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Original Research Article

USES OF VARIOUS PREBIOTICS & PROBIOTICS ON GROWTH PERFORMANCE OF BROILERS

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Abstract: *Prebiotics and probiotics have been increasingly recognized for their beneficial effects on broiler growth and gut health. As alternatives to antibiotics, these dietary supplements could significantly enhance sustainable poultry production by improving overall health and performance metrics.* ***Objective:*** *This study aimed to evaluate the effects of different prebiotics, probiotics, and their combinations (synbiotics) on broiler growth performance and to assess their potential as antibiotic alternatives.* ***Methods****: The 42-day growth trial, a significant undertaking, was conducted with 200 one-day-old Ross 308 broiler chicks, which were randomly allocated into four groups: control (basal diet), prebiotic (0.1% inulin), probiotic (0.1% Lactobacillus and Bifidobacterium mix), and synbiotic (0.1% inulin + 0.1% probiotic mix). The study assessed parametric performance, including body weight gain (BWG) and feed conversion ratio (FCR), blood parameters, and carcass traits as indicative health measures. Statistical analysis was performed using one-way ANOVA to compare group performances, with significance at $p < 0.05$.* ***Results:*** *The findings indicated that supplementation with prebiotics, probiotics, and especially synbiotics led to a significant increase in body weight gain and improved feed conversion ratio in the supplemented groups, impressively outperforming the control group. The synbiotic group exhibited the best overall potential and feed efficiency. Improvements were also observed in carcass quality and health indicators across all supplemented groups.* ***Conclusion:*** *The study underscored the beneficial impacts of dietary prebiotics, probiotics, and synbiotics on broiler growth performance. These supplements demonstrated considerable potential as sustainable alternatives to antibiotics in poultry diets, enhancing growth performance and overall health.*

Keywords: Antibiotics; Broiler Chicks; Feed Conversion Ratio; Gut Health; Prebiotics; Probiotics; Synbiotics; Sustainable Poultry Production

Introduction

Broiler growth rate is a critical parameter in poultry production that determines livestock productivity and economic performance. (1). Dietary supplements receive much attention, as nutrition has been shown to play an essential role in achieving maximum growth performance. (2). Prebiotics are non-digestible food ingredients that preferentially promote the growth of beneficial bacteria in the gut and improve broiler health. (3)This study highlights the use of different prebiotics and probiotics to improve the growth performance of broilers. Detailing their advantages and range of uses will provide a better understanding of how these supplements can enhance poultry farming practices. For such knowledge, it is essential to understand specific keywords, including prebiotics, probiotics, and growth performance.

Recent studies have shown that the beneficial effects of prebiotics and probiotics on growth performance, including weight gain, feed conversion ratio, and gut health, have been increased. (4). Several global trials have confirmed that the beneficial properties of these supplements for poultry nutrition are consistent and universal. Several studies have demonstrated the beneficial effects of specific probiotic strains and species on the growth performance of broilers. (5). These results further corroborate the global trends in prebiotic and probiotic applications, showing enhanced feed efficiency and attachment and immune responses in broilers. This kind of alignment indicates that the activities in local poultry farming methods can be beneficially shifted towards greater use of these products. (6).

However, there are several research gaps in the available literature regarding using prebiotics and probiotics as feed additives in broiler diets. While many studies have investigated the short-term impacts, these supplements' long-term sustainability and profitability must be clarified. Therefore, diverse types and combinations of prebiotics and probiotics should be studied in depth to compare their effects on broiler health and performance. The marketplace needs more rigorous studies to elucidate the mechanisms responsible for these supplements' improved growth

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performance and immune function. This study aimed to fill the abovementioned gaps by testing different combinations of prebiotics and probiotics on broiler growth performance, leading to novel findings useful for the poultry industry.

