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 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 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 extractionby distillation from the yeast fermentation, and drying at 75% of the resultant [8].Including DDGS in poultry diets to replace part of yellow corn and soybean mealhave shown positive results in terms of growth performance**(Alshelmani et 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 *etal.,* 2013**~~and~~**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**(Toghyani*et 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, Ministryof 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 aims 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 9dietary 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 (T_0) 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 andfinisher 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 were 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 one-way Analysis of variance (ANOVA) techniqueas per **Snedecar and Cochran (2004).**

Comment [MA1]: Since you used the one-way ANOVA, you have to use Tukey's test or Duncan test to compare the significance among the treatments. You need to add superscripts for comparison.

Results and Discussion

Comment [MA2]: If you used Tukey's test after ANOVA, you can explain which treatment was better the others!

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 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 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 *et al.*, (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<0.01) values of RBC ~~(total red blood cells)~~ 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*et al.*, (2017)** reported that he 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<0.01) among all treatment groupsWhereas**Gupta*et al.*, (2017)** reported thatinclusion of rDDGS at levels exceeding 5% significantly (P<0.01) 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).**

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

Comment [MA3]: Since you used the one-way ANOVA, you have to use Tukey's test or Duncan test to compare the significance among the treatments. You need to add superscripts for comparison.

Treatments	Hematological parameters						
	WBC m/µl	RBC m/µl	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~~ P-value	P>0.05 ~~NS~~*	~~S~~**P< 0.05	P<0.05 ~~S~~**	P<0.05 ~~S~~**	P>0.05~~NS~~*	P>0.05~~NS~~*	P>0.05~~NS~~*

Comment [MA4]: Better to add P- value for each one!

***= 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 thatnon-significant differences were observed in the values of neutrophil count at inclusion 0, 25, 50 and 75 percent of DDGS in broiler diet. **Roper*et al.*, (2019)** observed that non-significant difference on lymphocyte count and monocyte count of broiler.However, **Huang*et al.*,(2012)** reported thatmale 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 sources in poultry nutrition.

References

Alshelmani, M. I., Abdalla, E. A., Kaka, U., &Basit, M. A. (2021).Nontraditional feedstuffs as an alternative in poultry feed. In *Advances in poultry nutrition research*.IntechOpen.

- **Andrews J, Vazquez-Anon M, and Bowman G. (2006).** Fat stability and preservation of fatty acids with AGRADO antioxidant in feed ingredients used in ruminant rations. *Journal of Dairy Science*, 89:60-69.
- **Campbell, T. W., (1995).** Avian hematology and cytology (2nd). Iowa state university press, Ames, pp:104.
- **Daice, S. J.; and Lewis, S. M., (1991).** Practical Hematology, 7th ED. Churchill Livingstone.
- **Ghaly, K. (2017).**Effects of using ddgs and avizyme enzyme in the broiler diets on some physiological responses. *Egyptian Poultry Science Journal*, *37*(2): 363-677.
- **Ghazalah, A. A., Abd-Elsamee, M. O., & Moustafa, E. S. (2011).** Use of distillers dried grains with solubles (DDGS) as replacement for soybean meal in laying hen diets. *Int. J. Poult. Sci*, *10*(7): 505-513.
- **Govt. of India, Ministry of Agriculture & Farmers Welfare. (2016).** Area, production and yield of principal crops. In: Agricultural Statistics at a glance 2016. *Govt. of India Controller of Publication*. pp. 87-88.
- **Gupta, S. L., Tyagi, P. K., Tyagi, P. K., Mandal, A., Dinani, O., & Rokade, J. (2017).** Feeding effect of rice based dry distillers grains with soluble on hemato-biochemical and egg sensory attributes during 45th to 54th week of laying. *Int J Pure ApplBiosci*, *5*(6): 1521-7.

