% CA had higher LBW, PI at 38 days of age and heavier LBWG during the period from 4 to 38 days of age, while, those fed diets - 2% CP un-supplemented with OA had lower LBW, PI and LBWG during the same period, but differences were not significant (Table 2).

Similarly, Saki *et al.* (2012) revealed that supplementation of OA improved performance of broiler chickens. Also, Abdel-Fattah *et al.* (2008) reported that the use of 1.5% commercial OA (acetic, CA and LA) similarly improved broiler performances, no further improvements were observed when the dose of OA was increased to 3.0%. But is in agreement with others that reported no deleterious effects of CA on growth performance (Boling *et al.,* 2000, 2001b and Snow *et al.,* 2004).

Results indicated that feeding single or combined supplementation of CA and LA to broiler diets containing optimal and sub-optimal CP level significantly ($P \leq 0.01$) affected FI during the period from 4 to 38 days of age. It can be observed that chicks fed diets supplemented with OA had lower FI during this period, while, those fed diets un-supplemented with OA had higher FI during the same period (Table 2).

Table (2): Effect of adding citric and lactic acids in broiler diets varying in their protein content on productive performance of Cobb broiler chicks during the period from 4-38 days of age.

Item		Live body weight, g	Live body weight gain, g	Feed intake, g	Feed conversion	Crude protein conversion	Caloric conversion ratio	Growth rate	Performance index
Type of addition (T):									
Un-supplemented		1979.46	1894.94	3307.3[A]	1.77	0.32	5.22	0.93	65.97
2% citric acid (CA)		2004.63	1919.98	3218.8[C]	1.70	0.32	5.16	0.93	70.16
2% lactic acid (LA)		2004.00	1919.69	3229.8[B]	1.71	0.32	5.10	0.93	69.44
1% CA+1% LA		2000.73	1916.19	3202.3[D]	1.69	0.31	5.07	0.93	69.58
±SEM[1]		32.90	32.88	3.30	0.03	0.01	0.09	0.01	2.00
Level of crude protein (L):									
Recommended (R)		2064.96[A]	1980.4[A]	3236.63	1.66[B]	0.30[B]	4.91[B]	0.94[a]	73.22[A]
R -2% crude protein (CP)		1929.45[B]	1845.0[B]	3242.50	1.79[A]	0.33[A]	5.36[A]	0.93[b]	64.35[B]
±SEM		23.27	23.25	2.34	0.02	0.01	0.06	0.01	1.42
T × L (treatments):									
Un-supplemented	R	2050.00	1965.29	3267.3[B]	1.68	0.30	4.89	0.94	71.13
	R -2%CP	1908.92	1824.58	3347.3[A]	1.86	0.34	5.55	0.93	60.81
2% citric acid	R	2073.58	1988.96	3232.5[D]	1.64	0.31	5.00	0.94	74.64
	R -2%CP	1935.67	1851.00	3205.0[E]	1.76	0.33	5.33	0.92	65.68
2% lactic acid	R	2071.25	1986.92	3247.0[C]	1.66	0.30	4.91	0.94	73.26
	R -2%CP	1936.75	1852.46	3212.7[E]	1.77	0.33	5.30	0.93	65.62
1% CA+1% LA	R	2065.00	1980.38	3199.7[E]	1.64	0.30	4.85	0.94	73.86
	R -2%CP	1936.46	1852.00	3205.0[E]	1.75	0.33	5.28	0.92	65.30
±SEM		46.53	46.50	4.67	0.04	0.01	0.13	0.01	2.83

a, …b, and A,.. E, values in the same column within the same item followed by different superscripts are significantly different (at P≤0.05 for a to b; P≤0.01 for A to E). [1]
Pooled SEM

Negative effects regarding the decrease in FI by CA supplementation were observed by Angel *et al.* (2001) and Shellem and Angel (2002) who found that CA supplementation depresses FI in broiler chicks, which agreed with our findings.The results of the present study did not confirm the findings of several studies who state that the addition of CA or LA to broiler diets increased FI (Moghadam *et al*., 2006; Chowdhury *et al.*, 2009 and Saki *et al.*, 2012). However, Nezhad *et al.* (2007) reported that there was no significant effect on FI in broiler chicks fed a CA supplemented diet.