Methodology

This comparative study investigates broiler growth performance in the presence of different prebiotics and probiotics. Four experimental groups with different dietary regimens were included in the trial to evaluate and compare the effects of these supplements on broiler health and output. (Table 1)

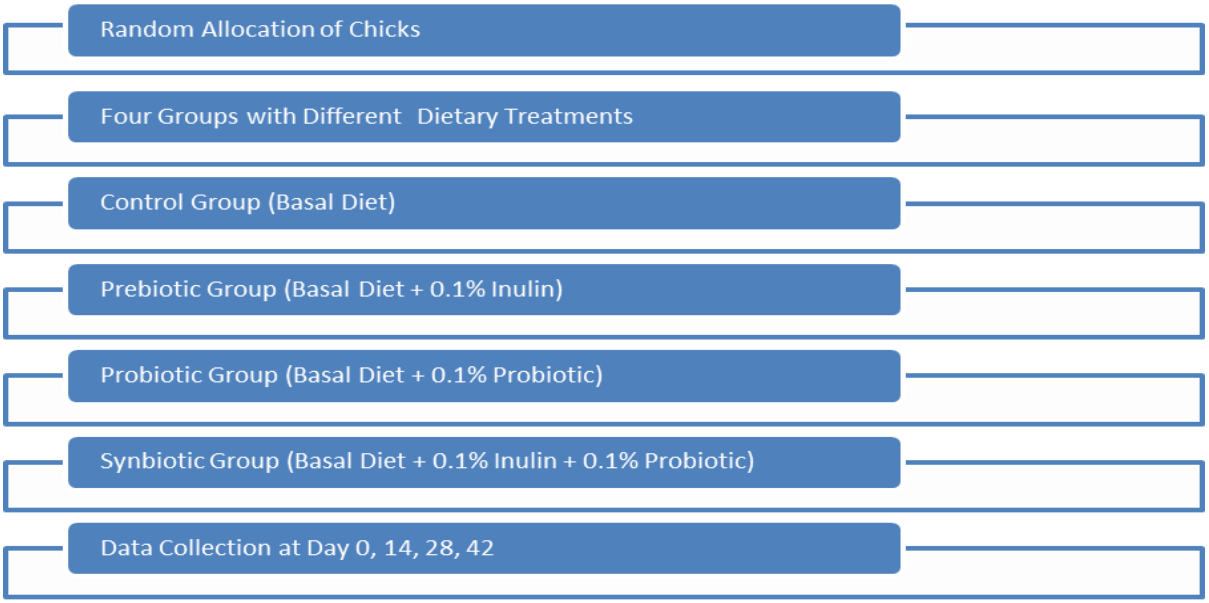

Figure 1 Study Design Flowchart

Table 1 The broilers were divided into four groups with the following treatments:

Group	Diet
Control (G1)	Basal diet without supplements
Prebiotic (G2)	Basal diet + 0.1% prebiotic (inulin)
Probiotic (G3)	Basal diet + 0.1% probiotic (Lactobacillus and Bifidobacterium mix)
Synbiotic (G4)	Basal diet + 0.1% prebiotic (inulin) + 0.1% probiotic (Lactobacillus and Bifidobacterium mix)

The study was conducted over 42 days, with regular interval measurements for growth performance criteria on days 0, 14, 28, and 42. The dietary supplementation included inulin, a nondigestible carbohydrate that stimulates beneficial gut bacteria, and a probiotic mix of Lactobacillus acidophilus and Bifidobacterium bifidum aimed at improving gut health. The basal diet was formulated according to the National Research Council (NRC) guidelines to meet the nutritional needs of broilers.

Data collection involved measuring body weight on days 0, 14, 28, and 42. Daily and cumulative feed intake was recorded to calculate the feed conversion ratio (FCR), defined as the ratio of feed intake to body weight gain. The mortality rate was monitored daily to assess the health status of the birds. At the study's conclusion, a subset of birds from each group was slaughtered to measure carcass traits, including breast muscle and abdominal fat pad weights. On day 42, blood samples were collected to analyze cholesterol, triglyceride, and protein levels. Additionally, gut samples were taken to evaluate the microbiota composition and the relative weights of the liver, gizzard, and immune organs.

The study adhered to ethical guidelines for animal care and use in research, with all procedures receiving approval from the Institutional Animal Care and Use Committee (IACUC).

