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Effect of dietary supplementation of postbiotics derived from *Lactobacillus plantarum* on growth performance and carcass characteristics of broiler chicken

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Abstract

A study was conducted at Avian Research Station, Thiruvazhamkunnu to study the effects of dietary supplementation of postbiotics derived from probiotic culture of Lactobacillus plantarum on growth performance and carcass characteristics of broiler chicken from day-old to 42 days of age. A total number of 180, day-old chicks were randomly allotted into six dietary treatment groups, viz., T1, T2, T3, T4, T5 and T6 having three replicates of ten birds each, in a completely randomised design. The birds in control group (T1) were fed with a standard broiler ration (SBR) formulated as per BIS (2007). The treatment group T2 were fed with the SBR containing chlortetracycline. Diets for T3 to T6 were formulated by inclusion of 0.15 per cent postbiotic (T3), 0.3 per cent postbiotic (T4), 0.45 per cent postbiotic (T5) and 0.6 per cent postbiotic (T6), respectively. Supplementation of 0.45 per cent postbiotic exhibited significantly (p<0.01) higher body weight, bodyweight gain and cumulative bodyweight gain than control group at six weeks of age. The feed intake, feed conversion ratio and carcass characteristics showed no significant change among the treatment groups.

Keywords: *Postbiotics, Lactobacillus plantarum, body weight, carcass*

Production performance of commercial broiler chickens is negatively influenced by physical, physiological and environmental stressors that cause physiological and behavioural changes in chickens. Stress results in reduced growth performance, viability and immunity in broiler chicken, which leads to huge economic losses in the poultry industry (Akinyemi and Adewole, 2021).

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Antibiotic growth promoters (AGP) were added in poultry feed at subtherapeutic doses to improve performance of broiler chicken by reducing harmful intestinal bacteria. Antibiotics growth promoters alter gut microflora, affecting immunity and disease resistance. Antibiotic overuse has resulted in the development of antibiotic-resistant microorganisms and increasing drug residues in animal products, posing risks to both animals and consumers which resulted in the ban on use antibiotic growth promoters as feed additives (Danladi *et al.,* 2022a). This resulted in increased interest in discovering safer substitute to AGP that can maintain or improve poultry production.

Several feed additives, including prebiotics, probiotics, synbiotics and postbiotics, are being used as antibiotic substitutes. Probiotics are live, non-pathogenic bacteria that enhance the integrity of gastrointestinal tract and host health when consumed (Reshma *et al*., 2023). These beneficial bacteria improve the immune system by excluding pathogenic microorganisms from the intestine and balancing intestinal microbial population (Supriya *et al*., 2022). Commercial probiotics have experienced challenges about their efficiency and the chance of developing antibiotic resistance genes spreading between organisms. Postbiotics emerged as a feed additive that can replace antibiotic growth promoters (Kareem *et al.,* 2021). It provides the advantages of probiotics in absence of living cells. Postbiotics are water-soluble metabolites synthesised by bacteria and are released upon bacterial lysis.

Postbiotics are beneficial for animal growth and gut health. They have the potential to restrict the growth of pathogenic microorganisms, enhance nutrient utilization, and hasten animal growth (Danladi *et al.,* 2022b). Postbiotics, which contain organic acids and bacteriocins, can reduce the pH of gut and inhibit the growth of opportunistic pathogens. Postbiotics obtained from *L. plantarum* have broad antagonistic actions, exhibiting their ability to suppress bacterial infections. Furthermore, postbiotics have improved growth, meat quality, faecal lactic acid bacteria, villus height and heat stress tolerance in chickens and pigs.

This study focuses on the use of postbiotics as a potential alternative for AGP in poultry production. The main benefits of postbiotics are their ability to improve gut health, inhibit harmful bacteria and enhance chicken growth. This research aims to provide a better understanding of the specific effects of postbiotics on broiler chicken in the climatic conditions of Kerala.

The experiment was conducted at Avian Research Station, Thiruvazhamkunnu, Palakkad to study the effects of postbiotics on production performance of broiler chicken from day one to 42 days of age.

