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EFFECTS OF FEEDING VARIOUS LEVELS OF POSTBIOTICS PRODUCED BY LACTIC ACID BACTERIA ON GROWTH PERFORMANCE, GASTROINTESTINAL MICROBIOTA COUNT, AND DIGESTIBILITY OF SOME NUTRIENTS IN BROILER CHICKENS

Taha H. Khayoon [1], **Rabia J. Abbas** [2], **Fawziah A. Abdullah** [3]

Department of Animal Production, College of Agriculture, University of Basrah, Basrah, Iraq 1,2

Department of Microbiology, College of Veterinary Medicine, University of Basrah, Basrah, Iraq 3

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Correspondence Email:
pgs.taha.hasheem@uobasrah.edu.iq

ABSTRACT

The purpose of this study was to evaluate the impact of adding postbiotics produced from two species of lactic acid bacteria, *Lactobacillus acidophilus* (Lap) and *Lactiplantibacillus plantarum* (Lpp), to broiler chicken diets on their productivity, gastrointestinal microbiota count, and nutrient digestibility. Using a completely randomized design, 315 one-day-old broiler chicks (Ross- 308) were randomly divided into seven groups and three replications, with fifteen unsexed chicks per replicate. The basal diet was administered without supplements (negative control) or supplemented with Tetracycline (TET) at 0.02% (positive control). The other five groups: T1, T2 (basal diet supplemented with Lap 0.25%, and Lap 0.50% respectively); T3, T4 (basal diet supplemented with Lpp 0.25%, and Lpp 0.50% respectively); T5, (basal diet supplemented with 0.25% Lap + 0.25% Lpp). Results indicated that feeding broiler chickens with postbiotics supplements (excluding T1) and a positive control (TET) resulted in significant improvements ($P \leq 0.05$) in body weight gain, feed intake, feed conversion ratio, production index, and economic efficiency compared to the negative control group. Also, postbiotics supplements showed the highest level ($P \leq 0.05$) Lactobacilli count of jejunum, and the lowest level of E. coli bacteria decreased significantly ($P \leq 0.05$) in all groups compared to the negative control. Additionally, postbiotics (excluding T1) and TET treatments improved ($P \leq 0.05$) digestibility of dry matter, protein, fat, protein efficiency ratio and passage rate compared to the negative control group. The results suggest that postbiotics supplements can enhance growth performance, nutrient digestibility, protein efficiency, passage rate, and intestinal microbiota count of broiler chickens..

INTRODUCTION

Poultry farming is exposed to a wide varied range of stressors, that affect production (Abdul-Majeed *et al.*, 2022), and still has numerous challenges even with the advancement of understanding on the nutritional needs of birds and the chemical composition of feed. The most crucial of which is finding natural growth stimulants that do not affect the health of the poultry or the consumer in the future (Okey, 2023).

Many additives are used in feed or water as growth stimulants (Alkado *et al*., 2022) or as antioxidants (Rahawi *et al*., 2022) and are considered an integral nutritional component of poultry farming due to their importance in enhancing growth and stop diseases (Altaleb and Batkowska, 2023). Feed additives with the ability to balance the gut microbiome are the most crucial (Stadnicka *et al*., 2023), by competing with pathogenic bacteria for villi locations, the gut microbiome prevents them from colonizing the intestinal epithelium. The gut microbiota also produces a wide range of health-promoting substances and byproducts, including vitamins, organic acids, short-chain fatty acids, and bacteriocins, which stop the growth of harmful organisms (Shah *et al*., 2021). Although these substances have gone by a variety of names, "postbiotics" have become the most popular and commonly accepted term describing all of the advantages of probiotics (Liang and Xing, 2023). Postbiotics are suggested as a novel alternative biotherapeutic strategy since they are a stable, safe preparation with a long shelf life that makes storage and shipping easier and offers health advantages comparable to probiotics (Mosca *et al.*, 2022). Probiotics and postbiotics were found to be equally helpful in improving disease resistance and modifying gut flora and metabolic pathways in a comparative study (Zhang *et al*., 2022). Because they don't need special preparation, manufacturing, or storage conditions, postbiotics are a great product for developing countries (Bourebaba *et al*., 2022).