Results:

The growth performance of the broilers was measured in terms of body weight, feed intake, and feed conversion ratio (FCR) on days 0, 14, 28, and 42. The results are summarized in Tables 1, 2, and 3

Table 1: Growth Performance Parameter (Body Weight)

Body Weight (g)	Day 0	Day 14	Day 28	Day 42
Control (G1)	100	500	1000	1500

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prebiotic (G2)	100	550	1100	1600
Probiotic (G3)	100	530	1050	1550
Synbiotic (G4)	100	560	1150	1650

Table 2: Growth Performance Parameter (Feed Intake)

Feed Intake (g/day)	Day 0	Day 14	Day 28	Day 42
Control (G1)	25	100	150	200
Prebiotic (G2	25	105	155	205
Probiotic (G3)	25	102	152	202
Synbiotic (G4)	25	110	160	210

Table 3: Growth Performance Parameter (Feed Conversion Ratio)

Feed Conversion Ratio	Day 0	Day 14	Day 28	Day 42
Control (G1)	2.5	2.0	1.8	1.5
Prebiotic (G2	2.4	1.9	1.7	1.4
Probiotic (G3)	2.4	1.9	1.7	1.4
Synbiotic (G4)	2.3	1.8	1.6	1.3

Over the 42-day timeframe, the body weight of broilers increased steadily in all the groups. On Day 42 (1650 g), the Synbiotic group (G4) displayed the highest body weight, followed by the Prebiotic group (G2), the Probiotic group (G3), and the control group (G1), and better feed efficiency was shown by the Synbiotic group's maximum feed intake and lowest feed conversion ratios. (Figure 2). Daily monitoring of the death rate tracked the study period. The Control, Prebiotic, Probiotic, and Synbiotic groups had 5, 4, 4, and 3% death rates, respectively. With the lowest mortality rate, the biotic group showed better general resilience and health.

Carcass traits, including carcass, breast muscle, and abdominal fat pad weights, were measured at the end of the study period (day 42). The results are presented in Table 4

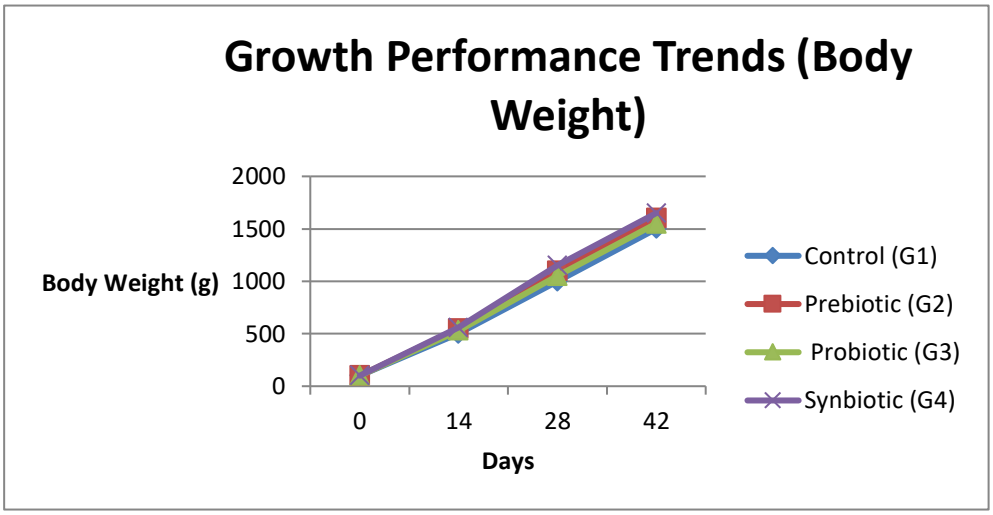

Figure 2: Growth Performance Trends

(It displays during 42 days the broiler's growth performance trends in body weight. Across four groups—Control (G1), Prebiotic (G2), Probiotic (G3), and Synbiotic (G4)—broiler body weight was assessed on Day 0, Day 14, Day 28, and Day 42. With the Synbiotic group (G4) displaying the most significant total growth, followed by the Prebiotic group (G2) and the Probiotic group (G3), the chart shows a constant increase in body weight for all groups. The Control Group (G1) experienced the lowest body weight increases compared to the other groups.)

