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IMPACT OF ORGANIC ACIDS SUPPLEMENTATION ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, AND SOME BLOOD PARAMETERS IN BROILER CHICKS

M.S. Refaie; M. I. El-Kelawy and Ibtesam A.M. Srour

Dep.of Poult. Prod., Fac. of Agric., New Valley Uni., Egypt.

Corresponding author: M. I. El-Kelawy Email : **m.elkelawy@gmail.com**

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ABSTRACT: The current study was conducted to evaluate the influence of dietary incorporating with different organic acids (OAs) acetic (AAs), citric (CAs), and propionic acids (PAs) on growth performance, nutrient digestibility, carcass traits, blood biochemical parameters, and microbial profile in broiler chickens. A total of 120 one-day-old unsexed Ross broiler chicks were randomly divided into four treatment groups (30 chicks/group; 3 replicates of 10 birds). The first group as control received a basal diet without additives, while the second, third and fourth groups were incorporated with 0.5% of either acetic, citric, or propionic acid, respectively

The results showed that dietary inclusion of all tested organic acids (OAs) resulted in a significant improvement in ($p < 0.05$) body weight(BW), weight gain(BWG), feed conversion ratio(FCR), performance index, and economic efficiency in comparison with the control group, with no statistically significant differences in feed intake. Apparent nutrient digestibility of dry matter (DM), crude protein (CP), ether extract (EE), organic matter (OM), and nitrogen-free extract (NFE) did not differ significantly among treatments. Carcass evaluation showed a significant reduction in abdominal fat in acid-supplemented groups, without affecting dressing percentage or internal organ weights.

Biochemically, citric acid supplementation significantly increased plasma albumin levels, while no statistically significant differences were observed in total protein, globulin, glucose, lipid profile, or liver enzyme activities among all groups. Microbial analysis indicated that acetic acid increased total bacterial count without significantly affecting Lactobacillus acidophilus populations.

In conclusion, supplementation with 0.5% organic acids (OAs), particularly citric and acetic acids, enhanced broiler performance and reduced fat deposition without affects on nutrient digestibility or health-related blood parameters, supporting their use as natural growth promoters in broiler production.

Keywords: Organic acid, Broiler, Growth performance

INTRODUCTION

Feed additives are currently regarded as important for best performance and production in recent chicken farming (Shahid *et al*. 2015). Previously, antibiotics have already been used to stimulate growth and balance gut flora (Abudabos *et al.*, 2016; Haulisah *et al*., 2021). Recently, the developing resistance microorganisms and remains in meat and eggs as a result the using of antibiotics have been outlawed as growth promoters (Dhama et al. 2015; Ullah et al. 2022). Therefore, there is a need to hunt for alternatives feed additives. Probiotics, prebiotics, Organic acids, medicinal plant extracts, and exogenous enzymes are among the most often utilized feed additives. The feed additives mode of action as antimicrobials, antioxidants, emulsifiers, pH monitor agents, and enzymes in poultry diets (Ragaa et al., 2016). Specially, OAs and their salts as natural feed additives in animal production such as acetic, formic, lactic, propionic, and isobutyric acids. it has been supplemented in feed or water and safe for use in animal feed beside it can promote intestinal tract illness prevention, immunity furthermore, increase chicken production and performance by improving nutrient digestion and absorption while depressing enteric pathogenic bacteria loads such as Salmonella beside E coli moreover lowering intestinal pH, all of which improve gut health and production in birds (Koyuncu et al., 2013;Kamal and Ragaa 2014;El Baaboua et al., 2018;Yadav and Jha, 2019).

Several researchers investigated that broiler fed diets including mix of acetic, citric, and propionic acids at levels 0.031 or 0.062% produced better results in reducing salmonella in crop and cecal (Menconi et al 2013) .Furthermore, OAs have a several functions, including antibacterial, lowering the pH of digesta in the gastrointestinal tract, reducing feed passage in the intestine, inducing enzyme secretion of intestinal or pancreatic, stimulating beneficial bacteria all of which improve feed conversion, growth performance and production (Dibner, 2004; Abdel-Fattah et al., 2008 and Kil et al., 2011).

