Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURE SCIENCES JOURNAL

Volume 7, Issue 3, 2024, Pages 46–52

Available online at https://aasj.journals.ekb.eg

DOI: https://dx.doi.org/10.21608/aasj.2024.347699.1180

Impact of propionic acid on growth performance, carcass traits, and nutrient digestibility in broiler chicks

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Abstract

This study investigates the influence of propionic acid addition on growth outcomes, carcass traits, nutrients digestion, and intestinal pH in broiler chicks. A total of 120 one-day-old Ross broiler chicks were divided into three treatment groups: a control group fed a basal diet without additives, and two experimental groups fed diets supplemented with 0.5% or 0.75% propionic acid. The results indicated that propionic acid supplementation significantly improved live body weight, average daily gain, feed intake, and feed conversion ratio, with the lower supplementation level (0.5%) showing greater efficacy than the higher level (0.75%). Additionally, carcass percentage was significantly increased, and abdominal fat percentage was lower in the treatment groups than the control group, with no notable variations between the two supplementation levels. Nutrient digestibility assessments revealed that 0.75% propionic acid significantly improved crude protein digestibility compared to the control, while both supplementation levels enhanced crude fiber digestibility, with the higher level demonstrating superior results. These findings suggest that propionic acid is an effective dietary supplement for promoting growth and improving nutrient utilization in broiler production, underscoring its potential to enhance poultry health and meat quality.

Keywords: propionic acid, broiler chicks, growth performance, nutrient digestibility, meat quality.

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1. Introduction

The poultry industry continually seeks innovative nutritional strategies to enhance broiler performance, improve feed efficiency, and elevate carcass quality. Among various feed additives, organic acids play a crucial role in promoting gut health in animals by modulating intestinal microbial populations, enhancing nutrient digestibility, and increasing mineral absorption (Pearlin *et al*., 2020). Organic acids, particularly short-chain monocarboxylic acids such as citric, propionic, fumaric, and formic acids, along with their salts, have demonstrated a remarkable ability to inhibit microbial growth in food and maintain microbial balance in the gastrointestinal tract (Vinus and Tewatia, 2017). This is attributed to their ability to lower intestinal pH, creating an unfavorable environment for pathogenic bacteria while enhancing the morphology and physiology of the gastrointestinal tract (GIT) and boosting the immune system. (Dittoe *et al*., 2018). Broiler production is significantly influenced by diet composition and feed additives, which directly affect growth rates, feed conversion efficiency, and meat quality. The incorporation of organic acids into broiler diets has shown promising results in improving growth performance and meat quality (Ma *et al*., 2021), enhancing nutrient digestibility (Abd El-Ghany, 2024; Attia 2018; Nguyen and Kim, 2020) and reducing reliance on antibiotic growth promoters (Du *et al*., 2024; Vinus and Tewatia, 2017). Propionic acid in particular, has been studied for its role in improving gut integrity, enhancing protein and energy retention, and promoting lean carcasses. For instance, Lakshmi *et al*. (2016) reported that adding propionic acid or butyric acid to broiler diets at levels of 0.1 and 0.2% significantly improved body weight, feed conversion ratio, and breast muscle production, while reducing abdominal fat compared to antibiotic and control diets. Similarly, Ebeid *et al*. (2021) demonstrated that incorporating 0.03% and 0.06% of a blended organic acid mixture containing acetic and propionic acids improved both humoral and cell-mediated immunity while reducing E. coli and Salmonella populations in the gut. This study explores how incorporating propionic acid into broiler diets influences growth outcomes, feed utilization, nutrient absorption, and carcass traits. By addressing these factors, the research aims to provide comprehensive insights into the efficacy of propionic acid as a dietary supplement and its potential contribution to sustainable poultry production.

2. Materials and methods

In this study, 120 newly hatched Ross broiler chicks were selected and monitored over a 42-day period. The birds were randomly allocated to three dietary groups, each group consisting of four replicates of 10 birds each. The treatment groups were as follows: T1) given a baseline diet with no additives (control), T2) provided with a baseline diet enriched with 0.5% propionic acid, and T3) provided with a baseline diet enriched with 0.75% propionic acid. Birds in each replicate were housed in floor pens with a 7 cm layer of sawdust litter. All birds were raised in a controlled environment, with necessary adjustments made to temperature, humidity, and ventilation. The lighting program, hygienic measures, and vaccination schedule were carried out according to the recommendations of the Ross broiler strain producer. Feed and water were supplied freely for the entire duration of the experiment. The composition and chemical analysis of the pelleted starter and grower diets used in the study are shown in Table (1).

