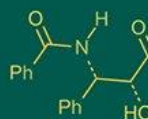


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Effect of supplementation of modified lignin on growth performance in broilers

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Abstract

An experiment was conducted using 180 day-old Cobb broiler chicks to study the effect of modified lignin on growth performance. The chicks were randomly divided into six treatment groups with three replicates of ten birds each for 42 days. Treatment groups included a control diet (T₁) as per BIS (2007)^[4], a reformulated diet with 2% reduction in metabolizable energy and crude protein of control diet (T₂), and experimental diets T₃ and T₄ supplemented with 0.2% modified lignin in both control and reformulated diets, respectively and similarly, the treatments T₅ and T₆ supplemented with 0.3% modified lignin in both control and reformulated diets, respectively. The results showed that birds supplemented with 0.2 and 0.3% modified lignin in both control and reformulated diets showed significantly improved body weight, feed intake and better feed conversion ratio compared to both the control and reformulated diets fed groups and no significant difference was noticed in survivability among all the groups. It was concluded that supplementing modified lignin improved growth performance in broilers.

Keywords: Modified lignin, reformulated diet, body weight, feed intake, feed conversion ratio, survivability

Introduction

The poultry industry in India has evolved from backyard farming to a modern organized sector, significantly contributing to the agro-livestock economy. It provides livelihood opportunities, especially in rural areas, due to its low capital requirements and high employment generation. As per BAHs (2024), India recorded a 3.17% increase in egg production, 4.95% rise in meat production, and 8.1% annual growth in poultry population, making it the second-largest egg producer and fifth-largest chicken meat producer globally. However, per capita availability remains below ICMR recommendations, highlighting the need for expansion to meet nutritional demands. With FAO projecting a 70% surge in demand for animal protein, sustainable intensification is necessary, especially as feed costs remain the major limiting factor. The focus is shifting towards alternative feed resources that improve nutritional quality and sustainability. Concerns over antimicrobial resistance have driven research on prebiotics, particularly lignocellulosic derivatives, which stimulate beneficial gut bacteria and improve digestive health (Gibson *et al.*, 2017)^[7]. Dietary fibers, once regarded as anti-nutritional, are now valued for promoting gut development, with lignin recognized for its natural prebiotic properties (Baurhoo *et al.*, 2009)^[2].

Lignin, a complex polyphenolic polymer and key component of lignocellulose, accounts for 20-35% of dry biomass weight. It strengthens plant cell walls, resists microbial degradation, and provides antioxidant, flame-retardant, and UV-protective functions. Structurally, it is composed of syringyl (S), guaiacyl (G), and p-hydroxyphenyl (H) monomers, whose proportions vary among plant types (Norgren and Edlund, 2014)^[11]. Softwood lignin is rich in guaiacyl, while hardwood lignin contains more syringyl units. Agricultural residues like sugarcane bagasse, wheat straw, and rice husk represent rich lignin sources. Extraction methods produce sulfur-containing types such as kraft lignin and lignosulfonates (Mahmood *et al.*, 2018)^[9] and sulfur-free types like soda and organosolv lignins. Since native lignin is chemically inert, modifications such as sulfonation, oxidation, graft copolymerization, and alkylation are applied to enhance reactivity and expand applications (Mahmood *et al.*, 2018)^[9].

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Lignin and its derivatives have found diverse industrial and biomedical applications. They are used in dye adsorption (Silva *et al.*, 2011) [6], dispersants, plasticizers, and catalysts (Zhu *et al.*, 2019) [15]. In healthcare, lignin exhibits anticancer, antibacterial, antioxidant, and antimicrobial (Alzagameem *et al.*, 2018) [1] activities. Recent research highlights applications in surfactants, UV protection, composites (Klimek *et al.*, 2017) [8] and drug delivery systems (Cauley and Wilson, 2017) [5]. These multifunctional roles make lignin a promising candidate for sustainable livestock feed formulations and value-added industrial products.

Materials and Methods

Venkateshwara Hatcheries Pvt. Ltd. provided 180 day-old commercial broiler chicks for this investigation, and modified lignin was procured from Phytaxis SA, Rueschlikon, Switzerland. The chicks were first evaluated based on their weight upon acquisition and then randomly divided into six experimental groups. Each group had three replicates, with 10 chicks in each replicate. Following the Bureau of Indian Standards (BIS) 2007 [4] guidelines, the control group (T₁) was fed a basal diet, while group T₂ was fed with reformulated diet [2% reduction in ME and CP in the basal diet] and the experimental groups T₃ and T₄ supplemented with 0.2% modified lignin in both basal and reformulated diets, respectively and similarly, the treatment groups T₅ and T₆ supplemented with 0.3% modified lignin in both basal and reformulated diets, respectively. The chicks were reared under standard management practices in a deep litter system until six weeks of age. The birds were vaccinated as per a standard vaccination schedule, and food and water were provided *ad libitum* throughout the trial. The study was approved by the Institutional Animal Ethics Committee, KVAFSU, Bidar, Karnataka.

The data on weekly body weight, feed intake, feed conversion ratio, and survivability were recorded throughout the experiment and subjected to statistical analysis.

