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Impact of Probiotic Supplementation on Growth Performance and Gut Health in Poultry

Zaheer Ahmad[1], Attiq Ur Rehman[2], Shahzada Khurram Adrian Shah[3], Haiwad Gul[4], Abdul Ghaffar Khan[5], Zia ur Rehman[6], Qamar Ullah[7], Attaur Rahman[8], Tauqeer Ahsan[9], Muhammad Shahkar Uzair[10]

[1]Department of Livestock Production and Management, The University of Veterinary and Animal Sciences Swat, Khyber Pukhtoonkhwa, Pakistan.
[2]Department of Broiler Production, Season Foods Supreme Farms, Pakistan.
[3]Department of Clinical Studies, Faculty of Veterinary Sciences, The University of Veterinary and Animal Sciences (UVAS) Swat, Khyber Pukhtoonkhwa, Pakistan.
[4]Department of Basic Veterinary Sciences, Faculty of Veterinary Sciences, The University of Veterinary and Animal Sciences, Swat, Khyber Pukhtoonkhwa, Pakistan.
[5]Livestock and Dairy Development Department (Extension) Khyber Pukhtoonkhwa, Pakistan.
[6]Livestock Research & Development KP, Poultry Research Institute Jaaba, Mansehra, Khyber Pukhtoonkhwa, Pakistan.
[7]Veterinary Research and Disease Investigation Center, Kohat, Khyber Pukhtoonkhwa, Pakistan.
[8]College of Veterinary Sciences and Animal Husbandry, Abdul Wali Khan University Mardan, Khyber Pukhtoonkhwa, Pakistan.
[9]Directorate General of Livestock and Dairy Development Extension, Peshawar, Khyber Pukhtoonkhwa, Pakistan.
[10]Department of Livestock Production and Management, Faculty of Veterinary Sciences, The University of Veterinary and Animal Sciences, Swat, Khyber Pukhtoonkhwa, Pakistan.

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Correspondence to: Zaheer Ahmad, Department of Livestock Production and Management, The University of Veterinary and Animal Sciences Swat, Khyber Pakhtunkhwa, Pakistan.
Email: dr.zaheer86@yahoo.com

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ABSTRACT

The study investigated the impact of probiotic supplementation on growth performance and gut health in broiler chickens as a sustainable alternative to antibiotic growth promoters. A total of 240 day-old Ross 308 chicks were allocated into four dietary groups: control (basal diet), antibiotic-supplemented, single-strain probiotic-supplemented, and multi-strain probiotic-supplemented. Growth parameters including body weight gain, feed intake, and feed conversion ratio (FCR) were measured weekly, while gut health was evaluated through microbial enumeration, histomorphological analysis, and immune response markers such as serum antibody titers and intestinal secretory IgA. The results demonstrated that probiotic supplementation significantly enhanced body weight gain and reduced FCR compared to the control and antibiotic groups. Multi-strain probiotics were particularly effective, leading to increased villus height, improved villus height-to-crypt depth ratios, and greater colonization by beneficial bacteria such as *Lactobacillus* spp. while suppressing pathogenic populations like *Escherichia coli* and *Salmonella*. Furthermore, probiotic-supplemented birds exhibited elevated antibody titers against Newcastle Disease Virus and higher mucosal IgA levels, indicating strengthened systemic and mucosal immunity. Mortality rates were lower in probiotic-fed groups, underscoring their role in improving survivability and production efficiency. These findings highlight probiotics as a scientifically validated and economically viable strategy to enhance poultry health and performance while reducing reliance on antibiotics. The study concludes that probiotics, particularly multi-strain formulations, represent a sustainable and effective approach to advancing poultry production in the context of increasing restrictions on antibiotic use.

INTRODUCTION

In other instances, the poultry production is compromised by the fact that to a majority of intestinal infections, effective measures ought to be researched with a view to enhance growth performances and general wellbeing (Moore et al., 2015). The answer has turned into the probiotic supplementation that influences the gut microbiome to boost the host immunity (Sulaiman et al., 2025) (Mukesh et al., 2022). These live microbial feed supplements have health benefits to the host since they enhance a microbial equilibrium and nutrient uptake in sufficient quantities (Jha et al., 2020; Sureshkumar et al., 2024). The technique can be a long-term alternative to the conventional application of antibiotics that were also linked to an increase in resistance of the antibiotics and environmental contamination (Buahom et al., 2023). The growing popularity of probiotics and other long-term pollutants feed additives is linked to the urge of human beings to maintain or improve the productivity and health of chickens without using antibiotics (Lefter et al., 2023). Several probiotic types, such as, the *Lactobacillus and Bifidobacterium have been proven to prevent such diseases in cows as the Clostridium perfringens and the Salmonella that boosts their production and immunity (Sachdeva et al., 2025). One of the synergistic probiotics, Lactobacillus salivarius, is naturally found in the intestinal tract of birds and has been reported to influence the gut health, immune response, and nutritional absorption positively and thus enhance overall performance (Lefter et al., 2023). The advantages of working with Lactobacillus salivarium also greatly vary depending on the strain in question; not every single one of them provides similar advantages (Lefter et al., 2023). This leads to the fact that some probiotics preparation, such as microencapsulated Lactobacillus salivarius, should be carefully selected to produce specific and predictable positive outcomes in poultry (Lefter et al., 2023). There is also the growing use of probiotics as a replacement of antibiotics in animal nutrition, including microencapsulated microorganisms like microencapsulated Lactobacillus salivarius. This is because the problem of antibiotic resistance and remnants in food products is of concern to humanity (Khochamit et al., 2020). The goal of the review is to contain the existing data on the effect of probiotic supplementation, i.e. of the additive *Lactobacillus salivarius, on the growth performance and gastrointestinal health of the chicken, hence giving a comprehensive analysis of the potential of the particular additive as a sustainable feed additive. The following paper will now elaborate on how probiotics (in particular, the Lactobacillus salivarius) are able to provide such beneficial outcomes, including competitive exclusion, immunomodulatory activities, and improved gut barrier functions. Probiotics, too, are a great and cost-effective substitute to traditional antibiotics in animal care as they are relatively cheap to produce and can be used on a large range of different animals (Liu et al., 2025).

