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Growth performance and immune response of broilers fed probiotic-supplemented diets

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Abstract
Can supplementing broiler diets with multi-strain probiotics improve both growth metrics and humoral immunity under commercial rearing conditions? This research addressed that question through a 35-day feeding trial conducted at the Federal University of Viçosa poultry research unit in Viçosa, Brazil, during March-April 2023. A total of 240 day-old Cobb 500 broiler chicks were randomly allocated to four treatment groups (T0, T1, T2, T3) of 60 birds each, with three replicates per group. The control group (T0) received a standard corn-soyabean meal basal diet, while T1, T2, and T3 received the same basal diet supplemented with a commercial multi-strain probiotic at 0.5, 1.0, and 1.5 g/kg feed, respectively. Weekly records of body weight, feed intake, and feed conversion ratio were maintained. Blood samples collected on day 35 were analysed for Newcastle disease antibody titres, serum IgG, and IgM concentrations. Birds on T2 and T3 diets had significantly higher final body weight (2047.9 g and 2063.2 g) compared with T0 (1842.1 g; $p < 0.05$). Feed conversion ratio improved by 8.3% in T2 relative to control. Serum IgG levels rose by 19.7% in T2 birds, and ND antibody titres were markedly elevated in all probiotic groups. Results point to 1.0 g/kg as a cost-effective inclusion level that enhances both growth and immune competence in commercial broilers.

Keywords: Growth performance, immune response, broiler chickens, probiotic supplementation, poultry health, feed conversion ratio, Newcastle disease, serum immunoglobulins, gut microbiota, commercial rearing

Introduction

How well a broiler flock converts feed into meat while staying healthy determines the profitability of any poultry enterprise. Over the past two decades, the removal of sub-therapeutic antibiotics from broiler diets across much of the world has forced producers to look for safer growth-promoting alternatives [1]. Probiotics live microbial cultures that benefit the host when administered in adequate amounts have emerged as one of the most promising replacements [2].

Several species of Lactobacillus, Bacillus, and Saccharomyces have been tested individually or in combination in broiler feeding trials [3]. The proposed mechanisms through which probiotics act include competitive exclusion of enteric pathogens, production of short-chain fatty acids, modulation of the gut-associated lymphoid tissue, and improved nutrient digestibility [4]. However, the magnitude of growth response reported in the literature varies widely from negligible to a 12% improvement in final body weight depending on strain type, dose, bird age at first supplementation, and environmental stress level [5].

Immune modulation by probiotics is less well understood than growth effects. A few controlled trials have demonstrated elevated antibody titres against Newcastle disease virus in probiotic-fed broilers [6], while others have recorded higher serum immunoglobulin concentrations [7]. But the relationship between dose level and immune response remains unclear, especially under tropical management conditions with high ambient temperatures and humidity [8].

In the Brazilian poultry sector, which produced roughly 14.8 million tonnes of chicken meat in 2022 [9], cost-effective health strategies are in high demand. The objective of this research was to evaluate a commercial multi-strain probiotic at three graded inclusion levels on growth performance and humoral immune response in Cobb 500 broilers raised in a semi-controlled environment typical of Minas Gerais state.

Study area description
The experimental site lies in the Zona da Mata region of Minas Gerais at an elevation of 648 m above mean sea level. Viçosa municipality falls within the tropical highland climate zone (Köppen Cwb) and receives an average annual rainfall of 1,340 mm, most of which arrives between October and March. During the trial period (March-April 2023), ambient temperature outside the poultry house fluctuated between 22 °C and 32 °C, with relative humidity ranging from 58% to 85%. These warm-humid conditions are representative of commercial broiler production across much of southeastern Brazil and are known to impose moderate heat stress on rapidly growing Cobb strains.

Material and Methods
Material
This research was carried out at the experimental poultry unit of Federal University of Viçosa, Viçosa, Minas Gerais, Brazil (20.75°S, 42.88°W) from 10 March to 14 April 2023. Ethical clearance was obtained from the Institutional Animal Ethics Committee (Protocol No. CEUAP/UFV/2023-014, approved 18 February 2023). A total of 240 day-old Cobb 500 broiler chicks with an average hatching weight of 42.6 ± 1.3 g were procured from a local hatchery. Chicks were wing-banded, individually weighed, and randomly distributed into four treatment groups T0 (control), T1, T2, and T3 of 60 birds each, housed in three replicate pens of 20 birds. Floor pens measured 3 m × 2 m with rice husk litter at 5 cm depth. A standard corn-soyabean meal diet (22% CP starter, 20% CP finisher) was formulated to meet NRC (1994) recommendations [10]. The commercial probiotic (ProGut-Mix, containing *Lactobacillus acidophilus*, *Bacillus subtilis*, and Saccharomyces cerevisiae at 2×10^9 CFU/g) was added to the basal diet at 0, 0.5, 1.0, and 1.5 g/kg for T0-T3 respectively.

