

Impact of Dietary Inclusion of Rice Distillers Dried Grains with Solubles (DDGS) on Hematological Parameters of Commercial Broiler Chicks

Abstract

An experiment was conducted to evaluate the impact of dietary inclusion of rice-derived distillers dried grains with solubles (DDGS) on the hematological parameters of commercial broiler chicks. A total of 2250 day-old broiler chicks were randomly assigned to treatment groups, each with five replicates. The birds in the control group were fed a basal diet fulfilled with the all nutrient requirements. The experimental diets contained rice DDGS at inclusion levels up to 16 per cent, respectively. At the end of the experiment, blood samples were collected from one bird per replicate for hematological analysis. The results showed significant differences ($P < 0.05$) in red blood cell (RBC) count, packed cell volume (PCV) and hemoglobin levels between the control and DDGS-treated groups, although the numerical differences were minimal. Non-significant differences ($P > 0.05$) in white blood cell (WBC) count and differential leukocyte counts between the control and DDGS-treated groups were observed. These findings revealed that the inclusion of rice DDGS up to 16% in broiler diets does not negatively affect key hematological indices. It was concluded that rice DDGS can be incorporated into broiler diets at inclusion levels up to 16% without adverse effects on hematological parameters.

Introduction

Poultry production is one of the fastest-growing sectors of the agricultural industry worldwide, driven by increasing consumer demand for poultry meat as a primary source of protein (Mottet and Tempio, 2017). Ethanol production in India is primarily derived from the starch content of cereal grains, including bajra, barley, corn, rice, sorghum, triticale, and wheat, utilizing either wet or dry processing methods. While a variety of cereal grains are employed, corn and rice serve as the predominant substrates for ethanol production. Secondary grains such as wheat, barley, and sorghum (milo) are also utilized to a lesser extent. The Distillers Dried Grains with Solubles (DDGS) available in India include DDGS derived from barley, bajra, corn, rice, sorghum, and wheat. Among these, rice-based DDGS is the most abundant and widely available. The protein content of DDGS varies depending on the source grain, with corn-based DDGS containing approximately 29-30% protein, rice-

based DDGS exhibiting a range of 38-53%, and sorghum-based DDGS providing 26-27% protein (Nutrinomics, Advanced Bio-Agro Tech Limited, Pune, 2013). Such byproduct can be defined as a product obtained after ethanol extraction by distillation from the yeast fermentation, and drying at 75% of the resultant. Including DDGS in poultry diets to replace part of yellow corn and soybean meal have shown positive results in terms of growth performance (Alshelmaniet al., 2021). Diet and nutritional regimen are critical determinants influencing hematological profiles and serum biochemical parameters in animals. These parameters serve as sensitive indicators of health status and provide insights into the intensity and efficiency of metabolic processes occurring within the organism (Andrews et al., 2006, Roy et al., 2013, Vazquez et al., 2008). Serum biochemical parameters are reliable indicators of the physiological, nutritional, and pathological status of animals and birds. These parameters can be effectively correlated to assess the influence of dietary nutritional factors and additives on the overall health and metabolic processes of the organism (Toghyaniet al., 2010, Kairalla et al., 2022a, 2022b, 2023). Dietary modifications in broiler chickens are anticipated to elicit distinct effects on their hematological profiles and serum biochemical parameters. In this context, rice distillers dried grains with solubles (rDDGS), a by-product of rice processing industries, represent a potentially cost-effective feed ingredient for poultry diets. India is one of the largest producers of rice in the world producing approximately 105 million tons of rice in 2015-16 (Govt. of India, Ministry of Agriculture & Farmers Welfare., 2016). Rice distillers dried grains with solubles (rDDGS), a by-product of rice ethanol production, have emerged as a cost-effective and nutritionally valuable alternative feed ingredient for poultry diets. Rich in protein, fiber, and energy, rDDGS provide an opportunity to reduce feed costs while maintaining or enhancing poultry health and productivity (Widyaratne and Zijlstra, 2007). However, the inclusion of rDDGS in poultry rations can lead to differential effects on physiological and biochemical parameters, necessitating a comprehensive evaluation of its impact on broiler chickens. This experiment aimed to assess the impact of dietary inclusion of rDDGS on the hematological parameters of commercial broiler chicks. Understanding these effects is crucial for determining the optimal use of rDDGS in broiler diets to ensure the health and productivity of the birds while supporting sustainable poultry production.