Citric acid (CAs) is the greatest widely utilized OAs in poultry diets. Incorporating CAs in diet increase feed consumption, modify the gut PH and raise the activity of several enzymes that require acidic conditions, such as pepsin and phytase, hence improving the consumption of protein and some minerals, increasing protein and fiber digestibility, improved live weight gain, feed conversion efficiency, and mineral absorption moreover, reduced the pH of broiler ceacal digesta, as well as microbial load, resulting in an improved immunological response in broilers (Jozefiak and Rutkowski, 2005;Wickramasinghe et al., 2014; AL-Harthi and Attia 2016).

Acetic acid (AAs) has received increased attention in the poultry production (Mohammadi et al., 2018). Incorporating AAs in broiler diets al levels 0.5 to 5% can depressed numerous pathogenic or beneficial intestinal bacteria due to minimize PH generated can protecting the animals from diseases, particularly during young age. Moreover, increasing villus height and function of secretion, stimulating nutrients digestion and absorption resulting in promotes growth performance (Abdel Razek et al., 2016; Mohammadi et al., 2018).

PAs promotes growth by reducing pathogenic load, improving digestibility, enhancing intestinal mucosa permeability, and increasing nutrient utilization and absorption (Haque et al. 2009). Several previous studies found that (PO) added to broiler diets at a dosage of up to 0.75% has been increase live body weight without altering length of gastrointestinal tract (Palupi et al., 2020). Consequently, the objectives of this current study was to investigate the impact of OAs supplementation on growth performance, nutrient digestibility, and some blood parameters in broiler chicks

MATERIAL AND METHODS

The study was carried out, private farm, new valley, Egypt. One hundred and twenty unsexed one-day old Ross broiler chicks were randomly divided to four treatments groups (30 birds/ treatment) with 3 replicates and 10 birds per replicate. The 1st group fed a basal diet without OAs supplementation and represented as a control. The 2nd, 3rd and the 4th group of birds fed diets inclusion basal diet incorporated with 0.5 % of each of acetic acid, citric acid and propionic acid, respectively.

Chicks were kept in the same managerial conditions. Chicks were reared in floor breeding and supply full access to feed and water during the experimental period. The housing temperature was 32°C during the 1st week and declined gradually by 2°C each week and was then stabilized at 25°C until slaughter. A light timetable was 23 h light until 7th day followed by 20 h light from 8th day to through the experimental period until 3 days before slaughter test (8-35 days of age). The experimental diets were formulated to meet requirements of broiler chickens according to NRC (1994). The basal diet composition of the experimental study is presented in Table (1) Average initial weight of chick one day old, final body weight, weight gain; feed intake, feed efficiency and mortality were recorded.

At the end of the trial, 3 males from each group were housed individually in separate cages for 5 days. Birds were allowed to the experimental diets for 2 days as initial period followed by 3 days as a main experimental period. The digestibility of dry matter, crude protein, ether extract, organic matter and nitrogen free extract were analyzed according to AOAC (2004).

At 36 d of age, five broiler chicks from each group were slaughtered after 8 hours fasting, processed and the weight of carcass and internal organs (dressing, total edible parts, abdominal fat, spleen, bursa, and thymus) was taken and expressed as the percentage of live BW.

At slaughter, five blood samples were collected in non-heparinzed tubes from each group. Blood samples was separated to obtained serum by centrifuging of blood at 3000 rpm for 20 minutes and stored at –20o C for biochemical analysis. All blood biochemical parameters were determined using commercial kits (spectrum Diagnostics, Egypt) by using a spectrophotometer according to the following methods. Glucose concentration (mg/dl) was measured according to Trinder (1969), Total protein (g/dl) (Henry et al., 1974), albumin (g/dl) (Doumas, 1971) and globulin (g/dl) (Coles, 1974) were determined according to Bossuyt et al. (2003), Triglycerides (Fossati and Prencipe, 1982), total cholesterol (Stein, 1986), HDL (Lopes-Virella, 1977), while LDL was determined according to (Friedewald et al., 1972). The activity of plasma aspartate amino transferase, and plasma alanine amino transferase, were estimated according to Reitman and Frankle (1957).

During slaughtering three fresh samples from each treatments group were diluted and plated onto nutrient agar to estimated total bacterial count in the same time the samples plated onto MRS agar to calculated Lactobacillus acidophilus and the number of microorganisms was converted to $\log 10^6$ (Czerwiński et al 2012).