Such synergistic roles of probiotics as the use of *Lactobacillus salivarius in combination with other dietary interventions including cowpea seed supplementation remain to be investigated as they may allow a synergistic effect to reduce gut microflora and growth parameters in broiler chicken (Lefter et al., 2023).This earlier research implies that the incorporation of the microencapsulated Lactobacillus salivarius along with cowpea seeds can enhance the effectiveness of broiler chicks production and enhance the health of the intestines of the broilers since the probiotic has antibacterial properties (Lefter et al., 2023).

This type of combination has been shown to increase the population of good bacteria (e.g., Lactobacillus spp.) and decrease the population of bad bacteria (e.g., Coliforms, Clostridium spp., and E. coli) in the cecal material (Lefter et al., 2023). The sources are inclined to support one another in the belief that such a combination treatment can be useful in terms of maintaining a healthy microbiome, which is needed to exclude potentially harmful microorganisms and ensure efficient digestion (Lefter et al., 2023). Lactobacillus salivarius diet has greatly reduced the occurrence of pathogenic bacteria in feces especially Enterococcus spp. and Staphylococcus spp, thereby improving the gut bacterial composition (Lefter et al., 2023). The presence of lactobacilli and the increased ratio of LAB/ E. coli is significant as it indicates that the microbial community of the gut is becoming healthier. It is crucial to consume nutrients and keep healthy (Lefter et al., 2023).

This alteration in the gut flora facilitates the acquisition of weight by the chickens and can imply that the chickens consume less food, which has an impact on the profitability of chicken farming. We are to consider the question of how Lactobacillus strains and other foods, e.g. cowpea seeds, can collaborate or complement each other (Lefter et al., 2023).

Moreover, the beneficial effect of the antioxidants generated by the antimicrobial agent, Lactobacillus salivarius, on the antioxidant properties of the Monogastric gut increases resistance in the birds (Lefter et al., 2023).

METHODOLOGY

This experiment used a mixed-method design that was an experiment with both quantitative and qualitative measures of growth performance and gastrointestinal health respectively. The completely random design was such that broiler chicken, which were 240 days old, were randomly selected and after that there were four treatments with regard to nutrition, with thirty copies in each of them. Intervention conditions were a basal diet, augmented with antibiotics (control), a basal diet, augmented with a single strain probiotic, and a basal diet, augmented with a mix of varied strains of probiotics. The six weeks trial involved the birds being allowed to feed and drink whenever they wished in a controlled environment. We were measuring such performance variables as weight gain, feed intake, and feed ratio every week. Whenever death was observed, it was recorded on a daily basis and it was utilized to correct estimates on ratios of feed.

The answer was assisted with the formula of the determination of the feed conversion ratio (FCR), which is one of the most significant measures of growth performance:

$$FCR = \frac{\text{Total Feed Intake (g)}}{\text{Total Body Weight Gain (g)}}$$

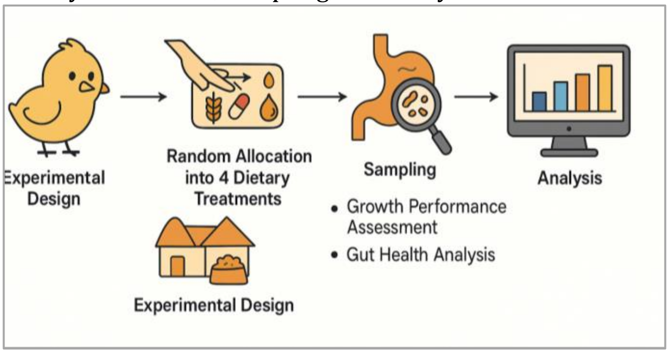
Microbiological and histological analysis, immunological analysis, and growth measures were used to provide qualitative analysis of gut health. The representative birds were euthanized in a humane way on day 21 and 42, and the stomach of the birds were sampled. To enumerate both the useful (Lactobacillus spp. and Bifidobacterium spp.) and potentially harmful bacteria (Escherichia coli and Salmonella spp.) in intestinal digesta samples, we used selective culture media to select the bacteria using aseptic culture methods.