Materials and Methods

Experimental Design and Management

The experiment was conducted on 2250 (Vencobb-400) commercial day-old chicks in deep litter system for six weeks. Chicks were randomly distributed in 9 dietary treatments and the chicks of each treatment were sub-divided into 5 groups to serve as replicates. The chicks were reared in 45 pens comprising 50 chicks in each. The birds in control group (T₀) were offered basal diet, adequate in all nutrients as per BIS (2007) during pre-starter, starter and finisher phases. Treatment combinations of Rice DDGS, lysine, methionine and enzymes are showed in Table 1.

Table 1. Treatment Combinations for pre- starter, starter and finisher feed

Treatment	Soybean meal (%)			Rice DDGS (%)	Lysine (%)	Methionine (%)	Phytase (%)	NSP Enzymes (%)
	Pre-starter	Starter	Finisher					
T ₀	37	32	27	00	0.00	0.00	0.00	0.00
T ₁	34.1	29.10	24.1	2	0.40	0.40	0.04	0.06
T ₂	31.98	26.98	21.98	4	0.45	0.45	0.05	0.07
T ₃	29.86	24.86	19.86	6	0.50	0.50	0.06	0.08
T ₄	27.74	22.74	17.74	8	0.55	0.55	0.07	0.09
T ₅	25.62	20.62	15.62	10	0.60	0.60	0.08	0.10
T ₆	23.5	18.5	13.5	12	0.65	0.65	0.09	0.11
T ₇	21.38	16.38	11.38	14	0.70	0.70	0.10	0.12
T ₈	19.26	14.26	9.26	16	0.75	0.75	0.11	0.13

(* Yellow maize 58, 63 and 67%, Soybean oil 1, 1 and 2% and premix (vitamins and minerals) 4% was constant in all treatments during pre- starter, starter and finisher phase respectively.)

Estimation of hematological parameters

At the end of the experiment, blood samples were collected from one bird per replicate for hematological analyses. Hematological samples were drawn into tubes containing Ethylene Diaminetetraacetic Acid (EDTA) as an anticoagulant. Packed Cell Volume (PCV) determination using capillary tubes and a microhematocrit centrifuge, with PCV measurements taken after centrifugation for 12 minutes. Hemoglobin (Hb) concentration

were determined according to **Henry *et al.* (1974)**. White blood cell (WBC) counts were performed as described by **Campbell (1995)**. Red blood cell (RBC) count was measured according to **Daice and Lewis (1991)**. The differential leukocyte count, including lymphocytes, monocytes, and neutrophils, was conducted using blood smears and staining techniques as described by **Schalm *et al.* (1975)**.

Statistical analysis

The data were analysed statistically using Analysis of variance (ANOVA) techniques per **Snedecar and Cochran (2004)**.

Results and Discussion

The hematological parameters of broiler chicks were influenced by various treatments of rice DDGS, essential amino acids, and enzyme supplementation, as shown in Table 2, revealed that significant differences ($P < 0.05$) were found in different treatments pertaining to RBC, hemoglobin and PCV whereas WBC, absolute neutrophil count, lymphocytes count and monocyte count showed non-significant differences.

From the perusal of data on WBC and RBC count of broiler chicks contained in Table 2, it was concluded that a non-significant difference ($P > 0.05$) was observed in the values of WBC count of broiler chicks at the inclusion of up to 16 percent rice DDGS in the diet. Similarly, **Ghazalah *et al.* (2011)** reported that there was no significant difference between the treatments of 0, 25, 50 and 75 percent DDGS of soybean meal in the layer diet. Also result revealed that red blood cell of broiler chicks were found significant. However numerically no much difference was found in the values of RBC count by fed DDGS up to 16 percent in broiler chick's diet. **Ghaly, (2017)** reported that at the levels of 5, 10 and 15 percent of DDGS in the broiler diet, no significant difference was observed between the values of WBC and RBC count. **Hristakieva *et al.*, (2023)** reported that broilers fed with 15% DDGS showed the highest ($P < 0.05$) values of RBC count as compared to other treatments.

