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Effect of supplementation of organic acids on gut health in broilers

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Abstract
An experiment was conducted using 120 day-old Cobb broiler chicks to study the effect of organic acids on gut health. The chicks were randomly divided into four treatment groups with three replicates of ten birds each for 42 days. Treatment groups included a control diet (T_1) as per BIS (2007) [6], 0.05% organic acids in control diet (T_2), and experimental diets T_3 and T_4 supplemented with 0.075% and 0.1% organic acids in control diets, respectively, the results showed that birds supplemented organic acid diets in all treatment groups showed significant improvement in gut morphology were evident through increased villus height and crypt depth in the duodenum, jejunum, and ileocaecocolic junction. Microbial analysis further revealed higher *Lactobacillus* counts and reduced *E. coli* populations in treated groups compared to control group. It was concluded that supplementing organic acids improved gut health in broilers.

Keywords: *Lactobacillus* counts and reduced *E. coli*, villus height, crypt depth, duodenum, jejunum, and ileocaecocolic junction

Introduction
Poultry farming is one of the fastest-growing sectors in Indian agriculture, contributing significantly to food security, rural livelihoods, and the national economy. According to the 20th Livestock Census (2019), India's poultry population rose by 17% to 851.81 million, while poultry meat and egg production reached 10.25 million tonnes and 142.77 billion, respectively, in 2023-24. Despite this growth, per capita availability of poultry products still falls short of ICMR recommendations, highlighting the need to further enhance productivity. The rapid expansion of poultry production has been achieved through advances in genetics, nutrition, and scientific management. However, intensive rearing systems expose birds to stress and disease, historically managed by including antibiotic growth promoters (AGPs) in feed. AGPs improved performance by reducing microbial competition and enhancing nutrient utilization. Yet, their long-term use raised concerns about antibiotic resistance and residues in poultry products, leading to regulatory bans such as the European Union's prohibition in 2006. This created a need for safe and effective alternatives.

Organic acids and their salts have emerged as promising substitutes for AGPs. By lowering gut pH, they suppress pathogens like *E. coli*, *Salmonella*, and *Campylobacter* while promoting beneficial microbes and improving enzymatic activity. Their antimicrobial action results from disrupting bacterial enzymes and transport systems, leading to better nutrient absorption and gut health. Additionally, organic acids improve feed hygiene and act as natural preservatives (Manvatkar *et al.*, 2022) [7].

A wide range of organic acids such as formic, acetic, propionic, butyric, lactic, citric, and fumaric acids are used in poultry diets, often in salt form for improved stability and safety. These acids, naturally present in fruits, vegetables, and dairy products, are effective in improving feed conversion, mineral absorption, and intestinal morphology. Considering that feed accounts for up to 75% of poultry production costs, organic acids play a vital role in enhancing productivity under antibiotic-free broiler production systems.

Materials and Methods

A total of 120-day-old commercial broiler chicks were sourced from Venkateshwara Hatcheries Pvt. Ltd. Bengaluru for the research project. Organic acids (Acidac gold) used in the study was procured from Bionnar Health Care Pvt. Ltd. Kannur, Andhra Pradesh. Chicks were randomly distributed into four treatment groups in a completely randomized design. Each group had three replicates, with 10 chicks in each replicate. Following the Bureau of Indian Standards (BIS) 2007 [6] guidelines, the control group (T_1) was fed a basal diet, the treatment group T_2 was fed with 0.05% organic acids, treatment group T_3 was supplemented with 0.075% organic acids and treatment group T_4 fed with 0.1% organic acids. The chicks were reared in a deep litter system until six weeks of age with free access to feed and water throughout the experiment. Standard management practices were followed to maintain optimal conditions and ensure the welfare of the birds. Standard management practices were followed to maintain optimal conditions and ensure the welfare of the birds. The study was approved by the KVAFSU Institutional Animal Ethics Committee in Bidar, Karnataka.

At the end of the experiment, two birds from each replicate within the T_1 to T_4 treatment groups were selected for slaughter, tissue samples from the duodenum, jejunum, and ileocaecocolic junction were collected from the sacrificed birds, rinsed with buffered saline, and then preserved in a 10% neutral buffered formalin solution. This preparation was for histomorphological analysis, enabled the assessment of villus height and crypt depth**.** Additionally microbial enumeration were assessed by quantifying *Lactobacillus* spp. and *E. coli* counts from the intestinal contents the data were statistically analysed.

Results

- **Gross morphology**

The results of supplementation of organic acids on intestinal villi height and crypt depth in broilers presented in Table 1. Across the six-week study, the statistical analysis revealed a significant differences ($p \leq 0.05$) were observed on intestinal villi height and crypt depth in broilers at 42nd day from different dietary treatment groups of the experiment of chicks among the different treatment groups. The treatment groups T_2, T_3 and T_4 were showed significantly higher intestinal villi heights and crypt depths in all the sections of intestine such as duodenal, jejunal and ileocaecocolic junction compared to T_1 with no significant difference among T_2, T_3 and T_4 treatment groups. These results indicate that treatments T_2, T_3 and T_4 were the most effective in enhancing the gut health of chicks.

Table 1: Effect of supplementation of organic acids on intestinal villi height (µm) and crypt depth (µm) (Mean ± SE) in broiler.