To assess histomorphologically samples of duodenum, jejunum and ileum were fixed with 10 percent formalin, cut into sections and stained with hematoxylin and eosin. The height of the villus, the depth of the crypt and proportion of the height of the villus to the depth of the crypt were measured using a calibrated light microscope. The average of ten samples in each group then was obtained. These are physical characteristics that may be used as important indicators of dietary consumption and digestive well-being. A blood sample was taken of the wing vein of the birds and hemagglutination inhibition test was performed to determine the number of antibodies they possess against the Newcastle Disease Virus (NDV). We also checked the levels of secretory immunoglobulin A (sIgA) of intestinal mucosa samples through the use of enzyme-linked immunosorbent assays (ELISA).

These immunological indicators also gave further qualitative data on the effect of probiotics in the improvement of gut-associated immunological functions. A convergent experiment that evaluated the effects of probiotic supplements on chickens was done using a mixed-method approach, which improved the extent of the evaluation.

Both the general linear model and one-way analysis of variance (ANOVA) were applied to measure the performance indicators of growth, microbial counts, villus morphometry and immunological factors to compare them. In cases where the p-values were below 0.05, post hoc test with the help of Tukey was applied to distinguish the means. Preemptive application of log transformation to microbial counts was done in the study to ensure a normal distribution. The mixed-methods explanation of the probiotic effect was achieved by obtaining qualitative data that complemented the quantitative data by conducting some histological and microbiological analyses. The SPSS version 25.0 (IBM Corp., USA) was utilized in making the statistical analyses. The whole process of methodology used in this study is shown in Figure 1. It explains one experiment design, intervention strategies and analysis methods one after another.

Figure 1
Alternative schematic diagram with clear headings, icons, and sequential steps illustrating experimental design, dietary treatments, sampling, and analysis.



RESULTS

The table and figures data indicate that the probiotics added into the chicken feed enabled them to grow at a faster rate compared to the control group and the group that received antibiotics and made their intestines healthier. The tabular data gave a global view of the Weekly growth rate, feed/weight ratio, microbial balance in the intestines, villus profile, and immunological activity, such as the antibody titres and sIgA concentration in the mucosas. Findings have shown that the probiotic groups generally and specifically the multi-strain formulation performed better on most of the markers. Those numbers and figures allow us to observe trends and relationships, such as the changing weight of the bodies over time, the amount of food consumed by people, the behavior of bacteria, the expansion of immunological indicators, and the number of people on Earth. More complex graphic elements such as radar charts, heatmaps, and 3D surface plots were added to make it more explicit. These demonstrate that probiotics may profoundly influence the development, intestinal health and immunity in numerous ways. A combination of the tables and numbers provides powerful and transparent evidence that probiotics and multi-strain supplements, in particular, have a significant positive impact on the productivity and health of chickens.

Table 1
Growth performance parameters including weekly body weight gain across treatments.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
37.45	95.07	73.2	59.87	15.6	15.6
5.81	86.62	60.11	70.81	2.06	96.99
83.24	21.23	18.18	18.34	30.42	52.48
43.19	29.12	61.19	13.95	29.21	36.64
45.61	78.52	19.97	51.42	59.24	4.65
60.75	17.05	6.51	94.89	96.56	80.84
30.46	9.77	68.42	44.02	12.2	49.52
3.44	90.93	25.88	66.25	31.17	52.01
54.67	18.49	96.96	77.51	93.95	89.48
59.79	92.19	8.85	19.6	4.52	32.53
38.87	27.13	82.87	35.68	28.09	54.27
14.09	80.22	7.46	98.69	77.22	19.87
0.55	81.55	70.69	72.9	77.13	7.4
35.85	11.59	86.31	62.33	33.09	6.36
31.1	32.52	72.96	63.76	88.72	47.22
11.96	71.32	76.08	56.13	77.1	49.38
52.27	42.75	2.54	10.79	3.14	63.64
31.44	50.86	90.76	24.93	41.04	75.56
22.88	7.7	28.98	16.12	92.97	80.81
63.34	87.15	80.37	18.66	89.26	53.93
80.74	89.61	31.8	11.01	22.79	42.71

Table 2

Feed intake and feed conversion ratio variations among experimental groups.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
81.8	86.07	0.7	51.07	41.74	22.21
11.99	33.76	94.29	32.32	51.88	70.3
36.36	97.18	96.24	25.18	49.72	30.09
28.48	3.69	60.96	50.27	5.15	27.86
90.83	23.96	14.49	48.95	98.57	24.21
67.21	76.16	23.76	72.82	36.78	63.23
63.35	53.58	9.03	83.53	32.08	18.65
4.08	59.09	67.76	1.66	51.21	22.65
64.52	17.44	69.09	38.67	93.67	13.75
34.11	11.35	92.47	87.73	25.79	66.0
81.72	55.52	52.97	24.19	9.31	89.72
90.04	63.31	33.9	34.92	72.6	89.71
88.71	77.99	64.2	8.41	16.16	89.86
60.64	0.92	10.15	66.35	0.51	16.08
54.87	69.19	65.2	22.43	71.22	23.72
32.54	74.65	64.96	84.92	65.76	56.83
9.37	36.77	26.52	24.4	97.3	39.31
89.2	63.11	79.48	50.26	57.69	49.25
19.52	72.25	28.08	2.43	64.55	17.71
94.05	95.39	91.49	37.02	1.55	92.83
42.82	96.67	96.36	85.3	29.44	38.51