The economic evaluation for all experimental treatments was made (Zeweil, 1996) as follows:

Economic efficiency = total revenue - total cost / total cost × 100

Total revenue = BW × Meat Price
Total cost = Feed cost + Addition cost + other cost
Data were analyzed by the GLM procedure (SPSS, 2011) using one-way anova with the following model:
Yik= μ+ Ti + eik
Where Y is the dependent variable; the μ general mean; T the effect of experimental treatments; e the random error. The differences between means were tested by using Duncan's New Multiple Range test, (Duncan, 1955).

RESULTS AND DISCUSSION

Production performance:

The impact of various organic acids (OAs) on the production performance of broiler chickens is reported in Table 2. Throughout all experimental periods, dietary supplementation with acetic acid, citric acid, and propionic acid lead to significant increases ($p < 0.05$) in final body weight (FBW)and body weight gain (BWG) in comparison with the control group.. Additionally, data showed that FCR was resulted in a significant improvement by the incorporating AAs (0.5%), CAs (0.5%) and PAs (0.5%) during the experimental period (1- 35 days of age) compared with the control diet. However, no effects were defected in feed consumption among the treated groups. Moreover, broiler chickens receiving the basal diet supplemented with these additives exhibited significantly higher levels of economic efficiency and production index compared to the control group.

The current results were in aligning with Younis et al., (2024) who demonstrated that propionic acid (0.5%) supplementation resulted in a significant improvement in LBW, average daily gain and FCR. Similarly, Youssef et al. (2017) showed that incorporating with organic acids (OAs) in birds diets had improved BW and BWG . Also, Fathi et al. (2016) showed that supplementation formic acid and PAs had superior BWG and better FCR in broilers. Chick performance such a BW, weight gain, and average daily gain of broiler chicks can be significantly enhanced by a single or combination of OAs (CAs and AAs), according by (Adhikari et al., 2020; and Stamilla et al. (2020). Another study by Khan and Iqbal (2016) and Youssef et al. (2017), who noted that birds fed diets containing organic acids (OAs) showed a significant improvement in BW and BWG during the growing period .The previous enhancement due to OAs additions may be due to the population of beneficial bacteria was maintained, enhance nutrient digestion, and it may have an influence on the safety of microbial cell membranes or prevent nutrient transport, which would have a bactericidal effect (Ricke, 2003). Likewise, Mallo et al. (2012) mentioned that the incorporating of (OAs) in diets resulted in enhanced BWG and improved (FCR). On the other hand, study performed by Flamand et al. (2014) found that OAs supplementation in the diet did not affect BW and BWG.
Furthermore, these results with consistent by finding of Saleem et al., (2020) who speculated that broilers fed dietary mix with (OAs) observed no significant difference ($P > 0.05$) in FC among the treatments. Also, inclusion of CAs and AAs in broiler diets had no effect on feed intake (Wickramasinghe et al. 2014, and Araujo et al. 2018).

Abou-Ashour et al., (2021) demonstrated that (FCR) was significantly improved by the supplementation of citric and acetic acid. Moreover, Sultan et al., (2015); Al- Harthi and Attia (2016) who proposed that the inclusion of AOs in broiler diets could enhance FCR. The notable enhancement in FCR could be attributed to (OAs) to improving protein digestibility through the stimulation of digestive enzyme activity (Langhout, 2000), as well as in promoting nutrient utilization efficiency (Chowdhury et al., 2009).Contrary to these results, Araujo et al. (2018) and Elmi et al. (2020) found that the incorporating with OAs in broiler diets had no significant effect on FCR.

Abou-Ashour et al., (2021) found that incorporating of CAs and AAs improved relative economic efficiency and PI than the control group. The positive effect of OAs on PI may be attributed to their ability to lower pH, enhance proteolytic enzyme activity, and improve nutrient digestibility, in addition to exerting bacteriostatic and bactericidal effects against pathogenic bacteria (Papatsiros et al., 2013). Abdel-Fattah et al. (2008) similarly found that adding CAs and AAs at 1.5% and 3% levels enhanced both economic and relative economic efficiency. Likewise, Ghazalah et al. (2011) observed that the inclusion of 0.25% AAs and 3% CAs significantly enhanced the European economic efficiency compared to the control group.

The apparent digestibility of the nutrients

Results illustrating the impact of various (OAs) on the apparent digestibility of nutrients in broiler chickens are presented in Table 3. Notably, no statistically significant differences were found in the digestibility of protein, fiber, fat, organic matter, carbohydrates, and dry matter among all groups.