Postbiotics can also benefit a bird's digestive system when added to its diet. Enhancing tissue structure is part of this (Danladi *et al*., 2022), strengthening the intestinal barrier, inhibiting the growth of harmful intestinal microbes (Scott *et al*., 2022), and enhancing the digestibility of feed components (Zhu, 2022). Thus, the aimed of this study was to investigate of postbiotics effects on the performance, gastrointestinal microbiota count and nutrient digestibility of broiler chickens.

MATERIALS AND METHODS

Ethical Approve

The study was approved by the research ethics committee of University Basrah, Iraq, with approval number 8-37-2024.

Bacteria source and preparation of postbiotics (Lap + Lpp)

The *Lactobacillus acidophilus* and *Lactiplantibacillus plantarum* were obtained from a Chinese Company (Herbasea Biotechnology). The postbiotics were prepared from these bacteria according to the following steps:

The culture was incubated at 30 °C for 48 h in MRS broth and harvested by centrifugation. Pasteurization of skim milk was performed to eliminate microbes. Then, the skim milk was inoculated with bacteria at a concentration of 10% and incubated at 30°C for 48 hours. Bacterial cells in the milk were harvested by centrifugation at 10,000 x g for 5 min at 20°C, and this process was repeated until sufficient amounts of harvested cells were obtained. Millipore filtration (0.22 µm) was performed on the collected supernatant. The bacterial cells were cooled by placing them on ice and then suspended in a filtrated supernatant. The sonication was carried out with some minor modifications according to Gutiérrez, (2022) at a frequency of 125 kHz, with 20 rounds, each lasting 1 minute, and at 70% amplitude, and placed the product on a water bath for 1.5 h at 80°C. The product underwent a process of being ground into a powder and then cultured to ensure that there were no live bacterial cells present. The postbiotics product was stored under cooling.

Experimental design

This experiment was conducted at the Poultry Field of the College of Agriculture, University of Basrah from February 18, 2023, to 24 March, 2023, spanning 35 days. Three hundred and fifteen (315) one-day-old broiler chicks (Ross 308) were used on a completely randomized design (CRD) in seven treatment groups each having 45 chicks and each group was further divided into three replicates containing 15 chicks each. The chicks in the negative control were given no supplement, positive control supplemented with Tetracycline (TET) at 0.02%. The other five groups: T1, T2 (basal diet supplemented with postbiotics (Lap) 0.25%, and (Lap) 0.50% produced from *Lactiplantibacillus acidophilus* bacteria respectively); T3, T4 (basal diet supplemented with postbiotics (Lpp) 0.25%, and (Lpp) 0.50% produced from *Lactobacillus plantarum* bacteria respectively); T5, (basal diet supplemented with postbiotics (0.25% Lap + 0.25% Lpp). The chicks were housed in cages and subjected to the same conditions and rearing system. They were all kept under consistent management throughout the duration of the experiment.

Table (1): Percentage and calculated composition for starter and grower basal diets.

Ingredient (%)	Starter diet 1-21 days	Grower diet 22-35 days
Ground corn	56.20	61.00
Ground wheat	04.00	04.00
Soybean meal (48%) CP	32.00	26.50
Vegetable oil	1.50	2.50
*Broiler protein concentrates (40%)	5.00	5.00
Limestone fine	0.80	0.50
Premix	0.25	0.25
Salt (NaCl)	0.25	0.25
Total	100	100
Calculated nutrients**		
Metabolizable energy (kcal/kg)	3023	3137
Crude protein	22.70	20.47
Crude fat	2.77	2.89
Crude fiber	2.36	2.22
Calcium	0.61	0.49
Available phosphorus	0.28	0.24
Lysine	1.21	1.15
Methionine + Cysteine	0.88	0.81