Regarding CP level, it can be observed that dietary CP level had insignificantly affected FI during the period from 4 to 38 days of age (Table 2). Similar results were observed by Abd El-Gawad *et al.* (2004) who found that level of CP did not affect FI.

Concerning to the interaction between type of addition with level of CP (Table 2), Chicks fed diet containing recommended level of CP supplemented with 1% CA + 1% LA had lower FI during the period from 4 to 38 days of age, while, those fed diets containing sub-optimal CP level without OA supplementation had higher FI during the same period. In conclusion, the experimental results demonstrated that OA can be used safely in C-SBM based diets for Cobb broiler chicks without any adverse effect on chicks LBW and LBWG.

These findings are in agreement with Atapattu and Nelligaswatta (2005) and Ao *et al*. (2009) who found that CA (1 and 2%) increased the digestibility of CP and CF of broilers. Recommended levels of CP gave better CPC values of the broiler chicks which fed different levels of crude protein (Abd El-Gawad *et al.*, 2004).

It can be concluded that CP can be reduced from the recommended level by 2% and supplement these diets with OA (i.e., CA and LA) without affecting performance. In this respect, Si *et al.* (2004); Abd El-Gawad *et al.* (2004) and Abdallah (2005) reported that diets low in CP and supplemented with EAA have improved growth rate. Recommended levels of CP gave best PI values of the broiler chicks, which were fed different levels of CP.

Slaughter parameters% and intestinal microflora count:

Results presented in Table 3 show the effect of using citric and lactic acids in broiler diets varying in their protein content on slaughter parameters % and total microflora count, colibacillus and lactobacillus of Cobb broiler chicks. Type of addition (Table 3) had significantly ($P \leq 0.01$) affected on total microflora count, it can be concluded that OA supplementation to broiler diets decrease total microflora count compared with those fed un-supplemented diet, while, insignificant ($P \geq 0.05$) effects were observed in slaughter parameters%, colibacillus and lactobacillus. Similarly, Abdel-Fattah *et al.* (2008) and Saki *et al.* (2012) reported that OA had no significant effect on carcass yield at day 42.

Further more, Chowdhury *et al.* (2009); Natsir *et al.* (2010) and Ghazalah *et al.* (2011) reported that dietary CA or LA supplementation significantly reduced the pH values in the different GI tract segments of the chicks or formulated diets. Dietary CA may decrease intestinal pH and increase Ca availability (Snow *et al.*, 2004).

Moreover, Brown and Southern (1985) reported that addition of CA and ascorbic acid did not affect intestinal pH of young chicks. Also, Cantor (2005) indicated that dietary addition of OA significantly lowered the pH of the diets and the crop content but did not change the pH of the gizzard and the small intestine.

These results disagree with the findings of Ghazalah *et al.* (2011) who found that relative weights of lymphoid organs (spleen, bursa and thymus gland) were significantly high by dietary CA supplementation in chicks. Also, Atapattu and Nelligaswatta (2005) and Chowdhury *et al.* (2009) indicated that dietary CA supplementation had positive effects on carcass yield of broilers.

The results of the present study are confirm the findings of Gunal *et al.* (2006) who reported a decrease in total bacteria and gram negative bacteria found in the small intestine. The acids can prevent bacteria and fungal growth, because they penetrate and disrupt the cell membrane and dissociate the acid molecule, thereby acidifying cell contents. Organic acids were used to control *E.coli* in poultry production (Chaveerach *et al.,* 2002 and Heres *et al.*, 2003). A healthy population of these beneficial bacteria in the digestive tract enhances the digestion and absorption of nutrients, detoxification, elimination processes and helps boost the immune system (No *et al.*, 2007 and Kong *et al.*, 2010).

Other researchers disagreed with our results; Ghazalah *et al.* (2011) established that dietary CA supplementation increased Lactobacillus count and coliforms in caeca content of the chicks. In addition, inclusion of LA significantly affected the number of LA bacteria, and *E .coli* in intestinal of broilers (Natsir *et al.*, 2010 and Saki *et al.*, 2012).

Table (3): Effect of adding citric and lactic acids in broiler diets varying in their protein content on some slaughter parameters% and intestinal microflora count of Cobb broiler chicks during the period from 4-38 days of age.