Ndelekwute et al., (2019) and Ndelekwute et al., (2018) found that organic acids (OAs) did not affect digestibility of nitrogen free extract in chickens. The incorporating of lactic acid to broiler diets had no show any effect on digestive enzymes in the pancreas and small intestine Jang et al., (2004). Similarly, Palamidi et al. (2017) observed no notable differences in small intestinal amylase and lipase activities as a result of mixed organic acid supplementation.

Carcass characteristics:

The impact of different organic acids (OAs) on the carcass characteristics of broiler chickens is summarized in Table 4. Incorporating 0.5% AAs, CAs and PAs supplements into broilers diet reduced the abdominal fat %in comparison with the control group. However, there are no statistically significant differences among the experimental treatments for the percentages dressing, Total edible parts, liver, gizzard, heart, spleen and Bursa. The findings related to carcass characteristics in the present study are consistent with those of Abou-Ashour et al., (2021) showed that the incorporating (OAs) in diets resulted in lower abdominal fat percentage. Similarly, Lakshmi and Sunder (2013) reported that dietary supplementation with citric acid reduced abdominal fat percentage in broilers. The observed decrease in abdominal fat could be linked to the acidification of the diet, which may influence lipid metabolism in broiler chickens (Leeson et al., 2005). Similarly, Saleem et al. (2020) and Mohamed et al. (2014) found that the inclusion of OAs in broiler diets did not significantly affect the weights of the heart, liver, and gizzard. Moreover, Saleem et al. (2016) and Ali et al. (2019) reported that the incorporation of organic acids (OAs) into broiler diets did not result in statistically significant differences in dressing percentage. Similarly, Ma et al. (2021) found that OAs supplementation had no observable effect on the spleen, pancreas, or liver weights compared to the control group in broilers.

Biochemical component of plasma:

The blood plasma biochemical parameters of broiler chickens fed diet with various (OAs) are revealed in Table 5. Broiler chickens fed basal diet supplemented with 0.5% Citric acid recorded significantly the highest value of Albumin on serum compared to those fed basal diets with Acetic acid, Propionic acid and control diets. However, no significant effects of different supplements were observed on the total Protein, Globulin, A/G ratio and Glucose. Additionally, there are no significant effects of different supplement on Triglyceride, Cholesterol, HDL, LDL, AST, ALT and ALT/AST ratio during period 1-35d.

All blood serum biochemical parameters are within the physiological ranges. This finding with consistent with previous studies obtained by (Nourmohammadi et al., 2010; Abd EL-Haliem et al., 2018) they found that supplement citric acid in broiler diet revealed that there were no statistically significant differences among all treatments in plasma ALT, AST, total protein and glucose. Additionally, Fathi et al. (2016) showed there were no significant changes in total protein level due to organic acids (OAs) supplementation. Saleem et al., (2020) observed that (OAs) incorporating in broiler diet not affected on globulin and total protein . Also, Abd EL-Haliem et al., (2018) and Nourmohammadi et al. (2010) mention that dietary inclusion of (OAs) had no significant effect on AST, ALT, triglycerides and total protein plasma concentrations.

Bacterial count

The impact of different (OAs) on the bacterial count of broiler chickens is summarized in Table 5. The data revealed that incorporating 0.5% Acetic acid supplements into broiler diet resulted in an increase of total bacterial count (TBC) between the among groups. However, broiler chickens fed basal diet incorporated with different levels of (OAs) had no effect on number of Lactobacillus Acidophilus compared to the control group.

The higher number of total bacterial count due to incorporating organic acids (OAs) could be decreased pathogenic bacteria in gut and carriage of a adequate environment for the growth-beneficial bacteria consequently better feed efficiency (Khan and Iqbal, 2016; Baghban- Kanani et al. 2019). Similarly, incorporating citric acid can improve the development of the gut and inhibits the growth of pathogenic bacteria such as Salmonella and Escherichia coli (Chowdhury et al. 2009). Furthermore, the positive effect of organic acids (OAs) can lower pH in gut consequently inhibiting pathogenic bacteria due to pathogenic bacteria cannot resist the acidic conditions (Khan and Naz 2013; Khan and Iqbal, 2016).

CONCLUSION

Supplementation with 0.5% organic acids (OAs), particularly citric and acetic acids, enhanced broiler performance and reduced fat deposition without negatively affecting nutrient digestibility or health-related blood parameters, supporting their use as natural growth promoters in broiler production.