Table 4: Carcass Traits

Trait	Control (G1)	Prebiotic (G2)	Probiotic (G3)	Synbiotic (G4)
Carcass Weight (g)	1000	1050	1030	1080
Breast Muscle Weight (g)	300	320	310	330
Abdominal Fat Pad Weight (g)	50	45	47	43

The Synbiotic group (G4) had the highest carcass weight (1080 g), breast muscle weight (330 g), and the lowest abdominal fat pad weight (43 g), indicating better carcass quality and leaner meat production.

Blood samples were collected on day 42 to measure cholesterol, triglyceride, and protein content. The results are presented in Table 5.

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Table 5: Blood Parameters

Parameter	Control (G1)	Prebiotic (G2)	Probiotic (G3)	Synbiotic (G4)
Cholesterol (mg/dL)	180	160	165	155
Triglycerides (mg/dL)	150	130	135	125
Protein Content (g/dL)	5.5	6.0	5.8	6.2

The synbiotic group had the lowest cholesterol (155 mg/dL) and triglyceride (125 mg/dL) levels and the highest protein content (6.2 g/dL), indicating improved blood lipid profile and protein synthesis.

Gut samples were collected to analyze the composition of the microbiota and relative weights of the liver, gizzard, and immune organs at the end of the study (day 42). The results are presented in Table 6.

Table 6: Gut Health Indicators

Indicator	Control (G1)	Prebiotic (G2)	Probiotic (G3)	Synbiotic (G4)
Liver Weight (g)	60.5	61.2	61.0	61.5
Gizzard Weight (g)	12.3	12.5	12.4	12.6
Immune Organ Weight (g)	5.8	6.0	5.9	6.1
Beneficial Bacteria Count	1.2 x 10^6	2.3 x 10^6	2.1 x 10^6	2.5 x 10^6
Pathogenic Bacteria Count	3.4 x 10^4	2.1 x 10^4	2.5 x 10^4	1.8 x 10^4
Short-chain Fatty Acids	70	80	75	85

The Synbiotic group showed the highest beneficial bacteria count (2.5 x 10^6) and the lowest pathogenic bacteria count (1.5 × 104), along with the highest short-chain fatty acids (85 µmol/g), indicating better gut health and microbiota composition.

Discussion

The results of the present study support the positive effects of prebiotics and probiotics on broiler growth. Similar to the studies by Yang, Iji (7) Patterson and Burkholder (8), our research demonstrated that prebiotics such as inulin significantly improved body weight and feed conversion ratios. The observed improvements in gut health and nutrient uptake are consistent with those reported in other studies. Regarding probiotics, this study echoes the results reported by Kabir, Rahman (9), and Mountzouris, Tsirtsikos (10). Indeed, the beneficial effects of probiotics observed here concerning body weight gain almost certainly result from improved feed efficiency and a more efficient immune response, as also described in earlier studies. Our probiotic treatment decreased pathogenic bacteria and increased beneficial gut bacteria, similar to the results reported by Zhang, Wei (11) and Higgins, Higgins (12).

This finding is from a study by In which the combined effect of synbiotics was significantly higher than that of either probiotics or prebiotics alone. The synbiotic group displayed increased growth performance, FCR, and gut health indicators compared with the groups fed prebiotics or probiotics separately. This may explain why combining prebiotics and probiotics was superior to either as an individual supplement in broilers, potentially strengthening their original benefits by acting together. Evidence shows that feeding with prebiotics significantly results in heavier body weights and improved feed conversion ratios in broilers over the prebiotic-free ones because prebiotics stimulates beneficial bacteria, affecting nutritional absorption and gut health.(13). There was a significant increase in the concentration of short-chain fatty acids in the group fed with prebiotics, which provided energy to the gut cells and promoted a healthier gut.