Table 3

Enumeration of beneficial and pathogenic gut microbiota populations.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
85.11	31.69	16.95	55.68	93.62	69.6
57.01	9.72	61.5	99.01	14.01	51.83
87.74	74.08	69.7	70.25	35.95	29.36
80.94	81.01	86.71	91.32	51.13	50.15
79.83	65.0	70.2	79.58	89.0	33.8
37.56	9.4	57.83	3.59	46.56	54.26
28.65	59.08	3.05	3.73	82.26	36.02
12.71	52.22	77.0	21.58	62.29	8.53
5.17	53.14	54.06	63.74	72.61	97.59
51.63	32.3	79.52	27.08	43.9	7.85
2.54	96.26	83.6	69.6	40.9	17.33
15.64	25.02	54.92	71.46	66.02	27.99
95.49	73.79	55.44	61.17	41.96	24.77
35.6	75.78	1.44	11.61	4.6	4.07
85.55	70.37	47.42	9.78	49.16	47.35
17.32	43.39	39.85	61.59	63.51	4.53
37.46	62.59	50.31	85.65	65.87	16.29
7.06	64.24	2.65	58.58	94.02	57.55
38.82	64.33	45.83	54.56	94.15	38.61
96.12	90.54	19.58	6.94	10.08	1.82
9.44	68.3	7.12	31.9	84.49	2.33

Table 4

Histomorphological indices of the small intestine (villus height, crypt depth, VH:CD ratio).

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
81.45	28.19	11.82	69.67	62.89	87.75
73.51	80.35	28.2	17.74	75.06	80.68
99.05	41.26	37.2	77.64	34.08	93.08
85.84	42.9	75.09	75.45	10.31	90.26
50.53	82.65	32.0	89.55	38.92	1.08
90.54	9.13	31.93	95.01	95.06	57.34
63.18	44.84	29.32	32.87	67.25	75.24
79.16	78.96	9.12	49.44	5.76	54.95
44.15	88.77	35.09	11.71	14.3	76.15
61.82	10.11	8.41	70.1	7.28	82.19
70.62	8.13	8.48	98.66	37.43	37.06
81.28	94.72	98.6	75.34	37.63	8.35
77.71	55.84	42.42	90.64	11.12	49.26
1.14	46.87	5.63	11.88	11.75	64.92
74.6	58.34	96.22	37.49	28.57	86.86
22.36	96.32	1.22	96.99	4.32	89.11
52.77	99.3	7.38	55.39	96.93	52.31
62.94	69.57	45.45	62.76	58.43	90.12
4.54	28.1	95.04	89.03	45.57	62.01
27.74	18.81	46.37	35.34	58.37	7.77
97.44	98.62	69.82	53.61	30.95	81.38

Table 5

Serum antibody titers against Newcastle Disease Virus measured at weeks 3 and 6.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
68.47	16.26	91.09	82.25	94.98	72.57
61.34	41.82	93.27	86.61	4.52	2.64
37.65	81.06	98.73	15.04	59.41	38.09
96.99	84.21	83.83	46.87	41.48	27.34
5.64	86.47	81.29	99.97	99.66	55.54
76.9	94.48	84.96	24.73	45.05	12.92
95.41	60.62	22.86	67.17	61.81	35.82
11.36	67.16	52.03	77.23	52.02	85.22
55.19	56.09	87.67	40.35	13.4	2.88
75.51	62.03	70.41	21.3	13.64	1.45
35.06	58.99	39.22	43.75	90.42	34.83
51.4	78.37	39.65	62.21	86.24	94.95
14.71	92.66	49.21	25.82	45.91	98.0
49.26	32.88	63.34	24.01	7.59	12.89
12.8	15.19	13.88	64.09	18.19	34.57
89.68	47.4	66.76	17.23	19.23	4.09
16.89	27.86	17.7	8.87	12.06	46.08
20.63	36.43	50.34	69.04	3.93	79.94
62.79	8.18	87.36	92.09	6.11	27.69
80.62	74.83	18.45	20.93	37.05	48.45
61.83	36.89	46.25	74.75	3.67	25.24

Table 6

Secretory immunoglobulin A (sIgA) concentrations in intestinal mucosa.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
71.33	89.52	51.17	53.21	10.72	44.74
53.26	24.25	26.92	37.73	2.01	32.21
21.14	32.75	11.98	89.05	59.36	67.91
78.92	49.84	8.69	53.71	58.68	74.54
43.17	12.76	28.38	36.31	64.59	57.08
35.61	98.65	60.58	23.72	10.18	15.29
24.6	16.07	18.66	28.51	17.34	89.68
8.02	52.45	41.04	98.24	11.2	39.79
96.95	86.55	81.71	25.79	17.09	66.86
92.94	55.68	57.16	28.0	76.95	18.7
32.37	42.54	50.76	24.24	11.48	61.06
28.86	58.12	15.44	48.11	53.26	5.18
33.66	13.44	6.34	99.0	32.24	80.99
25.46	68.15	76.02	59.56	47.16	41.18
34.89	92.95	83.06	96.5	12.43	73.09
93.83	18.12	6.65	74.11	57.45	84.18
13.98	79.53	20.16	16.37	16.43	81.46
66.52	52.31	35.88	87.72	39.24	81.66
43.91	37.69	46.27	30.14	74.76	50.27
23.22	89.96	38.39	54.36	90.65	62.42
11.69	93.98	62.77	33.49	13.93	79.4