* Broiler protein concentrates (Brocorn-5 special W), and exported by (Wafi B.V. Alblasserdam – Holland), inclusion per kg of the diet: Crude protein 40%, 2017 kcal/kg M.E, 5% fat, 2.20% crude fiber, 7.10% moisture, 28.30% ash, 4.20% calcium, 2.65% total phosphorus, 3.85% lysine, 3.70% methionine, 4.12% methionine+cysteine, 0.42% tryptophan, 1.70% threonine, 2.50% sodium, 4.20% chloride, 200 mg/kg copper, 1.600 mg/kg manganese, 2.000 mg/kg zinc, 2.000 mg/kg iron, 20.00 mg/kg iodine, 5.00 mg/kg selenium.

**The calculation was based on the chemical composition of the feedstuff found in NRC, (1994).

A two-stage feeding program was utilized, including the providing of starter diet from days 1 to 21, and the grower diets providing from days 22 to 35 based on ground yellow corn, wheat and soybean meal as displayed in Table (1). The diets was formulated to meet the nutrient requirements of the broiler (commercial recommendation). The chicks had free access to feed and water throughout the experiment period.

Growth Performance Measurements

Bird's performance: Broilers were weighted weekly from the beginning of the experiment until the fifth week of age. Feed intake and body weight gain were recorded weekly. The feed conversion ratio (FCR) was calculated by dividing the feed intake by weight gain. Production index (PI) was calculated according to Al-Fayadh *et al*., (2011):

$$PI = \frac{\text{average body weight (g)} \times \text{liveability percentage}}{\text{Age in days} \times \text{FCR} \times 10}$$

Livability percentage = 100– mortality percentage.
Economic efficiency (EE) was calculated according to Ibrahim, (2000):
EE = Feed cost (dinar/ton) × Feed conversion ratio

Crop and jejunum microbiota count

To determine the *E. coli*, *Lactobacilli* and total bacteria counts, six birds from each treatment (two birds per replicate) were sacrificed at the end of the fifth week old, after manually eviscerating the birds. A 1 gm homogenate of crop and jejunum contents was taken, and the dilution was prepared by sterile buffered peptone, and nine-fold serial dilutions were performed, selective agar plates for each type were used according to the manufacturer's instructions. Incubate 1 mL of dilutions were plated in Petri dishes and incubated at 35C° for 48 hours. The colony-forming units were expressed by 9 logarithms of CFU (log9 CFU/g) per gram (Da Silva *et al*., 2018)

Nutrient digestibility

A digestion experiment was conducted on birds at the age of 36-38 days. Where three birds (3 males) were kept from each treatment in individual cages. For three days, all birds were given the same grower diet, mixed with 2g of chromic oxide/kg as an indigestible marker. To determine the quantity of the marker in both the feed and excreta, the marker was thoroughly mixed with the bird feed. Daily feed consumption and excreta collection were measured quantitatively, and the excreta were dried at 65°C in a drying oven for 72 hours (Njeri *et al*., 2023). After drying, the excreta were ground into fine particles using an electric mill. The apparent digestibility coefficient values for protein and dry matter were calculated using the following equation described by Khan *et al*., (2003):

$$\text{Digestion coefficient of a nutrient} = 100 - (100 \times \frac{\text{\% Indicator in feed} \times \text{\% Nutrient in feces}}{\text{\% Indicator in feces} \times \text{\% Nutrient in feed}})$$

The passage rate was calculated according to Mobini, (2011), and the protein efficiency ratio was calculated according to Trevino *et al*., (2000):

$$\text{Protein efficiency ratio} = \frac{\text{Body weight gain (g)}}{\text{Protein intake (g)}}$$

Statistical analysis

Data were analyzed as a Completely Randomized Design by using SPSS program software (2016), and were compared by Duncan's Multiple Range Test, with a significance level of ($P \leq 0.05$).