Item		Slaughter parameters%									Intestinal microflora count		
		Live body weight (g)	Total giblets	Breast meat	Rear meat	Carcass weight after evisceration	Dressing	Bursa	Thymus	Intestinal pH	Total microflora count	Coliba-cillus	Lacto-bacillus
Type of addition (T):													
Un-supplemented		2165.00	4.49	65.68	65.30	68.12	72.61	0.18	0.14	6.22	10.62^{A}	4.64	6.18
2% citric acid (CA)		2207.50	4.48	64.84	57.29	68.71	73.18	0.15	0.16	6.24	10.07^{B}	4.51	6.14
2% lactic acid (LA)		2108.75	4.85	67.68	59.56	67.18	72.04	0.19	0.15	6.17	9.95^{B}	4.48	6.12
1% CA+1% LA		2112.50	4.48	65.77	60.50	67.63	72.12	0.18	0.14	6.24	9.69^{C}	4.41	6.25
±SEM[1]		94.77	0.30	2.04	5.09	0.72	0.59	0.03	0.03	0.04	0.05	0.14	0.05
Level of crude protein (L):													
Recommended (R)		2173.75	4.54	64.63	59.84	68.07	72.61	0.17	0.14	6.28^{a}	9.68^{B}	4.50	6.17
R -2% crude protein (CP)		2123.13	4.61	67.35	61.49	67.76	72.37	0.19	0.16	6.16^{b}	10.48^{A}	4.52	6.18
±SEM		67.01	0.21	1.44	3.60	0.51	0.42	0.02	0.02	0.03	0.04	0.10	0.04
T × L (treatments):													
Un-supplemented	R	2265.00	4.34	64.60	60.17	69.30	73.64	0.13	0.11	6.31	10.29	4.46	6.16
	R -2%CP	2065.00	4.64	66.75	70.43	66.95	71.59	0.23	0.16	6.13	10.96	4.83	6.21
2% citric acid	R	2180.00	4.51	64.62	60.35	68.54	73.06	0.16	0.18	6.32	9.74	4.59	6.16
	R -2%CP	2235.00	4.44	65.06	54.23	68.87	73.31	0.15	0.14	6.17	10.41	4.43	6.13
2% lactic acid	R	2150.00	4.64	64.76	60.98	67.16	71.80	0.19	0.12	6.17	9.47	4.51	6.14
	R -2%CP	2067.50	5.07	70.59	58.14	67.20	72.27	0.18	0.19	6.17	10.42	4.45	6.11
1% CA+1% LA	R	2100.00	4.67	64.54	57.86	67.26	71.93	0.18	0.13	6.31	9.25	4.44	6.21
	R -2%CP	2125.00	4.29	67.01	63.14	68.01	72.30	0.18	0.16	6.16	10.13	4.37	6.29
±SEM		134.03	0.43	2.88	7.20	1.02	0.84	0.04	0.04	0.05	0.08	0.19	0.07

a, …b, and A,.. C, values in the same column within the same item followed by different superscripts are significantly different (at P≤0.05 for a to b; P≤0.01 for A to C).

[1] *Pooled SEM*

Level of CP significantly ($P\leq0.01$) affected intestinal pH and total microflora count while, insignificant ($P\geq0.05$) effects were observed in other slaughter parameters%, colibacillus and lactobacillus. Chicks fed diets containing recommended level of CP had higher intestinal pH (lower total microflora count), while, feeding the sub-optimal CP level diet resulted in the lower intestinal pH (the reduction in buffering capacity in conjunction with improving digestibility coefficients of CP) value (higher total microflora count). On the other hand, the results showed a significant increase in total microflora count with decreasing CP level (Table 3). The results indicated no significant differences due to interaction effect of dietary treatments on slaughter parameters% and intestinal microflora count.

Similar results were reported by Zaman *et al*. (2008) who concluded that lowering the dietary CP with EAA supplementation resulted in breast meat yield similar to those birds fed on control diet. It seems that low CP slightly increased the digestibility of amino acids required for carcass formation.

Abd El-Gawad *et al.* (2004), Kamran *et al.* (2004) and Nawaz *et al.* (2006) found that there were no significant differences in carcass characteristics or abdominal fat weight due to either dietary protein level or probiotic supplementation. But, Si *et al.* (2004) reported significant increase in abdominal fat pad with decrease in the dietary CP level. However, no significant effect of CA on carcass characteristics or organ weights were observed except for liver which was significantly high in broilers fed a low CP diet (Abd El-Hakim *et al.*, 2009).