- **Henry, R., D. Cannon and J. Winkelman, (1974).** Clinical chemist principles and techniques, 2nd Edn., Haper and Row.
- **Hristakieva, P., Mincheva, N., Ivanova, I., Oblakova, M., Ivanov, N., & Slavov, I. (2023).** Use of Distiller´ s Dried Grains with Solubles (DDGS) from corn or wheat in broiler diets. *Bulgarian Journal of Animal Husbandry/ŽivotnovDniNauki*, *60*(5).
- **Huang PoChi, H. P., Yu Chi, Y. C., Chen ChingYi, C. C., Chen BaoJi, C. B., & Lee DerNan, L. D. (2012).** Effect of dietary inclusion of distillers dried grains with solubles on the immune responses of broilers with different genders.Pp 141-154.
- Kairalla, M. A., Alshelmani, M. I., &Aburas, A. A. (2022a). Effect of diet supplemented with graded levels of garlic (Allium sativum L.) powder on growth performance, carcass characteristics, blood hematology, and biochemistry of broilers. *Open Veterinary Journal*, *12*(5), 595-601.
- Kairalla, M. A., Aburas, A. A., & Alshelmani, M. I. (2022b). Effect of diet supplemented with graded levels of ginger (Zingiberofficinale) powder on growth performance, hematological parameters, and serum lipids of broiler chickens. *Archives of Razi Institute*, *77*(6), 2089-2095.

Kairalla, M. A., Alshelmani, M. I., &Imdakim, M. M. (2023). Effect of diet supplemented with different levels of moringa powder on growth performance, carcass characteristics, meat quality, hematological parameters, serum lipids, and economic efficiency of broiler chickens. *Archives of Razi Institute*, *78*(5), 1647.

- **Mottet, A., & Tempio, G. (2017).** Global poultry production: Current state and future outlook. *Animal Production Science*, 57(12): 2253–2264.
- **Nutrinomics, Advanced Bio-Agro Tech Limited, Pune, (2013).** abtlenzymes.com/knowledge-centre/nutrinomics.
- **Roper, J. M., Smith, B. L., Caverly Rae, J. M., Huang, E., Walker, C. A., McNaughton, J. L., ... & Reidinger, K. S. (2019).** Nutrient composition and safety evaluation of simulated isobutanol distillers dried grains with solubles and associated fermentation metabolites when fed to male Ross 708 broiler chickens (Gallus domesticus). *Plos one*, *14*(7), e0219016.
- **Roy A, Mandal G, and Patra A. (2013).** Evaluating the performance, carcass traits and conjugated linoleic acid content in muscle and adipose tissues of black Bengal

goats fed soybean oil and sunflower oil. *Animal Feed Science and Technology*, 185:43-52.

- **Schalm, O. W., Jain, N. C., & Carroll, E. J. (1975).***Veterinary Hematology* (3rd ed.). Lea &Febiger.
- **Snedecor, G. W., & Cochran, W. G. (2004).***Statistical methods* (8th ed.). Iowa State University Press.
- **Toghyani M, Tohidi M, Gheisari A.A, Tabeidian SA (2010).** Performance, immunity, serum biochemical and hematological parameters in broiler chicks fed dietary thyme as alternative for an antibiotic growth promoter. *African Journal of Biotechnology*, 9(40): 6819-6825.
- **Vazquez-Anon M, Nocek J, Bowman G, Hampton T, Atwell C, Vazquez P, and Jenkins T. (2008).** Effects of feeding a dietary antioxidant in diets with oxidized fat on lactation performance and antioxidant status of the cow. *Journal of Dairy Science*, 91: 3165-3172
- **Widyaratne, G. P., & Zijlstra, R. T. (2007).** Nutritional value of distillers dried grains with solubles (DDGS) for livestock and poultry. *Animal Feed Science and Technology*, 137(3-4): 265–279.
- **Yadav S. D. Lugar, A. Cahaner, M. Dotan, M. Ruzan and S. Hurwitz (1998)** Thermoregulation in necked neck chicken subjectef to diffrent ambient temptature. Br. Poult. sci., 39: 133-138.