RESULTS AND DISCUSSION

Growth performance

The effects of adding lactic acid bacteria-postbiotics (Lpp and Lap) as feed additives on the body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) values of broiler chickens were displayed in Table (2). The results of the study suggest that there were no significant differences ($P \leq 0.05$) in BWG, FI, and FCR observed among dietary treatments during the first growth period (1-21 days). However, all groups that received postbiotics supplements, except for T1 (0.25% Lap), as well as the positive control group (which received antibiotic TET treatment), showed significant improvement ($p \leq 0.05$) in body weight gain compared to the negative group (basal diet only). Additionally, the T4 group (0.50% Lpp) had the highest BWG rate, with 1533.35 g and 2446.61 g for 22-35 days and overall (d 1 to 35), respectively. During the grower (d 22 to 35) and overall phases (d 1 to 35), postbiotics supplements significantly ($P \leq 0.05$) increased feed intake (except for T1), as well as the positive control group (TET treatment) as compared to the negative group (without additive), also the T4 group (0.50% Lpp) consumed the largest amounts of feed, with 2755.18 g and 4107.26 g for the periods of 22-35 days and the total grow-out period (d 1to35), respectively. The feed conversion ratio was the lowest ($P \leq 0.05$) value when the birds were fed postbiotics supplements (except for T1 (0.25% Lap)), and the positive control group for d 22 to 35, and the total grow-out period (d 1 to 35) as compared with a negative group (basal diet only). Likewise, the T4 group (0.50% Lpp) had a better FCR when compared with other groups, reached with 1.80 and 1.68 (g feed/g gain) for the periods of 22-35 days and overall phases (d 1-35), respectively. Also, the study found that broilers which were fed diets with postbiotics supplements (excluding T1) and received TET treatment (positive control) had a significantly ($p \leq 0.05$) better production index (PI) compared to the negative control group.

Treatment T4 had the highest PI values (393.86), while the negative control group had the lowest rate (315.46), which was similar to T1 (319.32). The study also revealed that there was a significant decrease ($P \leq 0.05$) in economic efficiency (EE) values in postbiotics treatments (excluding T1) and TET treatment when compared to the negative control group, which reflects the best EE value. Treatment T4 had the best economic efficiency (1623), while the negative control group had the lowest value (1797), which was similar to T1 (1794). The improvement in body weight gain and feed conversion ratio can be attributed to the postbiotics effects on the health of birds. Other studies have confirmed that the postbiotics effects on bird health improves the feed conversion ratio and body weight gain. Piqué *et al*., (2019) reported that pathogens prevented from entering the digestive system and the permeability and integrity of the intestinal barrier are responsible for the improvement in feed conversion ratio and body weight gain.

According to Ozma *et al*., (2022), postbiotics are crucial for preserving homeostasis because of their special structure and ability to act as mediators between the intestinal microbiota and the host's cellular functions and metabolic pathways. Other studies found that adding postbiotics to broiler diets increases the health and safety of the intestinal mucosa (Thorakkattu *et al*., 2022; Humam *et al*., 2021). In other research, postbiotics were added to the diet of broiler chicks, and improvements were observed in body weight gain and feed conversion ratio (Humam *et al*., 2019; Mohammed and Kareem, 2022).

Table (2): Effect of feeding different levels of postbiotics on growth performance in broiler chickens.