Blood constituents:

Some blood constituents analyses are summarized in Table (4). The results indicated no significant differences due to main and interaction effect of dietary treatments on blood constituents except, dietary treatments significantly affected red blood cells count (RBCs) and mean corpuscular volume (MCV). Chicks fed diet containing sub-optimal CP level un-supplemented with OA had higher RBCs value.

While, those fed diet containing sub-optimal CP level supplemented with 2% LA had lower RBCs value (higher MCV value). Chicks fed diet containing sub-optimal CP level supplemented with 2% CA had lower MCV value (Table 4). Numerically, it can be concluded that OA supplementation to broiler diets increased plasma phosphorous (P) values compared with those fed un-supplemented diets, but differences were not significant (Table 4).

Similar results were previously observed by Ghazalah et al. (2011) who found that blood serum content of Ca and P were significantly increased by dietary CA supplementation in chicks. Improving the utilization of Ca and P due to provision CA was approved by Abdel-Fattah et al. (2008) who observed an increase in blood Ca of broiler fed dietary CA.

While, Liem *et al*. (2008) noted that CA addition did not increase plasma P levels. The present results disagree with Abdel-Fattah *et al*. (2008) and Ghazalah *et al.* (2011) who found that supplemental CA increased significantly the relative weight of spleen, bursa and thymus. These results might indicate that broiler chicks fed the acidifiers supplemented diets had better immune response and disease resistance. However, there was no effect on bursa or spleen weight when fed broilers on CA at 0.2, 0.4, 0.6 and 0.8% (EL-Afifi *et al*., 2001).

Chemical composition of broiler meat and tibia parameters:

Data presented in Table 5 showed that type of addition insignificantly affected chemical composition of broiler meat. Level of CP significantly affected protein, fat and ash of chicks meat. The highest fat% (the lowest protein and ash%) were observed for chicks fed diets containing sub-optimal CP level, while those fed diet containing recommended level of CP had lower fat% (the highest protein and ash%). However, insignificantly affected moisture and NFE%.

These results disagree with the findings of Neto *et al.* (2000) who indicated that chicks fed low protein diets supplemented with EAA had similar total carcass protein contents as those fed a 24% dietary CP. However, Zaman *et al*. (2008) reported that increases in dietary CP resulted in increased dry matter, CP and fat contents of carcass.

Table (4): Effect of adding citric and lactic acids in broiler diets varying in their protein content on some blood parameters of Cobb broiler chicks during the period from 4-38 days of age.

Item		Hemoglobin (g/dL)	RBC[1] ($10^6/mm^3$)	Hematocrit %	Blood index			WBC[5] $10^3/mm^3$	Plate	Differential count%				Phosphorus %
					MCV[2], μ^2	MCH[3], µµg	MCHC[4] %		count	Neutro-phils	Lympho-cyte	Mono-cytes	Eosino-phils	
Type of addition (T):														
Un-supplemented		11.13	3.32	42.25	128.83	33.78	26.03	16.05	41.50	30.00	64.50	4.75	2.25	3.15
2% citric acid (CA)		10.43	3.13	39.00	130.00	34.43	24.38	13.49	39.50	26.50	68.75	3.75	2.50	3.43
2% lactic acid (LA)		10.18	2.88	38.75	142.25	36.63	26.08	11.99	39.25	24.25	67.75	4.00	2.50	3.55
1% CA+1% LA		10.30	2.92	38.25	133.75	33.95	24.98	13.39	40.75	29.25	62.75	3.50	2.75	3.80
±SEM[1]		0.31	0.10	1.32	3.98	2.16	1.13	1.26	4.90	4.53	3.63	0.31	0.43	0.18
Level of crude protein (L):														
Recommended (R)		10.65	3.15	40.63	134.90	35.00	25.83	13.62	41.38	27.63	66.38	4.00	2.75	3.58
R -2% crude protein (CP)		10.36	2.97	38.50	132.51	34.39	24.90	13.84	39.13	27.38	65.50	4.00	2.25	3.39
±SEM		0.22	0.07	0.93	2.81	1.53	0.80	0.89	3.46	3.20	2.56	0.22	0.31	0.13
T × L (treatments):														
Un-supplemented	R	11.10	3.28[a]	41.50	126.25[b]	33.75	26.75	16.55	44.50	29.00	63.50	5.00	2.50	3.30
	R -2%CP	11.15	3.36[a]	43.00	131.40[a]	33.80	25.30	15.55	38.50	31.00	65.50	4.50	2.00	3.00
2% citric acid	R	10.70	3.16[a]	41.00	140.00[a]	36.85	25.00	13.98	40.50	29.50	70.00	4.00	2.50	3.65
	R -2%CP	10.15	3.10[a]	37.00	120.00[b]	32.00	23.75	13.00	38.50	23.50	67.50	3.50	2.50	3.20
2% lactic acid	R	10.25	3.30[a]	40.50	133.75[a]	32.20	24.90	10.81	34.50	21.00	69.50	3.50	3.00	3.30
	R -2%CP	10.10	2.46[b]	37.00	150.75[a]	41.05	27.25	13.17	44.00	27.50	66.00	4.50	2.00	3.80
1% CA+1% LA	R	10.55	2.86[ab]	39.50	139.60[a]	37.20	26.65	13.12	46.00	31.00	62.50	3.50	3.00	4.05
	R -2%CP	10.05	2.98[a]	37.00	127.90[b]	30.70	23.30	13.65	35.50	27.50	63.00	3.50	2.50	3.55
±SEM		0.43	0.15	1.86	5.63	3.06	1.60	1.79	6.92	6.40	5.13	0.43	0.61	0.26