Materials and methods

Preparation of postbiotics

The culture of *Lactobacillus plantarum* IDK 120 (VTCDM 648 B) obtained from starter culture laboratory of Dairy Microbiology division of Verghese Kurien Institute of Dairy science and Food Technology, Mannuthy was used for the study. Active *L. plantarum* cells were washed once with sterile 0.85 per cent (*w/v*) NaCl (Merck, Darmstadt, Germany) solution and adjusted to 10^9 CFU/mL used as an inoculum. Working cultures of *L. plantarum* were prepared by inoculating 10 per cent (*v/w*) 10^9 CFU/mL active bacterial cells into MRS media and incubating at 37°C for 18 h, followed by centrifugation at 10,000× *g* and 4°C for 15 min. The cell-free supernatant (CFS) was then collected by filtration through a cellulose acetate membrane as described by Loh *et al.* (2010). The CFS was stored at –20°C until the feeding trial was completed. The CFS was used as the liquid postbiotics and this was sprayed on the feed during mixing.

Biological trial

One hundred and eighty day-old broiler chicks (Vencobb-430Y) procured from a commercial hatchery were used for this study. The birds were wing banded, weighed individually and randomly allotted to six dietary treatment groups, each group consisting of three replicates of ten birds each in a completely randomised design. Diets were formulated as per BIS (2007) and fed up to 42 days of age. The broiler chickens in the control group (T1) were fed with a standard broiler ration (SBR). The birds of treatment group T2 were fed with SBR containing chlortetracycline 0.33 per cent. Diets for T3, T4, T5 and T6 were formulated by inclusion of 0.15 per cent postbiotic (T3), 0.3 per cent postbiotic (T4), 0.45 per cent postbiotic(T5) and 0.6 per cent postbiotic(T6), respectively. Standard management conditions were followed throughout the experimental period and chicks were reared under deep litter system with *ad libitum* feed and water.

The body weight (g) of individual birds were recorded at weekly intervals from day-old to six weeks of age and body weight gain at weekly intervals was calculated. Feed consumed (g) by birds in each replicate was recorded at weekly intervals up to six weeks of age and from this data cumulative feed consumption for the entire period was calculated. Feed conversion ratio (kg of feed consumed per kg weight gain) was calculated replicate wise, based on the data on body weight gain and feed consumption. At the end of the experiment (42 days of age), six birds from each treatment (two birds per replicate) were randomly selected and slaughtered humanely to study the carcass characteristics. Data on pre slaughter weight, carcass weight, weight of various cut-up parts, giblet weight and weight of abdominal fat were recorded. The percentage yield of carcass was calculated with respect to pre-slaughter weight while the per cent yield of cut-up parts, giblet and abdominal fat was calculated based on carcass weight. Data collected on various parameters were analysed by ANOVA using SPSS version 24.0.

Results and discussion

Bodyweight

The data on the mean body weight of broilers at weekly intervals in different dietary treatment groups (T1 to T6) revealed that the body weight of broilers in all treatment groups during the first four weeks of age were comparable (Table 1). Dietary supplementation of 0.6 per cent postbiotic resulted in reduced body weight at five weeks of age than the antibiotic group and other postbiotic supplemented groups. At the end of sixth week, the body weight was significantly ($p<0.01$) higher in 0.45 per cent postbiotic group (T5) than the control and 0.6 per cent postbiotic supplemented group.

Significantly higher body weight ($p<0.05$) obtained in the present study due to supplementation of postbiotic are in accordance with the findings of Thanh *et al.* (2009), Loh *et al.* (2010), Rosyidah *et al.* (2011), Humam *et al.* (2019), Kareem (2020), and Ghany *et al.* (2022a), (2022b) and Chaney *et al.* (2023) who reported improved body weight in broilers supplemented with postbiotics produced from *L. plantarum*. Similar results were revealed by Kareem *et al.* (2016) and Kareem *et al.* (2017) by supplementing postbiotics derived from *L. plantarum* and its combination with inulin and by Kudupoje *et al.* (2022) by supplementing postbiotic blended on yeast cell walls in broilers.

Feed consumption

The mean feed intake of broiler chicken revealed that the mean weekly feed consumption did not differ significantly by any of the treatments except on the fifth week (Table 2). Feed intake was significantly higher ($p<0.05$) in 0.3 per cent postbiotic supplemented group in fifth week than control, 0.45 and 0.6 per cent postbiotic group and was comparable to the antibiotic and 0.15 per cent postbiotic supplemented group. Higher weekly feed intake recorded in 0.3 per cent postbiotic supplemented group at fifth week did not influence the mean cumulative feed intake of broilers up to six weeks of age.