Items	Dietary treatments*						
	Negative control	Positive control	T1	T2	T3	T4	T5
Body weight gain (g)							
d 1 to 21	898.59 ± 4.05	908.35 ± 3.38	901.23 ± 7.07	910.76 ± 4.24	910.73 ± 3.19	913.26 ± 5.35	908.30 ± 4.96
d 22 to 35	1266.26 c ± 22.43	1426.82 b ± 19.55	1286.93 c ± 16.87	1417.78 b ± 25.35	1389.06 b ± 22.06	1533.35 a ± 17.25	1411.34 b ± 17.2
d 1 to 35	2164.86 c ± 18.52	2335.17 b ± 19.65	2188.17 c ± 23.83	2328.55 b ± 23.59	2299.79 b ± 18.87	2446.61 a ± 22.59	2319.64 b ± 22.01
Feed intake (g/chick)							
d 1 to 21	1337.06 ± 7.98	1339.18 ± 11.64	1329.22 ± 5.37	1334.59 ± 2.10	1348.76 ± 4.90	1352.08 ± 4.66	1330.73 ± 3.82
d 22 to 35	2526.05 c ± 21.42	2658.40 b ± 2.89	2562.66 c ± 23.3	2669.82 b ± 24.54	2634.86 b ± 18.98	2755.18 a ± 23.33	2660.85 b ± 25.72
d 1 to 35	3863.11 c ± 13.45	3997.58 b ± 14.23	3891.88 c ± 25.86	4004.40 b ± 24.53	3983.63 b ± 15.01	4107.26 a ± 24.68	3991.57 b ± 26.25
Feed conversion ratio (g feed/g gain)							
d 1 to 21	1.49 ± 0.004	1.47 ± 0.014	1.48 ± 0.011	1.47 ± 0.009	1.48 ± 0.004	1.48 ± 0.008	1.47 ± 0.007
d 22 to 35	1.99 a ± 0.02	1.86 b ± 0.024	1.99 a ± 0.010	1.88 b ± 0.018	1.90 b ± 0.017	1.80 c ± 0.006	1.89 b ± 0.005
d 1 to 35	1.79 a ± 0.009	1.71 b ± 0.009	1.78 a ± 0.010	1.72 b ± 0.007	1.73 b ± 0.009	1.68 c ± 0.006	1.72 b ± 0.006
Production Index	315.46 c ± 5.02	359.02 b ± 5.17	319.32 c ± 5.05	359.98 b ± 7.13	355.45 b ± 4.68	393.86 a ± 5.03	361.75 b ± 5.56
Economic efficiency	1797 a ± 18.25	1701 b ± 18.73	1794 a ± 16.70	1692 b ± 22.65	1692 b ± 10.39	1623 c ± 10.82	1677 b ± 16.70

*Negative control: (Basal diet), Positive control: (Basal diet + Tetracycline 0.02%), T1: (0.25% Lap), T2: (0.50% Lap), T3: (0.25% Lpp), T4: (0.50% Lpp), T5: (0.25% Lap + 0.25% Lpp), Lap: Postbiotics produced from *L. acidophilus* bacteria, Lpp: Postbiotics produced from *L. plantarum*.

a-c means within a row for each parameter with different superscripts are significantly different ($P \leq 0.05$).

Crop and jejunum microbiota count

Table (3) displays the effect of adding an antibiotic (tetracycline) or different levels of the postbiotics lactic acid bacteria-postbiotics (Lpp and Lap) or their mixture on microbiota count in the crop and jejunum of broiler chickens at 35-day-old. The table shows no significant differences in the total bacterial counts, *E.coli*, and *Lactobacilli* in the crop for all levels of supplementation and both negative and positive control treatments. While significant differences were observed in the microbiota count in the jejunum, as the results of statistical analysis showed a significant decrease ($P \leq 0.05$) in the total counts of bacteria and *E. coli* in all levels supplementation compared to the negative control treatment, which did not differ significantly from the (T1). The negative control treatment recorded the highest number of total bacteria and *E.coli*, while the supplementation treatments recorded lower levels of these bacteria and were statistically similar to the positive control treatment. Additionally, a significant increase in *Lactobacilli* counts was observed in all postbiotics treatments compared to the negative and positive control treatments, with the highest level of the postbiotics preparation for *L. plantarum* bacteria showing the highest increase in *Lactobacilli* counts in the jejunum. The decrease in the numbers of all types of bacteria in the positive control treatment is attributed to the effect of tetracycline, which works to inhibit the proliferation of both gram-negative and gram-positive bacteria by inhibiting protein synthesis in bacterial cells, thus preventing them from producing essential proteins (Chopra and Roberts, 2001). On the other hand, the impact of the postbiotics on the microbiota count in the jejunum part of the small intestines due to the presence of metabolites such as organic acids and bacteriocins in reducing the pH of the digestive system, thus preventing the proliferation of disease-causing agents (Abd El-Ghany *et al*., 2022).