Table (1): Composition and nutritional profile of starter and grower diets for broiler chicks.

Ingredients	%		Nutrients	%	
	Starter	Grower		Starter	Grower
Yellow corn	59.09	62.92	Dry matter	89.07	89.14
Soybean meal	28.40	23.36	Metabolizable energy k. calory/ kg feed	3000.00	3120.00
Vegetable Oil	0.78	2.01	Crude protein	23.00	21.00
Corn gluten meal 60% protein	8.00	8.00	Crude fiber	3.39	3.12
Lysine	0.40	0.33	Ether extract	3.45	4.79
Methionine	0.07	0.04	Lysine	1.40	1.20
Premi*	0.31	0.3	Methionine	0.47	0.42
Limestone, ground	1.47	1.44	Calcium	0.90	0.90
NaCl (common salt)	0.36	0.36	Phosphorus	0.60	0.60
Calcium phosphate, dibasic from	1.12	1.24	Sodium	0.16	0.16
Total	100	100	Chloride	0.26	0.26

*Each 3 kg of the premix contains 10,050,000 IU of Vitamin A, 2,280,000 IU of Vitamin D3, 20,100 IU of Vitamin E, 1,005 mg of Vitamin K3, 1,002 mg of Vitamin B1, 5,010 mg of Vitamin B2, 1,500 mg of Vitamin B6, 10.2 mg of Vitamin B12, 30,000 mg of Niacin, 10,002 mg of Pantothenic Acid, 50.1 mg of Biotin, and 1,002 mg of Folic Acid. It also includes 40,050 mg of Iron, 10,005 mg of copper, 50,100 mg of Zinc, 75,000 mg of Manganese, 1,500 mg of Iodine, 252 mg of Cobalt, and 300 mg of Selenium. Additionally, it contains 1,800 mg of Ethoxyquin as an antioxidant, with Calcium carbonate used as a carrier, making up the balance to 3 kg.

Growth performance traits, including final live body weight and total feed consumption, were measured, while the averages for daily weight gain, daily feed intake, and feed conversion ratio were calculated. At the end of the experimental period, 12 chicks (4 chicks per treatment) with body weights close to the average for their respective treatment were selected to assess carcass characteristics. The percentages of carcass yield and belly fat were calculated. The pH levels in the duodenum, jejunum, and ileum were measured using a digital pH meter. Additionally, 12 chicks (4 chicks per treatment) were selected for a digestion trial. These chicks were housed individually in metabolic cages for 4 days to record the feed intake and excreta output. The crude protein and crude fiber contents of the feed and feces were determined using the established procedures outlined by AOAC (1990). The formula for calculating the digestibility coefficient for crude protein or fiber is:

$$\text{Digestibility Coefficient (\%)} = \frac{\text{Nutrient content in feed} - \text{Nutrient content in feces}}{\text{Nutrient content in feed}} \times 100$$

2.1 Statistical analysis

The gathered data underwent statistical evaluation through a one-way ANOVA, utilizing the general linear model procedures in the SAS online platform (SAS OnDemand for Academics | SAS). Variations among treatment means were determined using Duncan's multiple range test (Duncan, 1955).

3. Results

The impact of propionic acid supplementation on the growth outcomes and carcass traits in broiler chickens are summarized in Table (2). Supplementing broiler diets with propionic acid significantly improved live body weight, average daily gain, feed intake, and feed conversion ratio. Notably, the lower supplementation level of propionic acid proved more effective in enhancing growth outcomes compared to the higher level. Furthermore, propionic acid supplementation significantly increased carcass yield and reduced abdominal fat percentage relative to the control group, with no notable differences detected between the two levels of supplementation.

Table (2): Effect of propionic acid supplementation on growth performance and carcass traits in broiler chicks.