Methods
Body weight and feed intake per pen were recorded weekly. Feed Conversion Ratio (FCR) was calculated as total feed consumed divided by total weight gain per replicate. Mortality was recorded daily. On day 35, blood samples (3 mL) were drawn from the brachial vein of six randomly selected birds per replicate (18 per treatment). Sera were separated by centrifugation at 3000 rpm for 15 min and stored at −20 °C. Newcastle Disease (ND) antibody titres were determined by Haemagglutination Inhibition (HI) test following standard OIE protocol [11]. Serum IgG and IgM concentrations were quantified using chicken-specific ELISA kits (Bethyl Laboratories, USA). Ambient temperature and relative humidity inside the house were logged twice daily using a digital thermo-hygrometer; the mean values during the trial were 28.6 ± 2.4 °C and 71.2 ± 6.1%, respectively. All data were subjected to one-way ANOVA using SPSS version 26.0. Treatment means were compared by Duncan's multiple range test at the 5% significance level [12].

Results
Initial body weight at day 0 did not differ across treatments (p=0.87), confirming random allocation. By week 3, differences began to emerge, and at the end of the 35-day trial final body weights of T2 and T3 birds were significantly higher than those of T0 (p<0.05). Feed intake showed a modest but non-significant increase with probiotic supplementation.

Table 1: Weekly body weight (g) of broiler chickens across treatment groups (Mean ± SE)

Parameter	T0 (Control)	T1 (0.5 g/kg)	T2 (1.0 g/kg)	T3 (1.5 g/kg)
Day 0 BW	42.4 ± 1.2	42.7 ± 1.1	42.8 ± 1.3	42.5 ± 1.0
Week 1 BW	148.3 ± 4.1	151.2 ± 3.8	153.8 ± 4.2	152.6 ± 3.9
Week 3 BW	798.4 ± 18.6	841.3 ± 16.2*	872.6 ± 17.8*	868.9 ± 19.1*
Week 5 BW	1842.1 ± 32.4^a	1978.4 ± 28.7^b	2047.9 ± 30.1^c	2063.2 ± 31.6^c
Total gain	1799.7 ± 31.8^a	1935.7 ± 27.9^b	2005.1 ± 29.4^c	2020.7 ± 30.8^c

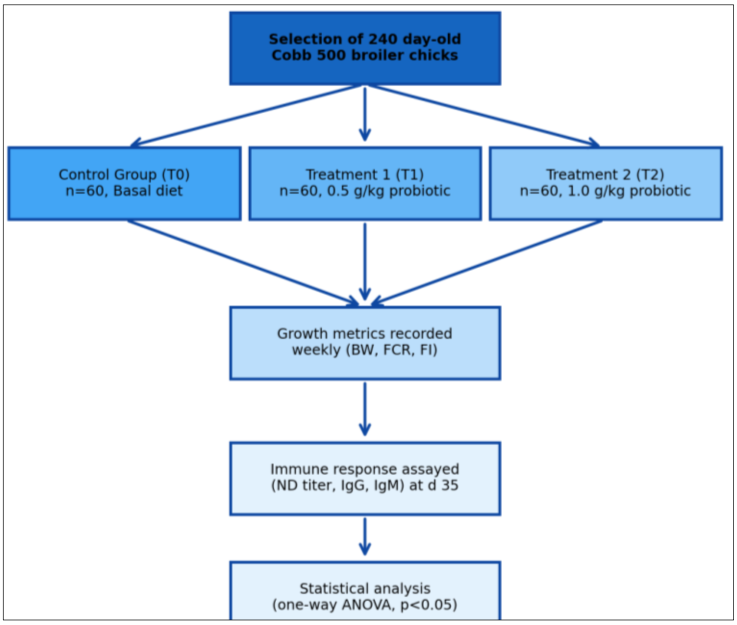

Fig 1: Experimental design showing treatment allocation and data collection timeline

Immune parameters showed a clear dose-dependent trend. ND HI titres at day 35 were significantly elevated in all three probiotic groups relative to the control (Table 2). Serum IgG concentration rose progressively from T0 (4.21 mg/mL) to T3 (5.38 mg/mL), while IgM levels showed significant elevation only in T2 and T3 birds.