Table (3): Effect of feeding different levels of postbiotics on the microbiota count of crop and jejunum in broiler chickens.

Parameters	Dietary treatments*						
	Negative control	Positive control	T1	T2	T3	T4	T5
In crop (Log9 CFU/g)							
E. coli	2.83 ± 0.30	2.50 ± 0.22	2.66 ± 0.33	2.33 ± 0.21	2.50 ± 0.22	2.16 ± 0.30	2.33 ± 0.21
Lactobacilli	2.33 ± 0.21	2.50 ± 0.22	2.50 ± 0.22	2.83 ± 0.30	2.50 ± 0.22	2.83 ± 0.30	2.66 ± 0.21
Total bacteria	4.66 ± 0.49	4.33 ± 0.21	4.83 ± 0.47	5.00 ± 0.25	5.50 ± 0.22	5.16 ± 0.40	5.50 ± 0.22
In jejunum (Log9 CFU/g)							
E. coli	4.83 a ± 0.30	2.66 c ± 0.33	4.16 ab ± 0.31	3.50 bc ± 0.56	3.16 bc ± 0.31	2.83 c ± 0.31	2.66 c ± 0.33
Lactobacilli	5.16 b ± 0.30	5.00 b ± 0.25	6.16 a ± 0.16	6.50 a ± 0.22	6.33 a ± 0.21	6.66 a ± 0.42	6.50 a ± 0.22
Total bacteria	7.83 a ± 0.31	6.16 b ± 0.16	7.66 a ± 0.33	6.83 b ± 0.30	6.66 b ± 0.21	6.33 b ± 0.33	6.50 b ± 0.22

*Negative control: (Basal diet), Positive control: (Basal diet + Tetracycline 0.02%), T1: (0.25% Lap), T2: (0.50% Lap), T3: (0.25% Lpp), T4: (0.50% Lpp), T5: (0.25% Lap + 0.25% Lpp), Lap: Postbiotics produced from *L. acidophilus* bacteria, Lpp: Postbiotics produced from *L. plantarum*.

$^{a-c}$ means within a row for each parameter with different superscripts are significantly different ($P \leq 0.05$).

Kareem *et al*., (2016) also observed that the addition of postbiotics led to a decrease in pH concentration, a decrease in *Enterobacteriaceae*, and an increase in the number of lactic acid bacteria in broiler feces. Furthermore, postbiotics stimulates the growth of important probiotic bacterial species such as *Lactobacillus* types (Dinu *et al*., 2022). Studies have indicated the importance of lactic acid bacteria in preventing intestinal inflammation by increasing the production of bacteriocins (Lou *et al*., 2023). Bacteriocins are antimicrobiota peptides with inhibitory and bactericidal activity against many disease-causing bacteria as well as bacteria resistant to multiple drugs (Aljohani *et al*., 2023). The results of the intestinal bacterial counts in this study are consistent with Kareem, (2020), who noted a significant increase in *Lactobacillus* counts and a significant decrease in *E. coli* counts for all treatment groups compared to the control group when postbiotics were added to the feed of Japanese quail. Similarly, Abd El-Ghany *et al*., (2022) reported a significant decrease in *E. coli* counts in broiler chickens fed postbiotics in water or feed compared to the control group, while Wang *et al*., (2023) observed a significant increase in *Lactobacillus* counts and a significant decrease in *E. coli* counts for all groups of broiler chickens fed on different diets.