The results obtained in the current study are in harmony with Loh *et al.* (2010), Choe *et al.* (2012), Kareem *et al.* (2016), Kareem *et al.* (2017), Humam *et al.* (2019), Kareem *et al.* (2021) and Chang *et al.* (2022) who observed non-significant difference in feed intake of broilers

Table 1. Mean (±SE) body weight of broilers at weekly intervals in different dietary treatments, g

Age in weeks	Treatments					
	T1 Control	T2 Diet with chlortetracycline	T3 Diet with 0.15% postbiotic	T4 Diet with 0.3% postbiotic	T5 Diet with 0.45% postbiotic	T6 Diet with 0.6% postbiotic
0	43.02 ±0.47	42.79 ±0.19	42.32 ±0.24	42.66 ±0.25	42.98 ±0.40	43.06 ±0.14
1	145.25 ±2.12	148.52 ±1.19	151.76 ±3.66	158.48 ±1.35	149.98 ±0.41	146.30 ±2.72
2	313.09 ±7.10	322.00 ±8.74	318.23 ±7.63	325.06 ±2.76	313.71 ±4.92	312.57 ±10.37
3	597.93 ±17.91	610.22 ±11.37	616.36 ±16.87	616.17 ±16.67	620.78 ±18.67	574.34 ±14.50
4	927.00 ±23.01	980.50 ±11.75	956.23 ±40.96	952.47 ±26.73	987.47 ±18.26	882.77 ±43.33
5	1383.28^{ab} ±26.85	1478.08^{a} ±19.80	1455.05^{a} ±39.09	1456.01^{a} ±45.32	1512.94^{a} ±22.65	1305.44^{b} ±70.71
6	1819.21^{bc} ±1 8.31	1922.87^{ab} ±40.43	1939.08^{ab} ±44.43	1941.91^{ab} ±13.61	1993.64^{a} ±27.40	1737.44^{c} ±87.01

Mean values bearing different superscripts within a row differ significantly ($p<0.05$)

Table 2. Mean (±SE) feed consumption of broilers at weekly intervals in different dietary treatments, g

Age in weeks	Treatments					
	T1 Control	T2 Diet with chlortetracycline	T3 Diet with 0.15% postbiotic	T4 Diet with 0.3% postbiotic	T5 Diet with 0.45% postbiotic	T6 Diet with 0.6% postbiotic
1	144.67 ±3.62	125.77 ±2.37	114.71 ±4.89	122.06 ±3.35	125.77 ±4.00	111.03 ±4.32
2	250.60 ±2.76	261.80 ±4.81	248.16 ±26.92	235.44 ±14.95	252.00 ±0.90	236.40 ±2.29
3	430.33 ±3.76	447.20 ±6.96	459.39 ±24.24	455.25 ±14.44	445.47 ±3.19	416.27 ±4.93
4	580.80 ±22.94	676.40 ±2.77	625.87 ±24.81	658.33 ±25.09	599.77 ±6.85	569.50 ±43.18
5	784.27^{b} ±27.48	822.77^{ab} ±19.66	819.23^{ab} ±36.36	891.74^{a} ±11.52	797.43^{b} ±21.63	778.50^{b} ±18.03
6	1022.23 ±12.42	1044.13 ±39.31	1074.07 ±17.39	1023.57 ±52.77	1011.43 ±6.36	1056.53 ±8.79
Cumulative (0-6)	3182.90 ±63.40	3378.07 ±44.68	3341.44 ±129.10	3386.40 ±110.24	3231.87 ±25.04	3168.23 ±72.35

Mean values bearing different superscripts within a row differ significantly ($p<0.05$)

Table 3. Mean (±SE) feed conversion ratio of broilers at weekly intervals in different dietary treatments

Age in weeks	Treatments					
	T1 Control	T2 Diet with chlortetracycline	T3 Diet with 0.15% postbiotic	T4 Diet with 0.3% postbiotic	T5 Diet with 0.45% postbiotic	T6 Diet with 0.6% postbiotic
1	1.12±0.09	1.19±0.07	1.05±0.05	1.13±0.04	1.18±0.03	1.08±0.07
2	1.49±0.05	1.51±0.06	1.49±0.13	1.35±0.06	1.54±0.05	1.43±0.08
3	1.51±0.05	1.56±0.07	1.54±0.02	1.57±0.07	1.46±0.06	1.59±0.03
4	1.76±0.05	1.83±0.03	1.86±0.14	1.97±0.14	1.64±0.02	1.86±0.05
5	1.72±0.04	1.65±0.05	1.64±0.08	1.78±0.07	1.52±0.08	1.86±0.10
6	2.35±0.09	2.36±0.18	2.22±0.06	2.11±0.08	2.10±0.01	2.45±0.07
Cumulative (0-6)	1.79±0.02	1.80±0.07	1.76±0.06	1.78±0.06	1.66±0.02	1.87±0.54