[1] Red blood cells [2] Mean corpuscular volume [3] Mean corpuscular hemoglobin [4] Mean corpuscular hemoglobin concentration [5] White blood cells

a, …b values in the same column within the same item followed by different superscripts are significantly different (at P≤0.05 for a to b).

[1] Pooled SEM.

Table (5): Effect of adding citric and lactic acids in broiler diets varying in their protein content on chemical composition of broiler meat % (on dry matter basis) and tibia parameters of Cobb broiler chicks during the period from 4-38 days of age.

Item		Chemical composition of broiler meat%					Tibia parameters				
		Moisture	Protein	Fat	Ash	NFE	Density (g/cm^3)	strength (kg)	Ash%	Calcium%	Phosphorous%
Type of addition (T):											
Un-supplemented		7.16	60.93	28.42	3.12	0.37	1.04	31.09	43.88	24.37^B	11.51^C
2% citric acid (CA)		5.94	62.29	28.34	3.06	0.37	1.04	31.44	44.30	26.33^A	13.45^A
2% lactic acid (LA)		6.01	62.28	28.18	3.14	0.41	1.06	31.81	43.91	25.32^{AB}	12.61^B
1% CA+ 1% LA		5.70	62.80	28.20	3.01	0.31	1.06	31.99	43.76	26.26^A	13.33^{AB}
±SEM[1]		0.53	1.18	1.62	0.20	0.04	0.02	0.39	0.14	0.31	0.24
Level of crude protein (L):											
Recommended (R)		6.41	63.37^a	26.26^b	3.56^A	0.40	1.11^A	32.01	44.41^A	26.00^a	13.03^a
R -2% crude protein (CP)		6.00	60.78^b	30.31^a	2.60^B	0.33	0.98^B	31.15	43.52^B	25.14^b	12.41^b
±SEM		0.37	0.83	1.15	0.14	0.03	0.01	0.28	0.10	0.22	0.17
T × L (treatments):											
Un-supplemented	R	7.25	62.15	26.68	3.54	0.39	1.08	31.20	44.30	24.77	11.55
	R -2%CP	7.07	59.71	30.17	2.70	0.36	1.00	30.98	43.36	23.97	11.47
2% CA	R	6.08	63.48	26.44	3.60	0.40	1.10	31.78	44.92	26.89	13.87
	R -2%CP	5.80	61.11	30.23	2.52	0.35	0.98	31.10	43.68	25.78	13.03
2% LA	R	6.19	63.69	26.00	3.64	0.48	1.12	32.11	44.21	25.99	13.03
	R -2%CP	5.82	60.86	30.35	2.63	0.34	0.99	31.51	43.62	24.66	12.19
1% CA +1% LA	R	6.11	64.17	25.91	3.47	0.35	1.14	32.96	44.19	26.37	13.70
	R -2%CP	5.29	61.43	30.49	2.54	0.27	0.98	31.02	43.33	26.16	12.97
±SEM		0.75	1.67	2.29	0.29	0.06	0.02	0.55	0.20	0.44	0.34
Carcass part:											
Breast		6.77^a	64.84^A	24.38^B	3.56^A	0.45^A	-----	-----	-----	-----	-----
Rear		5.63^b	59.30^B	32.19^A	2.60^B	0.28^B	-----	-----	-----	-----	-----
±SEM		0.34	0.44	0.56	0.13	0.02	-----	-----	-----	-----	-----

a, …b, and A,.. C, values in the same column within the same item followed by different superscripts are significantly different (at P≤0.05 for a to b; P≤0.01 for A to C). [1] *Pooled SEM*