The result pertaining to the hemoglobin level and packed cell volume of broiler chicks showed in Table 2, it was observed that significant differences were observed between the values of hemoglobin and packed cell volume. However, differences among the values are in normal range and there is minimal disparity between the rice DDGS treatments and the control group. **Ghaly, (2017)** reported that the lowest hemoglobin level ($p < 0.05$) were observed in broilers fed the control diet and the 10% DDGS diet, respectively, compared to

other DDGS inclusion levels. Conversely, broilers fed a diet containing 15% DDGS exhibited the highest hemoglobin level ($p < 0.05$) among all treatment groups. Whereas **Gupta et al., (2017)** reported that inclusion of rDDGS at levels exceeding 5% significantly ($P < 0.05$) increased the packed cell volume (PCV) and hemoglobin (Hb) concentrations in broiler chickens compared to those fed the control diet. Increased hemoglobin concentration may be due to higher oxygen consumption associated with more hemoglobin saturation and dissociation rates (**Yahav et al., 1998, Ghaly, 2017**).

Table 2 Hematological parameters of chicks influenced by different treatments of rice DDGS

Treatments	Hematological parameters						
	WBC m/ μ l	RBC m/ μ l	HB g/dl	PCV %	Neutrophil %	Lymphocyte %	Monocyte %
T ₀	291.6	2.37	13.2	30.28	41	57.6	3
T ₁	212.06	2.21	11.88	26.46	36.4	64	2.4
T ₂	256.6	2.08	12.02	26.96	35.2	59.4	4.4
T ₃	309.4	2.33	13.04	29.66	32.2	65.2	3.8
T ₄	262.4	2.05	12.32	26.86	34.2	60.8	4.4
T ₅	229.4	1.93	11.16	24.52	35	65.8	4
T ₆	271	2.11	11.62	26.24	30.6	64.4	5.2
T ₇	274.2	2.23	11.66	26.84	32	62.2	4.6
T ₈	271.8	2.27	12.24	26.62	32.2	61.8	4.6
Mean	264.27	2.17	12.12	27.16	34.31	62.35	4.04
Results	NS*	S**	S**	S**	NS*	NS*	NS*

*= Non-significant

**= Significant

From the perusal of data on neutrophil count, lymphocyte count and monocyte count of broiler chicks contained in Table 2, it was observed that non-significant differences in the values of neutrophil, lymphocyte and monocyte count of the broiler chicks at the inclusion of rice DDGS up to 16 percent in diet were found. Similarly, **Ghazalah et al., (2011)** reported that non-significant differences were observed in the values of neutrophil count at inclusion 0, 25, 50 and 75 percent of DDGS in broiler diet. **Roperet et al., (2019)** observed that non-significant difference on lymphocyte count and monocyte count of broiler. However, **Huanget al., (2012)** reported that male broilers may experience a reduction in lymphocyte-mediated immune responses, potentially influenced by male-biased suppression mechanisms.

Incorporating 24% DDGS into their diet could help to improve these immune responses by counteracting this suppression.

Conclusion

The findings of the present experiment indicate that the inclusion of rice DDGS up to 16% in broiler diets had no adverse effects on hematological parameters, including WBC count, RBC count, hemoglobin level, Packed cell volume percentage and differential leukocyte counts. The results revealed that rice DDGS inclusion up to 16% in broiler diets does not negatively impact on hematological parameters. It may be safely incorporated as a feed ingredient in broiler diet without compromising the health of the birds. Additionally, the inclusion of rice DDGS in the diet resulted in no significant changes in immune cell distribution, further supporting its potential as a sustainable protein source. Therefore, it may be concluded that broiler diets can incorporate rice DDGS at inclusion levels of up to 16% without any detrimental effects on hematological indices and it may serve as an effective alternative to soybean meal as a protein source in poultry nutrition.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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