Nutrients, digestibility, protein efficiency and passage rate

It can be observed from the results shown in Table (4) that a significant improvement (P≤0.05) in all levels of supplementation was found compared with the negative control groups (except for T1) in the protein, fat and dry matter digestibility coefficient. It also significantly increased the efficiency of protein ratio (PER) and decreased the feed passage (FPR).

Table (4): Effect of feeding different levels of postbiotics on apparent jejunum .digestibility of some nutrients, protein efficiency and passage rate in broiler chickens

Items	Dietary treatments*						
	Negative control	Positive control	T1	T2	T3	T4	T5
Dry matter %	72.49 c ± 0.33	74.36 b ± 0.29	72.74 c ± 0.23	74.43 b ± 0.33	73.93 b ± 0.28	75.37 a ± 0.31	74.49 b ± 0.21
Crude protein %	83.77 b ± 0.25	85.29 a ± 0.37	83.84 b ± 0.17	85.18 a ± 0.32	84.98 a ± 0.45	85.92 a ± 0.17	85.23 a ± 0.47
Crude Fat %	80.30 b ± 0.23	81.59 a ± 0.17	80.37 b ± 0.37	81.57 a ± 0.36	81.31 a ± 0.13	81.74 a ± 0.28	81.63 a ± 0.24
Protein efficiency ratio	2.71 c ± 0.014	2.79 b ± 0.011	2.73 c ± 0.014	2.80 b ± 0.015	2.79 b ± 0.019	2.87 a ± 0.020	2.81 b ± 0.018
Feed passage rate	1.870 a ± 0.0023	1.856 b ± 0.0021	1.868 a ± 0.0019	1.854 b ± 0.0012	1.856 b ± 0.0023	1.844 c ± 0.0018	1.848 c ± 0.0012

*Negative control: (Basal diet), Positive control: (Basal diet + Tetracycline 0.02%), T1: (0.25% Lap), T2: (0.50% Lap), T3: (0.25% Lpp), T4: (0.50% Lpp), T5: (0.25% Lap + 0.25% Lpp), Lap: Postbiotics produced from *L. acidophilus* bacteria, Lpp: Postbiotics produced from *L. plantarum*.

$^{a-c}$ means within a row for each parameter with different superscripts are significantly different (P≤0.05).

Among all the treatments, the T4 (0.50% Lpp) treatment showed the highest nutrients digestion coefficient and the best PER and FPR in comparison to the other treatments.The improvement in nutrient digestibility, FPR, and PER in postbiotics treatments may be attributed to the improvement in the rate of absorption of the digested nutrients inside the small intestine of birds as a result of the increase in the surface area for absorption due to the increase in the height of the villi in the ileum and duodenum of the small intestine, and increase of lactic acid bacteria and a decrease pH in the excreta (Kareem *et al*., 2016), which is reflected in reducing the number of pathological bacteria and improving gut health.

Also, the presence of short-chain fatty acids found in postbiotics, such as acetate, propionate, and butyrate, are important for intestinal health maintenance and digestive system physiological functions. They also contribute to specific metabolic pathways, which aid in nutrient digestion and absorption (Ducatelle *et al*., 2023). By enhancing the tissue structure and raising the height and depth of the villi, the addition of postbiotics to the feed improves the environment within the digestive system (Danladi *et al*., 2022). Furthermore, compared to the normal form, the zigzag shape of the villi slows down the rate at which feed passes through the digestive system, increasing the area in which the absorbent surface of the villi comes into contact with the nutrients in the digested feed (Thorakkattu *et al*., 2022). The rate of digestion and absorption increases with a slower passage rate, which is reflected in the feed's nutrient utilization efficiency. The feed is exposed to more digestive enzymes and its products are exposed to the intestinal mucosa (Nóbrega *et al*., 2022). While the positive control improvement resulted from the health status of the birds due to the effects of tetracycline, which has both bactericidal and bacteriostatic properties, and can enhance overall health and nutrient digestibility, thus improving growth in poultry (Basit *et al*., 2020).