Table (6): Effect of adding citric and lactic acids in broiler diets varying in their protein content on economical efficiency (EEf) of Cobb broiler chicks during the period from 4-38 days of age.

Type of addition	Un-supplemented		2% CA		2% LA		1% CA+1% LA	
Level of crude protein (L):	R*	R -2%CP	R	R -2%CP	R	R -2%CP	R	R -2%CP
a_1	0.4340	0.4580	0.4673	0.4517	0.4600	0.4527	0.4467	0.4690
b_1	213.90	204.79	217.70	208.59	221.90	212.79	219.80	210.69
a_1 x b_1=c_1	92.83	93.79	101.74	94.21	102.07	96.32	98.18	98.81
a_2	0.8773	0.9537	0.8810	0.9053	0.8777	0.9180	0.8690	0.9050
b_2	211.22	201.41	215.02	205.21	219.22	209.41	217.12	207.31
a_2 x b_2=c_2	185.31	192.08	189.43	185.78	192.40	192.24	188.68	187.62
a_3	1.9560	1.9357	1.8842	1.8480	1.9093	1.8420	1.8840	1.8310
b_3	219.16	209.98	222.96	213.78	227.16	217.98	225.06	215.88
a_3 x b_3=c_3	428.68	406.46	420.10	395.07	433.72	401.52	424.01	395.28
(c_1+c_2+c_3)=c_{total}	706.82	692.33	711.27	675.06	728.19	690.08	710.87	681.71
d	1.9653	1.8246	1.9890	1.8510	1.9869	1.8525	1.9804	1.8520
e	1300.0	1300.0	1300.0	1300.0	1300.0	1300.0	1300.0	1300.0
d x e=f	2554.9	2372.0	2585.6	2406.3	2583.0	2408.2	2574.5	2407.6
f- c_{total} =g	1848.1	1679.6	1874.4	1731.2	1854.8	1718.1	1863.6	1725.9
Economical efficiency(g/c_{total})	2.6146	2.4260	2.6352	2.5646	2.5471	2.4897	2.6216	2.5317
Relative efficiency(r)	100.00	92.79	100.79	98.09	97.42	95.22	100.27	96.83

a_1, a_2 and a_3 ……………………….average feed intake (Kg/bird) during the periods of starter, grower and finisher, respectively.

b_1, b_2 and b_3 ……………………… price / Kg feed (P.T.) during the periods of starter, grower and finisher, respectively (based on average local market price of diets during the experimental time).

c_1, c_2 and c_3 ……………………….. feed cost (P.T.) during the periods of starter, grower and finisher, respectively.

Total feed cost (P.T.) = c_{total} = (c_1+c_2+c_3)

Average LBWG (Kg/ bird) d

Price / Kg live weight (P.T.) e.…………………...…….…(according to the local market price at the experimental time).

Total revenue (P.T.) = d x e = f

Net revenue (P.T.) = f - c_{total} =g

Economical efficiency = (g / c_{total}) ………..…………………..(net revenue per unit feed cost).

Relative efficiency r.…………………...……..(assuming that economical efficiency of the control group (1) equals 100).

** Recommended*

Carcass part significantly influenced ($P \leq 0.01$ and $P \leq 0.05$) chemical composition of broiler meat. The results showed that rear part had higher fat than the breast part (32.19 vs 24.38%). However, breast part had higher moisture, protein, ash and NFE% (consequently lower fat%) than rear part (Table 5). The inverse relationship found between percentage moisture and fat values obtained in the present study is in agreement with that reported by Marks (1993); Ragab (2001) and Emam (2010) in chemical composition of Japanese quail meat and broiler chicks. The results indicated no significant differences due to interaction effect of dietary treatments on chemical composition of broiler meat (Table 5). Data presented in Table 5 show that type of addition insignificantly affects density, strength and ash of chicks tibia, while significantly affected Ca and P%.