Table 4. Carcass characteristics (Mean ±SE) of broilers in different dietary treatments at six weeks of age, per cent

Parameters	Treatments					
	T1 Control	T2 Diet with chlortetracycline	T3 Diet with 0.15% postbiotic	T4 Diet with 0.3% postbiotic	T5 Diet with 0.45% postbiotic	T6 Diet with 0.6% postbiotic
Carcass yield	74.96±0.80	74.07±0.62	72.49±0.47	73.09±0.48	75.44±1.42	73.30±0.94
Breast	29.31±0.89	29.49±0.75	28.76±0.61	30.86±0.85	28.27±1.62	29.67±0.59
Wings	11.75±0.62	11.15±0.51	11.52±0.30	12.76±0.85	11.24±0.74	12.31±0.46
Thighs	14.83±0.84	13.94±0.72	14.67±0.66	13.89±0.76	14.80±0.60	15.00±0.54
Back	18.71±0.66	20.80±1.38	21.33±1.43	22.24±1.86	17.75±0.79	19.28±1.02
Neck	5.56±0.43	6.12±0.78	6.35±0.95	5.08±0.54	7.36±1.24	5.39±0.44
Heart	0.75±0.05	0.68±0.03	0.73±0.06	0.64±0.02	0.75±0.04	0.65±0.08
Liver	2.51±0.08	2.64±0.11	2.56±0.07	2.53±0.11	2.47±0.07	2.70±0.09
Gizzard	2.73±0.10	2.61±0.21	2.59±0.18	2.92±0.13	3.63±0.57	2.98±0.22
Abdominal fat	2.30±0.26	2.55±0.22	2.13±0.25	1.98±0.32	1.94±0.34	2.17±0.35

supplemented with postbiotics derived from *L. plantarum.* Similar results were observed in layer chickens and quails by Loh *et al.* (2014) and Kareem (2020). The present study indicates that dietary supplementation of postbiotics did not affect weekly feed consumption except during fifth week and cumulative feed consumption of broilers up to six weeks of age.

Feed conversion ratio (FCR)

Data on weekly and cumulative feed conversion ratio among the treatment groups supplemented with postbiotic in feed up to six weeks of age in broilers presented in Table 3 revealed that the mean weekly FCR and cumulative FCR did not differ significantly between the treatment groups throughout the experimental period.

Non-significant effect of postbiotic on FCR from day one to six weeks of age in the current study is in agreement with reports of Kareem *et al.* (2017) and Mohammed and Kareem (2022) who also observed no significant change in FCR by dietary supplementation of 0.3, 0.45 and 0.6 per cent postbiotics in broilers and by Loh *et al*. (2014) in layers. Similarly, Kareem (2020) and Kareem *et al.* (2021) also observed no significant effect of postbiotic on FCR in broiler chickens. In contrast to the current study, Thanh *et al*. (2009), Loh *et al*. (2010), Rosyidah *et al*. (2011) and Danladi *et al*. (2022a) stated improved FCR in broilers supplemented with various levels of postbiotics. The findings of this study revealed that the dietary inclusion of postbiotics did not affect the feed conversion ratio in broilers.

Carcass characteristics

The carcass characteristics did not show significant changes in any of the dietary treatments groups as presented in Table 4. The per cent yield of carcass, breast, wings, thigh, back, neck, heart, liver, gizzard and abdominal fat did not differ significantly among treatment groups.

In accordance with the current study, Humam *et al*. (2019) reported that the dietary supplementation of postbiotics had no effect on the yield of breast, leg, wing, back, gizzard, abdominal fat and heart of the broiler chickens. Similarly, Kareem *et al*. (2015) and Danladi *et al.* (2022a) observed no significant difference in carcass weight and carcass yield of broiler chicken by supplementation of 0.2 and 0.3 per cent postbiotic in feed, respectively.

Conclusion

Dietary supplementation of postbiotics at 0.45 per cent improved body weight of broiler at fifth and sixth weeks of age in chicken when compared to the non-supplemented group, without any significant difference in cumulative feed intake, FCR and carcass characteristics. Based on the observations in the current study, it could be summarised that the dietary inclusion of 0.45 per cent postbiotic derived from *L. plantarum* IDK 120 (VTCDM 648 B) could be recommended without having any negative effects on the production performance of the birds and can be used as an alternative to AGP in feed of commercial broilers.

Conflict of interest

The authors declared that they have no conflict of interest.

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