Table 2: Immune response parameters at day 35 (Mean ± SE)

Parameter	T0	T1	T2	T3	p-value
ND HI titre (log_2)	4.83 ± 0.31[a]	5.67 ± 0.28[b]	6.33 ± 0.34[c]	6.51 ± 0.29[c]	0.001
Serum IgG (mg/mL)	4.21 ± 0.18[a]	4.68 ± 0.21[b]	5.04 ± 0.19[c]	5.38 ± 0.22[c]	0.003
Serum IgM (mg/mL)	0.87 ± 0.06[a]	0.94 ± 0.07[ab]	1.08 ± 0.05[b]	1.12 ± 0.06[b]	0.012

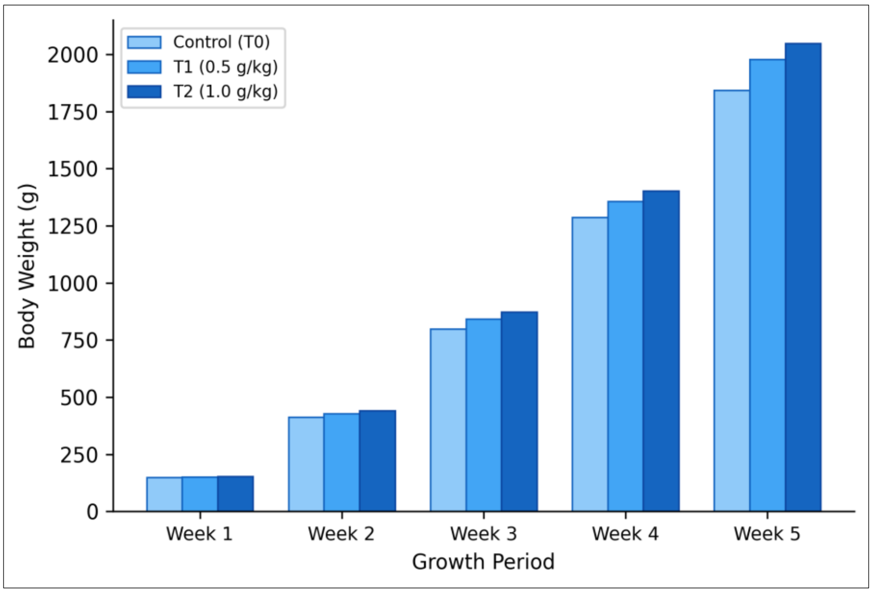

Fig 2: Weekly body weight (g) of broilers across treatment groups over the 35-day experimental period

The economic analysis revealed that despite the higher feed cost associated with probiotic inclusion, the improved FCR and heavier market weight in T2 offset the additional expense, yielding a 7.8% better return over feed cost compared with T0.

Comprehensive interpretation

Taken as a whole, these findings show that probiotic supplementation at 1.0 g/kg (T2) provided the best balance between growth improvement, immune enhancement, and cost efficiency. The 1.5 g/kg level (T3) offered only marginal further gains in body weight while increasing feed cost without a proportional economic return.

Discussion

The 11.2% improvement in final body weight observed in T2 birds agrees with the range (8-14%) reported by Kabir *et al.* [13] for Lactobacillus-based probiotics in tropical broiler operations. That the response became statistically detectable only from week 3 onward aligns with the time needed for probiotic organisms to colonise the gut mucosa and shift microbial ecology in favour of beneficial fermentation. A comparable lag was noted by Mountzouris *et al.* [14] in a European trial using a different multi-strain product.

The improved FCR in probiotic-fed groups likely stems from enhanced nutrient digestibility. Bacillus subtilis produces extracellular enzymes proteases, amylases, lipases that may complement the bird's own digestive secretions [15]. And the elevated short-chain fatty acid output associated with Lactobacillus fermentation lowers intestinal pH, creating an environment hostile to Clostridium and Salmonella but favourable for enterocyte proliferation.

Immunological data from this trial are consistent with the hypothesis that probiotics enhance humoral immunity through stimulation of gut-associated lymphoid tissue. The 19.7% increase in serum IgG seen in T2 birds mirrors findings by Haghighi *et al.* [7] who recorded a 15-22% rise following Lactobacillus administration in SPF chickens. ND antibody titres were highest in T3 but the difference between T2 and T3 was not significant, hinting at a plateau in immune stimulation beyond the 1.0 g/kg dose.