It can be concluded that OA supplementation to broiler diets increase Ca and P% compared with those fed un-supplemented diet. On the other hand, chicks fed single supplementation of CA had higher Ca and P% (the increase in tibia ash resulting from CA supplementation indicate that the CA markedly improved phytate P utilization in broiler chicks).

Similar to the present results, inclusion of CA improves mineral utilization (Snow *et al.*, 2004 and Rafacz *et al.*, 2005). Further more, Liem *et al.* (2008) reported that the addition of CA increased the percentage of tibia ash, similar results were reported by Nezhad *et al.* (2007) and Chowdhury *et al.* (2009). The results of the present study did not confirm the findings of Sifri *et al.* (1977) who reported that CA did not have any effect on Ca metabolism in chicks.

Level of CP significantly affected tibia parameters except, tibia strength which was insignificantly affected. The highest density, ash, Ca and P values were observed for chicks fed diets containing optimal CP level, while, those fed diet containing sub-optimal level of CP had lower values. The results indicated no significant differences due to interaction effect of dietary treatments on tibia parameters (Table 5).

Economical efficiency (EEf):

Results in Table (6) show that EEf value during the period from 4 to 38 days of age was improved of chicks fed diet containing recommended level of CP supplemented with 2% CA (2.635 and 100.79%, respectively) and chicks fed diet containing recommended level of CP supplemented with 1% CA +1% LA (2.622 and 100.27%), respectively as compared with those fed the control diet and other treatments. Whereas, chicks fed diet containing sub-optimal level of CP un-supplemented with OA had the lowest corresponding value, being 2.426 and 92.79%, respectively. The relative efficiency varied between 92.79% to 100.79%, which is of minor importance relative to other factors of production.

The results of this study are in agreement with those of Abd-Elsamee (2002) and Abd El-Gawad *et al.* (2004) who found that broiler chicks fed diets containing either optimum level of CP or adding probiotics, EEf values were increased.

The results of the present study indicated that Cobb broiler chicks fed low protein diets supplemented with OA maintain the same performance and economical efficiency as that obtained from chicks fed diets containing recommended level of CP. On the other hand, it can be concluded that CP can be reduced from the recommended level by 2% and supplement these diets with OA (i.e., CA and LA) without affecting performance. Besides, using such diets reduces feed cost and nitrogen pollution.

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تأثير إضافة حمضى الستريك واللاكتيك فى علائق بدارى التسمين المختلفة فى محتواها من البروتين على الأداء الإنتاجى ، العد البكتيرى وبعض مكونات الدم.

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تم إجراء التجربة خلال الفترة من شهر يناير إلى فبراير لسنة ٢٠١٢. غذيت الكتاكيت عمر يوم ولمدة ٣ أيام علي عليقة الكنترول وتم توزيع ١٩٢ كتكوت غير مجنس (سلالة كب) بصورة عشوائية إلى ثمانية معاملات (٢٤ طائر/معاملة) كل معاملة مقسمة إلي ثلاثة مكررات (٨ طائر/مكرر). وكانت المعاملات التجريبية كما يلي:

١-غذيت الكتاكيت علي عليقة المقارنة. ٢-عليقة المقارنة -٢% بروتين خام.

٣-عليقة المقارنة +٢% حمض ستريك. ٤-عليقة المقارنة -٢% بروتين خام +٢% حمض ستريك.

٥-عليقة المقارنة +٢% حمض لاكتيك. ٦-عليقة المقارنة -٢% بروتين خام +٢% حمض لاكتيك.

٧-عليقة المقارنة +١% ستريك+١% لاكتك. ٨-عليقة المقارنة -٢% بروتين خام +١% ستريك+١% لاكتيك.