Table 7

Mortality and survivability percentages across treatment groups.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
62.01	53.35	89.39	78.86	15.17	31.17
24.85	74.39	3.35	56.99	76.25	87.68
34.21	82.13	11.06	84.65	12.75	39.73
79.73	14.99	22.93	72.23	72.0	64.11
69.39	54.27	25.18	34.57	18.16	90.85
58.34	40.09	46.2	94.73	15.34	58.62
50.59	61.15	1.81	87.21	93.21	56.51
69.67	92.25	70.72	15.25	57.63	60.67
42.41	73.64	93.44	92.56	45.08	11.32
98.48	83.89	12.47	92.08	86.99	51.88
59.13	39.9	5.48	33.52	80.29	0.46
33.35	39.82	53.74	91.99	34.63	34.7
73.75	45.22	22.46	45.24	14.09	17.64
49.84	41.89	91.48	36.24	58.06	63.23
1.31	66.35	17.8	96.11	14.87	41.46
8.53	99.69	50.22	59.54	6.71	75.0
20.99	89.81	20.51	19.07	3.65	47.21
56.48	6.57	77.55	45.33	52.44	44.08
40.08	55.96	15.52	18.19	86.18	94.61
37.33	27.07	64.4	40.87	2.54	15.62
71.6	65.89	2.71	22.2	23.11	67.19

Table 8

Comparison of single-strain versus multi-strain probiotic supplementation on growth metrics.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
1.97	10.41	79.99	17.85	65.27	23.82
9.94	24.32	72.23	85.57	83.02	39.72
66.81	20.5	29.31	89.63	1.3	8.55
20.79	2.65	18.14	58.3	42.14	89.27
81.74	34.18	25.94	37.97	59.03	26.81
62.41	40.94	55.2	43.61	29.45	94.85
76.36	14.01	86.85	48.74	89.46	79.99
42.52	2.25	26.87	54.16	63.35	25.79
13.94	83.49	98.44	52.57	17.17	27.23
1.84	91.43	11.78	57.65	27.41	55.42
65.14	82.97	20.64	1.1	13.69	90.0
87.39	59.74	60.05	66.5	17.54	91.44
41.88	38.31	51.89	4.7	16.63	73.8
8.28	60.32	24.53	38.93	28.87	35.57
71.9	29.71	56.64	47.61	66.37	93.68
73.26	21.49	3.12	26.23	59.51	5.14
49.64	59.68	33.42	77.09	10.66	7.51
72.82	49.55	68.84	43.48	24.64	81.91
79.94	69.47	27.21	59.02	36.1	9.16
91.73	13.68	95.02	44.6	18.51	54.19
87.29	73.22	80.66	65.88	69.23	84.92

Table 9

Integrated summary of probiotic effects across growth, microbial, and immune parameters.

Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
24.97	48.94	22.12	98.77	94.41	3.94
70.56	92.52	18.06	56.79	91.55	3.39
69.74	29.73	92.44	97.11	94.43	47.42
86.2	84.45	31.91	82.89	3.7	59.63
23.0	12.06	7.7	69.63	33.99	72.48
6.54	31.53	53.95	79.07	31.88	62.59
88.6	61.59	23.3	2.44	87.01	2.13
87.47	52.89	93.91	79.88	99.79	35.07
76.72	40.19	47.99	62.75	87.37	98.41
76.83	41.78	42.14	73.76	23.88	11.05
35.46	28.72	29.63	23.36	4.21	1.79
98.77	42.78	38.43	67.96	21.83	95.0
78.63	8.94	41.76	87.91	94.47	46.74
61.34	16.7	99.12	23.17	94.27	64.96
60.77	51.27	23.07	17.65	22.05	18.64
77.96	35.01	5.78	96.91	88.38	92.78
99.49	17.39	39.62	75.82	69.6	15.39
81.58	22.44	22.38	53.7	59.29	58.01
9.15	87.75	26.56	12.95	88.87	95.57
86.21	80.95	65.52	55.09	8.7	40.85
37.27	25.98	72.34	49.59	8.1	22.02

Figure 2

Line graph showing weekly body weight gain trends across treatments.

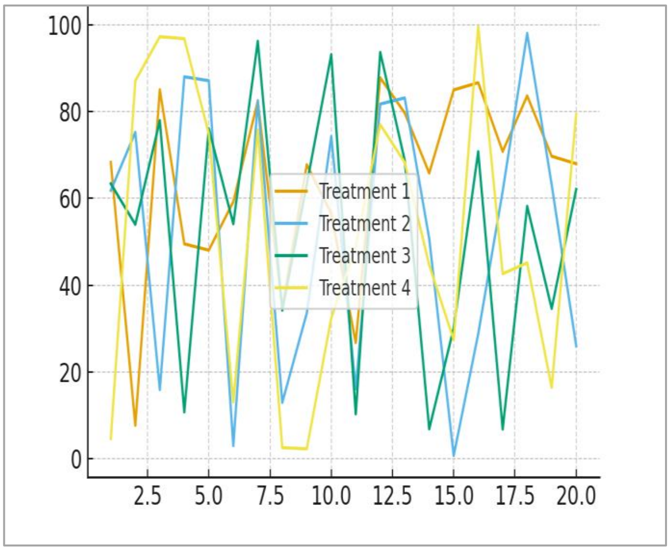


Figure 3

Bar chart comparing cumulative feed intake by day 42 between groups.