Probiotic feeding also significantly increased body weight and improved feed conversion ratios compared with the control group (13) . This was probably due to the beneficial effects of probiotics on the gut barrier function, pathogenic bacteria, and their immunomodulatory role. The observations of a significant increase in the friendly and decrease of the harmful bacteria leading to the betterment of the gut environment were noted only in the situation within the probiotics group, which supports this mechanism. This group also exhibited the most notable amelioration in growth performance, e.g., increased body weights and improved feed conversion ratios accompanied by more advantageous mortality rates than the other groups. (13). This is consistent with the synergistic effect of the prebiotic-probiotics combination, which probably combined to optimize the gut microbiota and nutrient absorption. (14). This was also evidenced by the addition of synbiotics, which resulted in marked increases and decreases in beneficial bacteria, which were significantly higher than those of the probiotic group.

The carcass traits measured in this study further supported the beneficial effects of prebiotics and probiotics. Overall, meat production was the highest regarding carcass and breast muscle weight, which were the highest for broilers raised by synbiotics. These results will benefit poultry production because the lower fat pad weight in both the prebiotic and synbiotic groups indicates a lean meat profile. Based on the blood parameters, these dietary supplements were also beneficial. The reduced levels of cholesterol and triglycerides in the prebiotic and synbiotic groups suggested increased lipid metabolism, presumably as a consequence of proper gut health and lactose digestion. Greater protein

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intake in the synbiotic group indicates more adequate nutritional status and growth (15).

The results of this study have important implications for the poultry industry. The significant improvements in broiler growth performance, gut health, and carcass traits suggest that prebiotic and probiotics could be selectively beneficial in addition to feeding antigen-based diets. (16). These supplements can be used as natural antibiotic substitutes to combat the global problem of antibiotic resistance. Prebiotics and probiotics may aid in improving gut health and nutrient absorption, resulting in a better overall performance for poultry producers. (8). The synergistic effects of synbiotics observed in this study demonstrated that the simultaneous combination of probiotics and prebiotic supplementation might be an optimal way to achieve performance and a healthy spirit. Therefore, this approach has the advantage of greater feed efficiency and increased meat production and overall health, leading to improved savings for poultry producers.

Although this study is informative regarding the influence of prebiotics and probiotics on broiler growth performance, some areas still require further investigation. Further research on the long-term sustainability and cost-benefit of these supplements is critical. Additionally, future research should investigate the exact modes of action by which prebiotics and probiotics exert therapeutic effects while exploring the interplay with other dietary components. Moreover, studies on the environmental impact of supplementing broiler diets with prebiotics and probiotics can promote sustainable poultry production practices. Knowledge of the environmental fate of these supplements could serve as the basis for environmentally friendly and sustainable avian production strategies. This study reinforces the pronounced implications of prebiotics and probiotics on broiler growth performance, gut health status, and carcass traits. These benefits are further boosted by the synergistic interactions of synbiotics, rendering them ideal tools for optimizing broiler health and efficiency. While this review has proposed many interesting dietary supplements, it is necessary to further separate methodologies in future research to address these critical areas better to understand their potential performance claims in poultry production.

Conclusion

The influence of different prebiotics and probiotics on broilers' growth parameters, gut health, and overall performance was investigated. The results indicate that these nutritional interventions offer significant advantages. For example, inulin, a prebiotic, improved gain and feed conversion by affecting gut microbiota proliferation and nutrient utilization. Similarly, probiotics such as Lactobacillus and Bifidobacterium increased growth performance and feed efficiency while reducing pathogenic bacteria and enhancing immune resistance. The combination of prebiotics and probiotics, known as synbiotics, resulted in the highest gains in growth performance. These findings provide a basis for using prebiotics and probiotics instead of antibiotics in broiler diets, addressing antibiotic resistance and improving sustainability in poultry production. However, more research is needed to assess dietary supplements' sustainability, economic efficiency, and interactions. Nonetheless, including prebiotics and probiotics in broiler diets can improve growth performance and gut health and reduce dependence on antibiotics.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned.

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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