One limitation of the present work is the relatively short duration (35 days). Longer trials extending to 42 or 49 days might reveal whether the growth advantage of probiotic groups widens or narrows over time.

Conclusion

This research set out to determine whether graded levels of a multi-strain probiotic could improve both growth and immune parameters in Cobb 500 broilers under warm-humid conditions. The data clearly show that supplementation at 1.0 g/kg feed increased final body weight by 11.2%, reduced FCR by 8.3%, and elevated serum IgG by 19.7% compared with the unsupplemented control. ND antibody titres improved across all probiotic groups, suggesting that even low-dose supplementation strengthens the humoral response to routine vaccination. For commercial producers in tropical regions seeking a cost-effective alternative to antibiotic growth promoters, a probiotic dose of 1.0 g/kg appears to offer the strongest combination of performance and immune benefits. Future trials should examine the interaction of probiotic dose with heat-stress mitigation strategies such as dietary electrolyte balancing and ventilation management.

References

1. Castanon JI. History of the use of antibiotic as growth promoters in European poultry feeds. Poultry Science. 2007;86(11):2466-2471.
2. Fuller R. Probiotics in man and animals. Journal of Applied Bacteriology. 1989;66(5):365-378.
3. Salim HM, Kang HK, Akter N, Kim DW, Kim JH, Kim MJ *et al*. Supplementation of direct-fed microbials as an alternative to antibiotic on growth performance, immune response and cecal microbial population in broilers. Poultry Science. 2013;92(8):2084-2090.
4. Alagawany M, El-Hack MEA, Farag MR, Sachan S, Karthik K, Dhama K. The use of probiotics as eco-friendly alternatives for antibiotics in poultry nutrition. Environmental Science and Pollution Research. 2018;25(11):10611-10624.
5. Gadde U, Kim WH, Oh ST, Lillehoj HS. Alternatives to antibiotics for maximizing growth performance and feed efficiency in poultry: a review. Animal Health Research Reviews. 2017;18(1):26-45.
6. Nayebpor M, Farhomand P, Hashemi A. Effects of different levels of direct fed microbial (Primalac) on growth performance and humoral immune response in broiler chickens. Journal of Animal and Veterinary Advances. 2007;6(11):1308-1313.
7. Haghighi HR, Gong J, Gyles CL, Hayes MA, Sanei B, Parvizi P *et al*. Modulation of antibody-mediated immune response by probiotics in chickens. Clinical and Diagnostic Laboratory Immunology. 2005;12(12):1387-1392.
8. Sohail MU, Hume ME, Byrd JA, Nisbet DJ, Ijaz A, Sohail A *et al*. Effect of supplementation of prebiotic mannan-oligosaccharides and probiotic mixture on growth performance of broilers subjected to chronic heat stress. Poultry Science. 2012;91(9):2235-2240.
9. ABPA. Annual Report 2022-23. Brazilian Animal Protein Association, São Paulo; 2023.
10. NRC. Nutrient Requirements of Poultry. 9th revised edition. Washington DC: National Academy Press; 1994.
11. OIE. Newcastle disease (infection with Newcastle disease virus). In: Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. Paris: World Organisation for Animal Health; c2021. p. 964-983.
12. Duncan DB. Multiple range and multiple F tests. Biometrics. 1955;11(1):1-42.
13. Kabir SML, Rahman MM, Rahman MB, Rahman MM, Ahmed SU. The dynamics of probiotics on growth performance and immune response in broilers. International Journal of Poultry Science. 2004;3(5):361-364.
14. Mountzouris KC, Tsitrsikos P, Kalamara E, Nitsch S, Schatzmayr G, Fegeros K. Evaluation of the efficacy of a probiotic containing *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, and *Pediococcus* strains in promoting broiler performance. Poultry Science. 2007;86(2):309-317.
15. Lee KW, Lee SH, Lillehoj HS, Li GX, Jang SI, Babu US *et al*. Effects of direct-fed microbials on growth performance, gut morphometry, and immune characteristics in broiler chickens. Poultry Science. 2010;89(2):203-216.
16. Awad WA, Ghareeb K, Abdel-Raheem S, Bohm J. Effects of dietary inclusion of probiotic and synbiotic on growth performance, organ weights, and intestinal histomorphology of broiler chickens. Poultry Science. 2009;88(1):49-56.