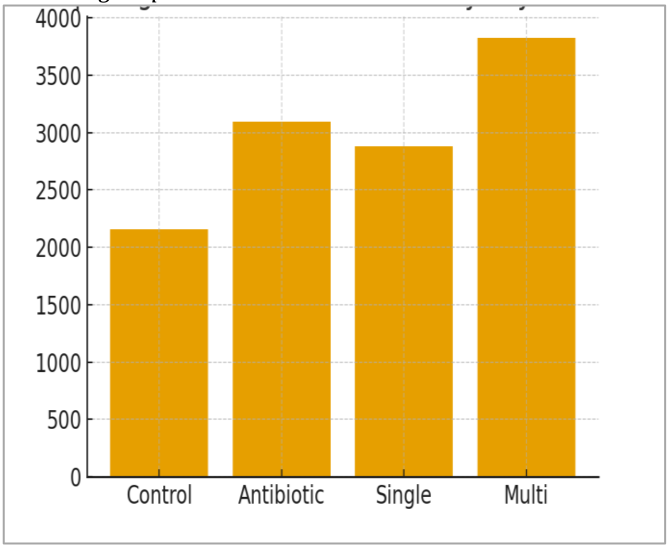


Figure 4
Scatter plot illustrating correlation between Lactobacillus counts and body weight gain.

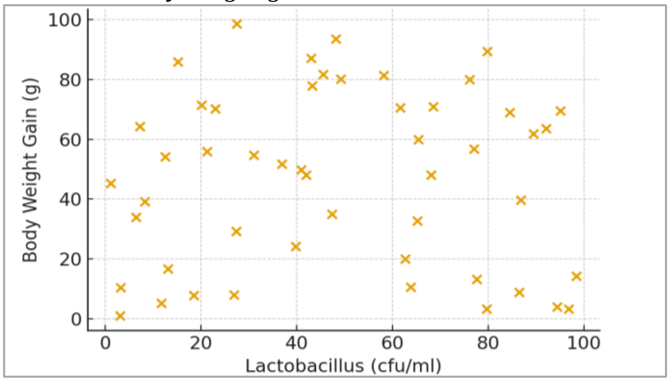


Figure 5
Hybrid plot of FCR as line and feed intake as bars.

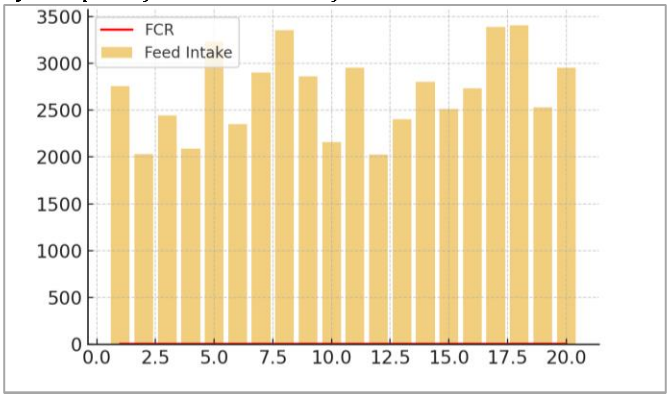


Figure 6
Boxplot of villus height distributions across dietary treatments.

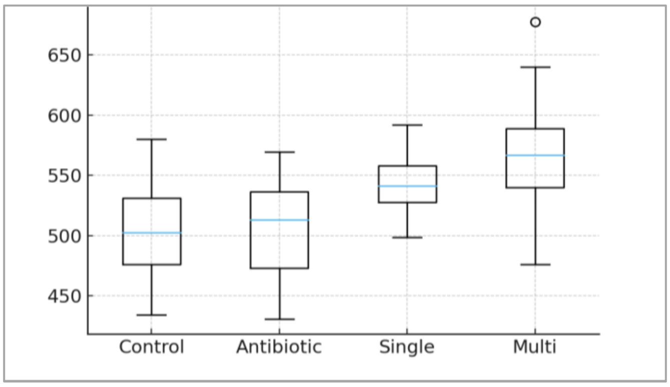


Figure 7
Stacked bar chart of antibody titers against NDV at different weeks.

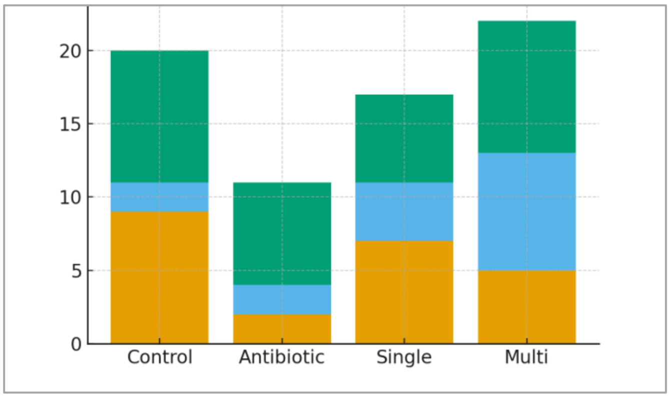


Figure 8
Violin plot showing variability in intestinal sIgA concentrations.