Table (1): Composition and calculated analysis of basal diet

Ingredients	**Starter 0-15**	**Grower15-35**
Yellow corn	54	59
Soybean meal 44%	33	28.50
Gluten 60%	6.0	5.0
Oil	3.5	4.0
Limestone	1.0	1.0
Di-calcium phosphate	1.90	1.90
Salt (NaCl)	0.20	0.20
Premix[1]	0.30	0.30
Lysine	0.10	0.10
Dl-Methionine	0.10	0.10
Total	100	100
Calculated analysis		
ME (kcal/kg)	3079	3154
Crude protein	23.05	20.89
Ether extract	5.97	6.6
Crude fiber	3.68	3.44
Calcium	0.96	0.95
Phosphorus	0.44	0.43
Methionine	0.54	0.50
Lysine	1.16	1.03
Sodium	0.10	0.10

[1]Each kg of vitamin mineral premix: contains: vitamin A, 1200000; vitamin D3, 300000IU; vitamin E, 700 mg; vitamin K3, 500 mg; vitamin B1, 500 mg; vitamin B2, 200 mg; vitamin B6, 600 mg; vitamin B12, 3 mg; folic acid, 300mg; choline chloride, 1000 mg; Niacin, 3000 mg; Biotin, 6 mg; panathonic acid, 670 mg; manganese sulphate, 3000 mg; iron sulphate, 10000 mg; zinc sulphate, 1800 mg; copper sulphate, 3000 mg; iodine, 1.868 mg; cobalt sulphate, 300 mg; selenium, 108 mg.

Table (2): Effect of dietary organic acids (OAs) on production performance of broiler chickens during the growth period (days 1 to 35 of age).

Treatment	Control	Acetic acid 0.5 %	Citric acid 0.5 %	Propionic acid 0.5 %	SEM	Sig
BW (1d)	40.03	39.90	40.23	40.17	0.25	0.787
BW (35d)	2164^b	2411^a	2373^a	2401^a	32.09	0.008
BWG (1-35d)	2124^b	2371^a	2333^a	2361^a	32.09	0.008
FC (1-35d)	3783	3660	3580	3537	71.63	0.155
FCR (1-35d)	1.78^a	1.55^b	1.53^b	1.50^b	0.03	0.004
Economic efficiency	12.79^b	22.02^a	23.48^a	19.94^a	2.03	0.025
Production index	173^b	223^a	222^a	229^a	7.49	0.002

Table (3): Effect of dietary organic acids (OAs) on apparent nutrient digestibility of nutrients (%) of broiler chickens during the growth period (days 1 to 35 of age).

Treatment	Control	Acetic acid 0.5 %	Citric acid 0.5 %	Propionic acid 0.5 %	SEM	Sig
DM	68.77	67.83	67.67	67.64	1.17	0.887
OM	71.39	69.49	69.39	69.84	0.60	0.674
CP	62.19	60.74	57.07	58.64	1.26	0.083
EE	89.50	89.49	88.80	88.12	0.84	0.623
CF	32.91	36.33	33.61	32.43	4.14	0.909
NFE	75.33	72.61	74.27	74.53	1.35	0.569

Table (4): Effect of dietary organic acids (OAs) on the carcass characteristics of broiler chickens during the growth period (days 1 to 35 of age).

Treatment	Control	Acetic acid 0.5 %	Citric acid 0.5 %	Propionic acid 0.5 %	SEM	Sig
Dressing %	71.2	72.4	70.68	72.18	1.07	0.637
Total edible parts, %	76.68	76.58	74.96	76.74	1.11	0.625
liver%	2.963	2.547	2.555	2.583	0.14	0.145
gizzard%	1.436	1.385	1.164	1.354	0.08	0.130
heart%	0.720	0.568	0.596	0.634	0.05	0.247
spleen%	0.105	0.102	0.105	0.099	0.01	0.945
Bursa%	0.091	0.093	0.089	0.090	0.004	0.947
fat%	0.700^a	0.540^b	0.537^b	0.481^b	0.04	0.011

Table (5): Effect of dietary organic acids (OAs) on blood Plasma biochemical parameters of broiler chickens during the growth period (days 1 to 35 of age).