CONCLUSIONS

It was concluded that the effects of Lap, Lpp, and TET on growth performance measurements in broiler chickens were similar. Lap and Lpp can replace antibiotics without affecting the growth, yield, or intestinal microbiota count of broiler chickens. However, Lpp at 0.50% was more effective than Lap and antibiotics in terms of efficacy.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, and all authors approve the manuscript for publication.

تأثير اضافة مستويات مختلفة من مستحضر البوستبيوتكس المنتج من بكتيريا حامض اللاكتيك على أداء النمو والعد الميكروبي وقابلية هضم بعض العناصر الغذائية في فروج اللحم

طه هاشم خيون [1]، ربيعة جدوع عباس [2]، فوزية علي عبدالله [3]
قسم الإنتاج الحيواني / كلية الزراعة / جامعة البصرة / البصرة / العراق [1،2]
قسم الاحياء المجهرية / كلية الزراعة / جامعة البصرة / البصرة / العراق [3]

الخلاصة

هدفت الدراسة الحالية لمعرفة تأثير إضافة مستحضر البوستبيوتكس المنتج من نوعين من بكتيريا حامض اللاكتيك، (Lap) *Lactobacillus acidophilus* و (Lpp) *Lactiplantibacillus plantarum*إلى علائق فروج اللحم في الاداء الإنتاجي واعداد الميكروبات وقابلية الهضم لبعض العناصر الغذائية. استخدم في التجربة 315 فرخاً من فروج اللحم (Ross-308) بعمر يوم واحد غير مجنسة وزعت عشوائياً على سبع معاملات تجريبية وبواقع ثلاث مكررات للمعاملة الواحدة و15 فرخا لكل مكرر وفق التصميم العشوائي الكامل (CRD). تم إعطاء عليقة اساسية بدون اضافات (سيطرة سالبة)؛ أو عليقة اساسية مضافا اليها المضاد الحيوي التتراسيكلين بنسبة 0.02% (سيطرة موجبة). المجموعات الخمس الأخرى: T1، T2 (عليقة اساسية مضافا اليها Lap 0.25%، و0.50% Lap على التوالي)؛ T3، T4 (عليقة اساسية مضافا اليها Lpp 0.25%، و Lpp 0.50% على التوالي)؛ T5، (عليقة اساسية مضافا اليها Lap 0.25% +Lpp 0.25%). اظهرت النتائج حصول تحسن معنوي (P≤0.05) في معدل الزيادة الوزنية، استهلاك العلف، معامل التحويل الغذائي، الدليل الإنتاجي والكفاءة الاقتصادية في جميع معاملات اضافة مستحضر البوستبيوتكس (باستثناء T1) مقارنة بمجموعة السيطرة السالبة، كما سجلت معاملات الاضافة ارتفاع معنوي (P≤0.05) في اعداد بكتريا *Lactobacilli* مقارنة بمعاملتي السيطرة السالبة والموجبة، وانخفاض معنويا في اعداد بكتريا القولون لجميع المعاملات مقارنة بمعاملة السيطرة السالبة، كما ظهر تحسن معنوي (P≤0.05) لمعاملات الإضافة (باستثناء T1) في معامل هضم المادة الجافة والبروتين والدهون ونسبة كفاءة البروتين ومعدل سرعة مرور الغذاء مقارنة بمعاملة السيطرة السالبة. تؤكد الدراسة أن اضافة البوستبيوتكس يمكن أن يعزز أداء النمو، ومعامل هضم العناصر الغذائية، وكفاءة البروتين، وسرعة مرور الغذاء واعداد الميكروبات المعوية لفروج اللحم.

الكلمات المفتاحية: الاداء الإنتاجي، التغذية، المضادات الحيوية، بكتريا حامض اللاكتيك، فروج اللحم.

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