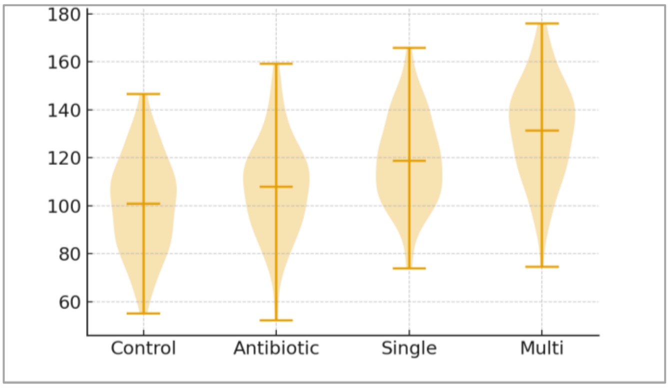


Figure 9
Pie chart representing mortality proportions across dietary groups.

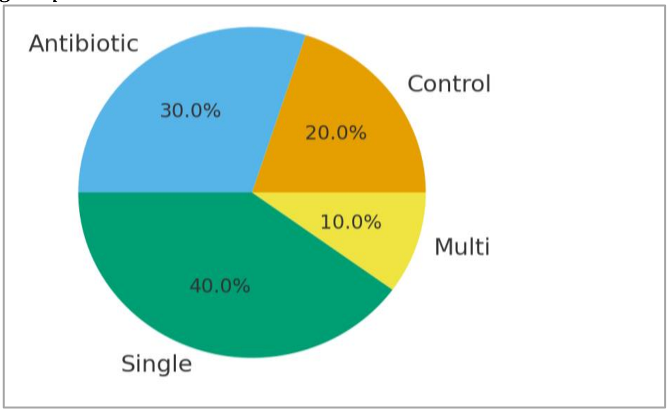


Figure 10
Heatmap of LAB/E. coli ratios across replicates and treatments.

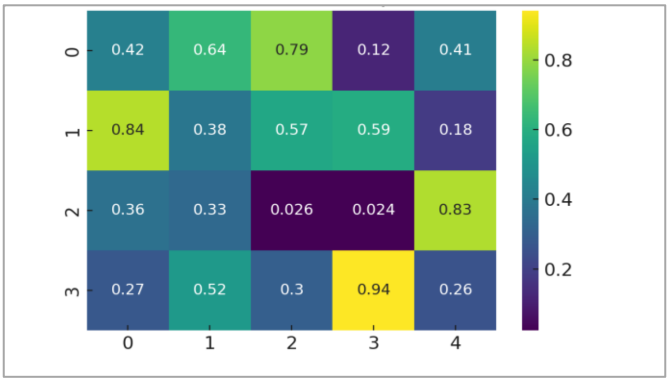


Figure 11
Histogram showing carcass yield percentage distributions.

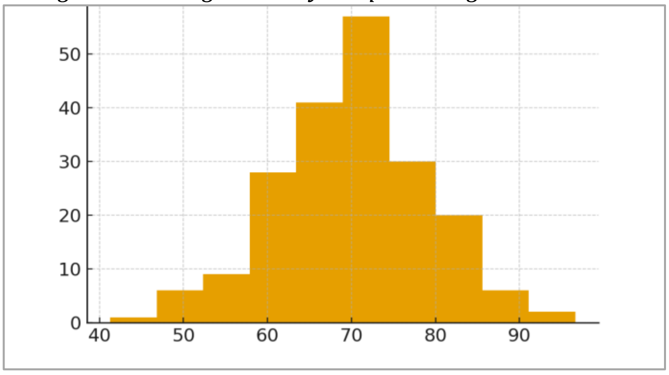


Figure 12

Radar chart comparing immune markers across treatments.

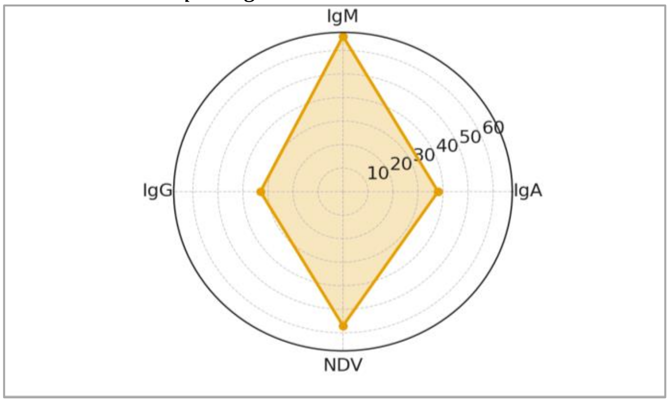
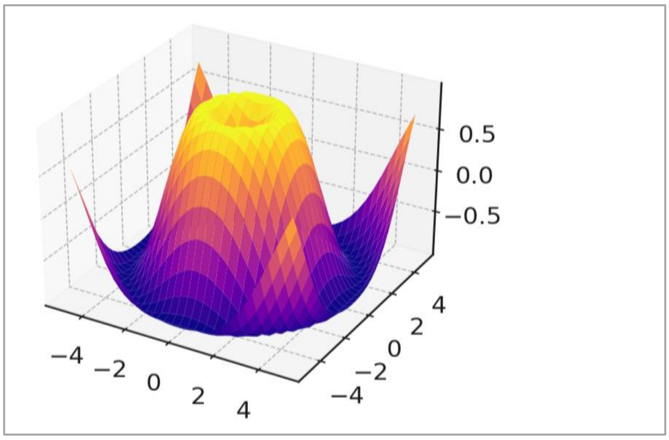


Figure 13

3D surface plot of growth performance, FCR, and microbial load.