Variables	T1	T2	T3	*p*-value
Initial body weight	42.189±0.015	42.521±0.015	41.939±0.011	0.9839
Final body weight	2280.76±4.07^{c}	2466.92±6.57^{a}	2405.21±3.27^{b}	<.0001
Average daily weight gain	53.30±0.10^{c}	57.72±0.17^{a}	56.27±0.08^{b}	<.0001
Average daily feed consumption	74.74±0.48^{b}	77.46±0.33^{a}	76.68±0.10^{a}	0.0009
Feed conversion ratio	1.40±0.003^{a}	1.34±0.004^{c}	1.36±0.002^{b}	<.0001
Carcass %	70.3±0.22^{b}	73.7±0.59^{a}	73.8±0.40^{a}	0.0001
Abdominal fat %	1.9±0.02^{a}	1.3±0.02^{b}	1.28±0.01^{b}	<.0001

Superscripts a, b, and c within the same row indicate a statistically significant difference at $P < 0.05$. T1) Birds receiving the control diet, T2) Birds provided with the 0.5% propionic acid-enriched diet, T3) Birds provided with the 0.75% propionic acid-enriched diet.

The influence of propionic acid supplementation on nutrients digestion and intestinal pH are shown in Table (3). Supplementing the broiler diet with 0.75% propionic acid significantly improved crude protein digestibility compared to the control, with no differences observed among the other treatments. Additionally, supplementation with either 0.5% or 0.75% propionic acid enhanced crude fiber digestibility relative to the control group, with the higher supplementation level proving more effective.

Table (3): Effect of propionic acid supplementation on gut pH and nutrient digestibility in broiler chicks.

Variables	T1	T2	T3	*p*-value
Intestinal pH				
Duodenum	5.56±0.02^{a}	5.00±0.06^{b}	5.00±0.06^{b}	<.0001
Jejunum	6.10±0.08	5.88±0.10	5.77±0.24	0.3625
Ileum	6.78±0.08^{a}	6.12±0.09^{c}	6.48±0.12^{b}	0.0015
Nutrient digestibility				
Crude protein digestion	73.58±0.24^{b}	75.32±0.68^{ab}	76.7±0.70^{a}	0.0086
Crude fiber digestion	38.72±0.55^{c}	46.954±0.77^{a}	43.86±0.47^{b}	<.0001

Superscripts a, b, and c within the same row indicate a statistically significant difference at $P < 0.05$. T1) Birds receiving the control diet, T2) Birds provided with the 0.5% propionic acid-enriched diet, T3) Birds provided with the 0.75% propionic acid-enriched diet.

4. Discussion

The significant improvements in live body weight, average daily gain, feed intake, and feed conversion ratio indicate that propionic acid enhances the overall growth efficiency of broilers. Interestingly, the low level of propionic acid supplementation proved more effective than the high level in improving growth outcomes. The notable improvement in carcass yield and the marked reduction in belly fat percentage are particularly noteworthy. An increase in carcass yield is economically beneficial for poultry production, while a reduction in abdominal fat is desirable due to its positive impact on meat quality and consumer preference. The observed improvements in growth performance and carcass characteristics in broilers are largely attributed to the beneficial effects of organic acids. These substances support the proliferation of advantageous bacteria by lowering pH levels within the digestive tract. This acidic environment not only facilitates better nutrient digestion but also enhances the immune response in chickens (Chukwudi *et al.*, 2024). Moreover, organic acids support gut health by improving gut morphology and modulating gene expression associated with bacterial virulence (Broom, 2015). By reducing harmful bacterial metabolites and suppressing intestinal bacteria that compete with the host for nutrients, dietary acidification enhances nutrient absorption. This, in turn, improves overall birds' performance while strengthening both specific and non-specific immunity in poultry (Khan and Iqbal, 2016). Our results are consistent with those of Lakshmi and Sunder (2015), who reported that incorporation of propionic acid into broiler diets at levels of 0.2 or 0.3% resulted in significant improvements in broiler body weight, feed conversion ratio, breast muscle production, and reduction in abdominal fat percentage. Also, Tawfeeq and Al-Mashhdani (2020) observed that incorporating 3 g/kg of propionic acid into broiler diets enhanced live body weight, weight gain, and carcass weight, while also improving feed conversion ratio (FCR) and regulating duodenum pH.

5. Conclusion

The study concludes that propionic acid supplementation positively affects broiler growth performance and carcass traits. Specifically, a 0.5% inclusion level enhances live body weight, average daily gain, feed efficiency, carcass yield, and reduces abdominal fat. It also improves the digestibility of crude protein and fiber. These findings highlight the potential of propionic acid in optimizing broiler diets, warranting further research into its mechanisms and practical applications in poultry nutrition.