وتم تلخيص النتائج المتحصل عليها كما يلى:

١-الأداء الإنتاجي: لم يكن هناك أي تأثير معنوي لأي من نوع الإضافة (حمض ستريك أو لاكتيك) ولا للتداخل بين نوع الإضافة مع مستوي البروتين علي وزن الجسم الحي والزيادة في وزن الجسم ومعامل التحويل الغذائي وكفاءة تحويل البروتين وكفاءة تحويل الطاقة ومعدل النمو ومعامل الأداء الإنتاجي. وتشير النتائج إلي أنه كان هناك إنخفاض معنوي لوزن الجسم الحي والزيادة في وزن الجسم ومعدل النمو و معامل الأداء الإنتاجي مع خفض مستوي بروتين العليقة. كان للكتاكيت المغذاة علي علائق تحوي المستوي الموصي به من البروتين أحسن معامل تحويل غذائي و أحسن كفاءة تحويل البروتين والطاقة. انخفضت معنويا كمية الغذاء المأكول للكتاكيت المغذاة علي العلائق المحتوية علي الأحماض العضوية خلال الفترة من ٤-٣٨ يوم من العمر. لم يكن هناك أي تأثير معنوي لمستوي البروتين علي كمية الغذاء المأكول خلال الفترة من ٤-٣٨ يوم في العمر. انخفضت معنويا كمية الغذاء المأكول للكتاكيت المغذاة علي علائق تحوي المستوي الموصي به من البروتين مضافاً إليها ١% ستريك+١% لاكتيك خلال الفترة من ٤-٣٨ يوم من العمر.

٢-صفات الذبيحة وميكروفلورا الأمعاء: إضافة الأحماض العضوية المدروسة قلل معنويا العدد الكلي للميكروفلورا بينما لم يكن هناك تأثير معنوي علي صفات الذبيحة%، *colibacillus and lactobacillus*. الكتاكيت المغذاة علي العلائق ذات المستوي المثالي من البروتين الخام كانت الأعلى معنويا في مستوي الحموضة للأمعاء (اقل عدد كلي للميكروفلورا). لم يكن هناك أي تأثير معنوي للتداخل بين نوع الإضافة مع مستوي البروتين علي صفات الذبيحة% و العدد الكلي للميكروفلورا.

٣- مكونات الدم: الكتاكيت المغذاة علي العلائق المنخفضة في نسبة البروتين الخام بدون إضافة الأحماض العضوية المدروسة كانت أعلي معنويا في قيمة عدد خلايا الدم الحمراء بينما تلك المغذاة علي مستوي البروتين المنخفض مع ٢% حامض اللاكتيك كانت أقل معنويا في قيمة عدد خلايا الدم الحمراء (أعلي قيمة لمتوسط حجم الخلايا).

٤- التركيب الكيماوي للحم بداري التسمين و قياسات عظمة التيبيا: كان للكتاكيت المغذاة علي المستوي المنخفض من البروتين الخام أعلى نسبة دهون% وأقل نسبة بروتين ورماد%. لم يكن هناك أي تأثير معنوي للتداخل بين نوع الإضافة مع مستوي البروتين علي التركيب الكيماوي للحم بداري التسمين. أدي إضافة الأحماض العضوية إلي زيادة معنوية في نسبة الكالسيوم والفوسفور% مقارنة بالتي غذيت علي العلائق غير المحتوية علي أي إضافات. كان للكتاكيت المغذاة على نسبة البروتين المثالية أعلى معنوية لكثافة العظم ونسبة الرماد و الكالسيوم والفوسفور في عظمة التيبيا. لم يكن هناك أي تأثير معنوي للتداخل بين نوع الإضافة مع مستوي البروتين علي قياسات عظمة التيبيا.

٥-الكفاءة الاقتصادية: تحسنت الكفاءة الاقتصادية والنسبية للكتاكيت المغذاة علي المستوي المثالي للبروتين مع إضافة ٢% حامض السيتريك والكتاكيت المغذاة على المستوي المثالي للبروتين مع إضافة ١%حامض السيتريك مع ١% حامض لاكتيك مقارنة بتلك التي غذيت على علائق الكنترول وباقي المعاملات.

من وجهة النظر الغذائية والاقتصادية يمكن التوصية بأن تغذية الكتاكيت (كب) على العلائق المنخفضة في البروتين الخام مع إضافة الأحماض العضوية يماثل في أداءه تلك المغذاة على العلائق المثالية في البروتين. و بمعني أخر يمكن استنتاج انه يمكن خفض نسبة البروتين الخام ٢% عن المستوي الموصي به مع إضافة الأحماض العضوية (ستريك أو لاكتيك) بدون التأثير علي الأداء. بالإضافة إلى أن استخدام هذه العلائق يقلل من تكلفة الغذاء والتلوث بالنيتروجين.