Results

1. Body weight

The results of the experiment on cumulative body weight are presented in Table 1. Statistical analysis revealed a significant difference ($p \leq 0.05$) among the treatment groups. The treatment groups T₃ and T₅ consistently showed significantly higher average body weights compared to T₁, T₂, T₄, and T₆, with no significant difference between T₃ and T₅ and the groups T₁, T₄, and T₆ exhibited significantly higher body weights than T₂, while no significant differences were found among T₁, T₄, and T₆. These results indicate that treatments T₃ and T₅ were the most effective in enhancing the growth performance of chicks.

2. Feed intake

The results of the experiment on cumulative feed intake are presented in Table 2. Statistical analysis revealed a significant difference ($p \leq 0.05$) among the treatment groups during first, fourth, fifth, and sixth weeks. In the first week, treatment T₂ showed significantly higher feed intake compared to T₁, T₄, T₅, and T₆ and no significant difference between T₂ and T₃. During the fourth week, treatments T₁, T₃, and T₄ had significantly higher feed intake than T₂ and T₆ no significant difference between T₁, T₃, T₄ and T₅. During fifth and sixth weeks, treatments T₁, T₃, T₄, T₅, and

T₆ exhibited significantly higher feed intake compared to T₂, with no significant difference between T₁, T₃, T₄, T₅, and T₆ groups. However, during the second and third weeks, no significant differences ($p > 0.05$) were observed in cumulative feed intake among treatment groups. Overall, feed intake during the later weeks was lower in the T₂ group.

3. Feed conversion ratio

The results of the experiment on cumulative feed conversion ratio (FCR) are presented in Table 3. Statistical analysis revealed a significant difference ($p \leq 0.05$) among the treatment groups from second week to sixth week, except during the first week there was no significant difference was observed. However, the treatments T₃ and T₅ consistently exhibited significantly better FCR compared to T₁, T₂, T₄ and T₆, while no significant differences between T₃ and T₅ groups. Additionally, the treatments T₁, T₄, and T₆ showed significantly better FCR than T₂, while no significant differences were observed among T₁, T₄ and T₆. Overall, treatments T₃ and T₅ proved to be most effective in improving feed conversion ratio in broiler chicks across the study period.

4. Survivability

The survivability or livability (%) values at the end of the experiment were 96.67, 93.33, 96.67, 93.33, 100 and 100 in all groups T₁, T₂, T₃, T₄, T₅ and T₆ respectively. Statistical analysis revealed no significant difference in survivability among different treatment groups.

Discussion

There was a significant difference ($p \leq 0.05$) in body weight of the birds supplemented with modified lignin compared to the control group from first week to sixth week.

The results of the present study were in agreement with Sozcu (2019) [13] who observed significantly higher body weight in broilers supplemented with 1 kg of processed lignocellulose per ton of feed compared to the control group. They attributed the increase in body weight due to improved gizzard function through a reduction in pH, as well as enhanced activity of proteolytic enzymes in digestive organs such as the proventriculus and pancreas.

The results of the present study were in disagreement with Rohe *et al.* (2020) [12] who studied the effect of dietary lignocellulose in broilers. Their findings indicated that supplementation of lignocellulose at different levels had no significant effect on body weight compared to control group.

There was a significant difference ($p \leq 0.05$) in feed intake of the birds supplemented with modified lignin compared to the control group in first week and from fourth week to sixth week.

The results of the present study were in agreement with Makivic *et al.* (2019) [10] who conducted a trial by supplementing lignocellulose at different levels in broilers and reported that the supplementation of 0.6 percent lignocellulose significantly increased their feed intake compared to control group. They attributed this result to the low pH in the gizzard, as well as increased gizzard function and enhanced proteolytic digestive enzyme activities in the proventriculus and pancreas due to lignocellulose supplementation.

The results of the present study were in disagreement with Zeitz *et al.* (2020) ^[14] who conducted a trial supplemented with different forms of lignocellulose and reported that there was no significant difference in feed intake in comparison to control group.

There was a significant ($p \leq 0.05$) difference in feed conversion ratio of the birds supplemented with modified lignin compared to the control group from second week to till the end of the experiment.

The results of the present study were in agreement with Sozcu (2019) ^[13] who observed significantly lower feed conversion ratio in broilers supplemented with 1 kg of processed lignocellulose per ton of feed compared to the control group. They attributed the decrease in feed conversion ratio is due to improved gizzard function through a reduction in pH, as well as enhanced activity of proteolytic enzymes in digestive organs such as the proventriculus and pancreas.

The results of the present study were in disagreement with Baurhoo *et al.* (2007) ^[3] they reported that supplementation of Alcell lignin at different levels in broilers showed no significant difference in feed conversion ratio compared to control group.

There was no significant difference ($p > 0.05$) in survivability of the birds supplemented with modified lignin in comparison to control from first week to till the end of the experiment.

The results of the present study were in agreement with Makivic *et al.* (2019) ^[10] who observed no significant difference in mortality in broilers fed diet with different levels of lignocellulose compared to those on a control diet.

Conclusion

Based on the results, it was concluded that the addition of 0.2 and 0.3% modified lignin to the basal diet improved growth performance in broilers. However, the supplementation of 0.2 and 0.3% modified lignin in reformulated diet showed similar results like that of control diet. Hence, it was concluded that supplementing 0.2% modified lignin in both control and reformulated diets (2% reduction in ME and CP) was beneficial in improving growth performance.

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