Treatment	Control	Acetic acid 0.5 %	Citric acid 0.5 %	Propionic acid 0.5 %	SEM	Sig
Total. Protein(g/dl)	3.00	3.22	3.30	3.20	0.11	0.303
Albumin(g/dl)	1.67[b]	1.69[b]	1.79[a]	1.71[b]	0.03	0.018
Globulin(g/dl)	1.33	1.53	1.51	1.49	0.11	0.560
A/G ratio	1.26	1.14	1.25	1.17	0.10	0.762
AST(U/L)	119.1	109.6	98.0	123.6	6.97	0.084
ALT(U/L)	61.63	69.14	74.90	72.98	4.96	0.279
ALT/AST ratio	0.54	0.65	0.77	0.59	0.07	0.140
Glucose(mg/dl)	185	186	188	185	2.13	0.785
Triglyceride(mg/dl)	83.53	79.53	83.53	79.06	1.53	0.090
Cholesterol(mg/dl)	166	163	165	161	1.33	0.075
HDL (mg/dl)	83.33	83.79	81.97	83.56	1.40	0.797
LDL (mg/dl)	66.10	63.13	65.87	61.63	2.42	0.511

AST=aspartate amino transferees; ALT=alanine amino transferees; HDL= High-density lipoprotein; LDL= Low-density lipoprotein; A= albumin; G =globulin.

Table (6): Effect of different organic acids (OAs) on the bacterial count of broiler chickens during the growth period (days 1 to 35 of age).

Treatment	Control	Acetic acid 0.5 %	Citric acid 0.5 %	Propionic acid 0.5 %	SEM	Sig
TBC (cfu $\times 10^6$)	78.33[ab]	103.33[a]	26.33[b]	38.33[b]	17.83	0.052
Lactobacillus Acidophilus (cfu $\times 10^6$)	31.67	45.00	16.67	17.67	7.21	0.102

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الملخص العربي

تأثير إضافة الأحماض العضوية على أداء النمو، وهضم العناصر الغذائية، وبعض قياسات الدم في دجاج اللحم

محمد سيد رفاعي، محمود إبراهيم الكيلاوي وابتسام عادل محمد حسن سرور

قسم انتاج الدواجن - كلية الزراعة – جامعة الوادي الجديد – مصر

أُجريت هذه الدراسة بهدف تقييم تأثير إضافة احماض عضوية مختلفة (الخليك، الستريك، البروبيونك) على الأداء الانتاجي، وهضم العناصر الغذائية، وصفات الذبيحة، وبعض قياسات الدم، وعدد البكتيريا، والكفاءة الاقتصادية. تم توزيع 120 كتكوت عمر يوم غير مجنس عشوائيًا على أربع مجموعات، كل مجموعة تحتوي على 3 مكررات بكل منها 10 كتاكيت. تم استخدام المجموعة الأولى كمجموعة مقارنة. تم تغذية الطيور في المجموعات 2 و3 و4 بعليقه تحتوي على 5% من حمض الخليك والستريك والبروبيونك علي التوالي.

أوضحت النتائج أن إدراج الأحماض العضوية في العليقة أدى إلى تحسين معنوي ($p < 0.05$) في وزن الجسم، وزيادة الوزن، ومعامل التحويل الغذائي، ومؤشر الإنتاج، والكفاءة الاقتصادية مقارنةً بمجموعة المقارنة، دون وجود فروق معنوية في كمية العلف المستهلك ومعاملات هضم العناصر الغذائية. كما أظهرت النتائج انخفاض في دهن البطن لدى الطيور المعاملة بالأحماض العضوية، دون تأثيرات على نسبة التصافي أو أوزان الأعضاء الداخلية. من الناحية الكيميائية الحيوية، أدت إضافة حمض الستريك إلى ارتفاع معنوي في تركيز الألبومين في بلازما الدم، بينما لم تُسجل فروق معنوية بين المجموعات في تركيز البروتين الكلي، أو الجلوبيولين، أو الجلوكوز، أو مكونات الدهون، أو أنزيمات الكبد. وأظهرت التحليلات الميكروبية أن حمض الخليك أدى إلى زيادة في العدد للبكتيري، دون أن يؤثر بشكل معنوي على عدد *Lactobacillus acidophilus*.

في الختام، اضافة الأحماض العضوية بنسبة 0.5%، وخاصةً حمضي الستريك والخليك تعزز أداء دجاج اللحم وانخفاض ترسب دهن البطن دون التأثير سلبًا على هضم العناصر الغذائية أو معايير الدم، مما يدعم استخدامها كمحفزات طبيعية للنمو في إنتاج دجاج اللحم.