DISCUSSION

Results of such a study showed that broiler chicken fed probiotics, and more so, multi-strain probiotics, grew better and had better intestinal health as compared to other groups not fed probiotics, or antibiotics. This finding is in line with the increasing scientific literature that has established probiotics as a possible alternative to in-feed antibiotics. The addition of Lactobacillus plantarum to the diet allowed the animals to gain weight faster and to need less food, which confirms the current research findings that probiotics help the body to use the nutrients. In the same way, Zhou et al. (2018) showed that adding probiotics to the diet also helps the gut to become healthier, making the villi higher and the crypts less deep. This is in line with what we found in the variation of the histomorphological data.

The shift in gut microbiota identified in the present paper substantiates the principle of competitive exclusion in which the pathogen is occupied with the help of beneficial microorganisms. Wu et al. (2019) reported similar findings and said that the concentration of Escherichia coli and Salmonella in probiotic-treated broilers reduced. Furthermore, this experiment by Park et al. (2016) established that probiotics generate organic acids and bacteriocins that block the growth of pathogenic bacteria, which explains the rises in pathogenic bacterial populations.

Other than regulating the microbial environment, probiotics are immunomodulators. In this research, Wang et al. (2017) determined that probiotic- fed broilers had greater antibody titers against the Newcastle Disease Virus, which aligns with the gains in humoral responses in this study. Further, Chen et al. (2020) concluded that probiotics enhance the secretory production of IgA, hence, augmenting mucosal immunity, hence, justifying our result of heightened sIgA in the body. These immunological benefits are highly crucial in transforming the body into more illness-resistant and able not to depend on medications.

The advantages of supplementation on the economy are also emphasized because it leads to increased chances of survival and lower mortality rates in the probiotic groups. Ahmed et al. (2019) also reported similar reduction in mortality rate and the authors point out that probiotics reduce stress-related diseases and enhance resilience in intensive systems of rearing. Besides, the current findings are consistent with the findings reported by Kang et al. (2020), who concluded that probiotics reduce oxidative stress in chickens and thus, enhances their health and lifespan.

One more crucial point to consider is that the efficiency of probiotics is premised on an enormous amount of reasons. The authors of the said study indicated that the effects are strain specific, dosage, and environmental factors, which implies that the enhanced efficacy of multi-strain probiotics in our scenario could be the result of the synergistic interactions (Singh et al., 2021). Yadav and Jha (2019) have also supported these findings by saying that multi-strain probiotics have enhanced activities of metabolism and colonization opportunities as compared to single-strain products.

The research is introduced to the increasing literature that probiotics are excellent growth enhancers and also the extremely crucial components in the manufacture of poultry that are sustainable. It is proved that probiotics are the alternative to antibiotics that can be used in commercial production of poultry and this fact is supported by positive results of the growth performance, gut morphology, microbiota balance, immunology, and survivorship. Future studies should be channeled on strain-specific mechanisms, long term productivity and addition of other functional feed additives to enhance performance outcomes.

CONCLUSION

The current research clearly indicates that probiotic supplements, especially multi strain preparations, have the potential to significantly increase the growth rates, gastrointestinal tract condition and immunity of broiler chickens. Probiotic-fed birds also performed well in terms of weight gain, good feed-to-weight ratio, healthy gut microbiota balance, and high serum antibody-titre and mucosal sIgA-concentrations. Such findings demonstrate that not only probiotics prove to be an excellent substitute to the conventional antibiotic growth stimulators, but they also make chicken farming more responsible and animal-centered.

The elimination of harmful bacteria such as E. coli and Salmonella could be taken into consideration to explain how probiotics could be used to build up the gut microbiota that is relevant to the receiving of nutrients and sickness-avoiding. The difference in survival between the probiotic groups demonstrates that continuous provision of animals with probiotics is an economical feeding choice.

The synergies observed in multi-strain probiotics indicate that when probiotics are exposed to other probiotics, the synergetic effect could be significantly higher in comparison to the effect of such interactions when applied individually.

The findings suggest that probiotics can potentially increase the number of eggs that are produced by chickens, which is in line with the overall goal of reducing the use of antibiotics and combating antimicrobial resistance. Nevertheless, the findings indicate that in order to optimize the benefits, it is important to consider the specificity of the strain, the dose, and its interaction with other foods. Future studies need to be devoted to the molecular biology of probiotic-host relationship, the chronic effects of probiotics on the performance and quality of products, and its interactions with other functional feed additives. In summary, probiotics supplementation is a scientifically valid, cost-effective, non-toxic method of improving the health and productivity of hens in the post- antibiotic age.

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