References

Abd El-Ghany, W. A. (2024), "Applications of organic acids in poultry production: An updated and comprehensive review", *Agriculture*, Vol. 14 No. 10, Article No. 1756.

AOAC (1990), *Official Methods of Analysis of the Association of Official Agricultural Chemists*, 7th ed., Association of Official Analytical Chemist, Washington DC, USA.

Attia, F. M. (2018), "Effect of organic acids supplementation on nutrients digestibility, gut microbiota and immune response of broiler chicks", *Egyptian Poultry Science Journal*, Vol. 38 No. 1, pp. 223–239.

Broom, L. J. (2015), "Organic acids for improving intestinal health of poultry", *World's Poultry Science Journal*, Vol.71 No. 4, pp. 630–642.

Chukwudi, P., Umeugokwe, P. I., Ikeh, N. E. and Amaefule, B. C. (2024), "The effects of organic acids on broiler chicken nutrition: A review", *Animal Research and One Health*, Vol. 4 No. 3, pp. 1–11

Dittoe, D. K., Ricke, S. C. and Kiess, A. S. (2018), "Organic acids and potential for modifying the avian gastrointestinal tract and reducing pathogens and disease", *Frontiers in Veterinary Science*, Vol. 5, Article No. 216.

Du, H., Sarwar, I., Ahmad, S., Suheryani, I., Anjum, S., Andlib, S., Kakar, M. U. and Arain, M. A., (2024), "Organic acids in poultry industry: a review of nutritional advancements and health benefits", *World's Poultry Science Journal*, Vol. 80 No. 1, pp. 133–153.

Duncan, D. B. (1955), "Multiple range and multiple F tests", *Biometrics*, Vol. 11 No.1, pp. 1–42.

Ebeid, T., Al-Homidan, I., Fathi, M., Al-Jamaan, R., Mostafa, M., Abou-Emera, O., El-Razik, M. A. and Alkhalaf, A. (2021), "Impact of probiotics and/or organic acids supplementation on growth performance, microbiota, antioxidative status, and immune response of broilers", *Italian Journal of Animal Science*, Vol. 20 No. 1, pp. 2263–2273.

Khan, S. H., and Iqbal, J. (2016), "Recent advances in the role of organic acids in poultry nutrition", *Journal of Applied Animal Research*, Vol. 44 No. 1, pp. 359–369.

Lakshmi, K. V., Reddy, A. R., Sunder, G. S. and Reddy, Y. N. (2016), "Dietary supplementation of propionic acid, butyric acid or antibiotic and their influence on the performance, carcass parameters and immune response in broiler", *Indian Journal of Poultry Science*, Vol. 51 No. 2, pp. 159–163.

Lakshmi, V. K. and Sunder, S. G. (2015), "Supplementation of propionic acid (PA), butyric acid (BA) or antibiotic (AB) in diets and their influence on broiler performance, carcass parameters and immune response", *International Journal of Science Research*, Vol. 4 No. 3, pp. 1002–1006.

Ma, J., Wang, J., Mahfuz, S., Long, S.,

Wu, D., Gao, J. and Piao, X. (2021), "Supplementation of mixed organic acids improves growth performance, meat quality, gut morphology and volatile fatty acids of broiler chicken", *Animals*, Vol. 11 No. 11, Article No. 3020.

Nguyen, D. H. and Kim, I. H. (2020), "Protected organic acids improved growth performance, nutrient digestibility, and decreased gas emission in broilers", *Animals*, Vol. 10 No. 3, Article No. 416.

Pearlin, B. V., Muthuvel, S., Govidasamy, P., Villavan, M., Alagawany, M., Ragab Farag, M., Dhama, K. and Gopi, M. (2020), "Role of acidifiers in livestock nutrition and health: A review", *Journal of Animal Physiology and Animal Nutrition*, Vol. 104 No. 2, pp. 558–569.

Tawfeeq, W. S. and Al_Mashhdani, H. E. (2020), "Effect of adding propionic acid, formic acid and antibiotics to broiler diet on the production performance, some histological traits and microbial characteristics", *Plant Archives*, Vol. 20 No. 1, pp. 468–472.

Vinus, N. S. and Tewatia, B. S. (2017), "Organic acids as alternatives to antibiotic growth promoters in poultry", *The Pharma Innovation Journal*, Vol. 6, pp. 164–169.