Experimental group	Week					
	Duodenal villi height	Duodenal crypt depth	Jejunal villi height	Jejunal crypt depth	Ileocaecocolic Junction villi height	Ileocaecocolic Junction crypt depth
T_1	1169.50±15.37^a	142.17±6.92^a	909.50±15.37^a	125.17±4.82^a	654.17±12.81^a	134.83±3.55^a
T_2	1225.00±15.26^b	196.83±6.83^b	958.33±5.76^b	174.83±11.57^b	703.00±2.66^b	171.17±10.89^b
T_3	1229.50±8.20^b	197.33±7.20^b	957.83±8.10^b	175.67±12.89^b	710.83±8.10^b	173.67±6.87^b
T_4	1221.33±8.37^b	191.33±11.39^b	961.33±8.37^b	181.33±11.39^b	714.33±8.37^b	172.83±3.41^b

$^{a, b}$ Means in the same column with no common superscript differ significantly ($p \leq 0.05$)

- **Gut microbial count**

The results of supplementation of organic acids on gut microbial load in broilers presented in Table 2. The intestinal *E. coli* counts (log_{10} CFU/g) in groups T_1, T_2, T_3 and T_4 were 7.82, 6.70, 6.71 and 6.69, respectively. The statistical analysis revealed significant ($p>0.05$) difference in the *E coli* counts of birds among treatment groups. The treatment groups T_2, T_3 and T_4 showed significantly ($p \leq 0.05$) lesser *E coli* counts than the group T_1. There was no significant difference ($p>0.05$) in *E coli* counts among treatment groups T_2, T_3 and T_4. The intestinal *Lactobacillus* counts (log10CFU/g) in groups T_1, T_2, T_3 and T_4 were 6.65, 6.99, 6.99 and 7.06, respectively. The statistical analysis revealed significant ($p \leq 0.05$) difference in the *Lactobacillus* counts of birds among treatment groups at the end of sixth week. The treatment groups T_2, T_3 and T_4 showed significantly ($p \leq 0.05$) better *Lactobacillus* counts than the group T_1. There was no significant difference ($p>0.05$) in *Lactobacillus* counts among treatment groups T_2, T_3 and T_4.

Table 2: Effect of supplementation of organic acids on gut microbial load (log_{10} CFU/g), (Mean ± SE) in broiler.

Experimental group	*E. coli* (Log_{10} CFU/g)	*Lactobacillus* (log_{10} CFU/g)
T_1	7.82±0.055^b	6.65±0.045^a
T_2	6.70±0.104^a	6.99±0.049^b
T_3	6.71±0.086^a	6.99±0.040^b
T_4	6.69±0.082^a	7.06±0.126^b

$^{a, b}$ Means in the same column with no common superscript differ significantly ($p \leq 0.05$)

Discussion

There was significant difference ($p \leq 0.05$) in intestinal villi height and crypt depth in the groups fed with organic acids compared to the control group at the end of the experiment.

The present study findings were in agreement with Yang *et al*. (2018) [9] who investigated in broilers on organic acids and noted significant increase ($p<0.05$) in villus height and deeper crypts in the jejunum and ileum in dietary blend of essential organic acids supplemented groups compared to control group. This can be due to changes resulted from altered gut micro flora, improving epithelial proliferation and overall intestinal absorptive capacity.

In contrast Dong *et al*. (2024) [5] who investigated the impact of acidifiers and essential oils added on broiler intestinal morphology and the results noted no significant ($p>0.05$) difference on villus height, crypt depth, or villus height to crypt depth ratios in the duodenum, jejunum, and ileum among all groups.

There was significant difference ($p \leq 0.05$) in gut microbial load of birds in the groups fed with organic acids compared to the control group at the end of the experiment.

The current study findings were in agreement with Dai *et al*. (2021) [4] who studied the effects of organic acids on gut microbiota of broilers and the results revealed significantly

modified the gut micro biota composition ($p<0.05$) in gut health and performance improvement in organic acids supplemented group compared to control group. This may be due to organic acids reduce gut pH which reduced pathogenic bacterial population through bacteriostatic and bactericidal property.

The present study was in disagreement with Agboola *et al.* (2015) [1] who investigated the effects of organic acid, probiotic, and combination on gut health in broiler chickens and noticed no effects on lactic acid bacteria, coliform bacteria or total bacterial counts in the gut in organic acid alone fed groups than organic acid and probiotic combined group.

Conclusion

Based on the above results it was concluded that the gut morphology of different groups fed with 0.05, 0.075 and 0.1% organic acids diet showed significant difference ($p\leq0.05$) in comparison to the control group at the end of the experiment (42nd day). The gut microbial count of *E. coli* and *Lactobacillus* spp. in different groups supplemented with 0.05, 0.075 and 0.1% organic acids diet showed significant difference ($p\leq0.05$) in comparison to control group at the end of the experiment (42nd day). There was no significant difference among 0.05, 0.075 and 0.1% organic acids on gut health. Hence it was concluded that addition of 0.05% organic acids is more beneficial in improving gut morphology, gut microbial count of *E. coli* and *Lactobacillus* spp. in broilers.

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Conflict of Interest

Not available

Financial Support

Not available

Reference

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