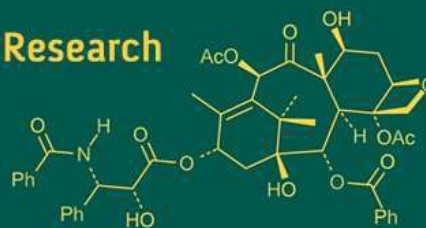


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Effect of feeding rice distillers dried grains with solubles with or without enzymes on gut health in broilers

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Abstract

A biological experiment was conducted at the Department of Poultry Science, Veterinary College, Hebbal, Bengaluru, to evaluate the effect of dietary inclusion of rice distillers dried grains with solubles (DDGS) with or without enzyme supplementation on the growth performance of broilers over a six-week period. A total of 240 day-old Cobb broiler chicks were distributed into eight dietary treatment groups with three replicates of ten birds each. Diets were formulated as per BIS (2007) [3] standards to be iso-caloric and iso-nitrogenous, with rice DDGS incorporated at 2.5, 5, and 7.5% levels, with or without 0.02% enzyme supplementation, while the control group received a basal diet. Results indicated no significant differences ($P > 0.05$) among treatment groups with respect to gut histomorphometry and gut microbial load. It was concluded that rice DDGS can be included up to 7.5% with or without enzyme supplementation in broiler diets without any adverse effects on gut health.

Keywords: DDGS, enzymes, gut histomorphometry, gut microbial load

Introduction

India now produces 10.25 million tonnes of meat annually, nearly half of which (48.96%) is contributed by poultry (BAHS, 2024) [2]. The country also ranks second in global egg production and fifth in total meat output, growth that is largely driven by advances in intensive poultry farming, including improved genetics, feed innovations, and scientific management. This development is further supported by rising consumer demand, population pressure, the affordability and nutritional benefits of poultry meat, and minimal religious restrictions on its consumption.

Feed represents the single largest input cost in poultry production, but the steady rise in the prices of maize, soybean meal, di-calcium phosphate, fats, and vitamins has created challenges in sustaining profitability (Dale, 2009) [5]. To address this, researchers have focused on identifying cost-effective, locally available, and nutritionally comparable alternative feed resources. Unconventional ingredients can partially replace conventional ones, thereby lowering costs, provided they are safe, nutritionally adequate, and economically viable. A major source of such alternatives comes from the biofuel and distillery industries, which produce millions of tons of fermentation by-products annually. One of the most widely available is distillers dried grains with solubles (DDGS), generated during the production of ethanol from cereals like maize, sorghum, wheat, and rice.

Rice production in India reached 1,378.25 lakh tonnes in 2023-24, providing significant potential for rice by-products to be utilized in livestock feed (Ministry of Agriculture & Farmers Welfare, 2024). Broken rice and deoiled rice bran are already in use as fillers, while damaged or substandard rice is diverted to alcohol production. The resulting by-product, rice DDGS, is increasingly incorporated into poultry diets. India's ethanol blending program, which aims to achieve 30% blending in petroleum products by 2030 (AFVP, 2025), will further enhance the availability of rice DDGS.

Rice DDGS nutrient composition makes it a valuable feed ingredient, with protein levels ranging between 38-53% in rice-based DDGS (Nutrinomics, 2013) [10]. Typically, rice-DDGS contains around 45% protein, 3500 kcal/kg metabolizable energy, 6.71% crude fiber, and 7.93% crude fat (Talsani *et al.*, 2021) [15]. The ethanol fermentation process reduces starch and concentrates nutrients, while also incorporating yeast residue (Babcock *et al.*,

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2008)^[1]. Although its lysine content (0.64-1.23%) is lower than that of soybean meal (2.99-3.22%), other amino acids are present in satisfactory amounts. Additionally, it is a good source of linoleic acid and xanthophylls (Runnels, 1957)^[13], lacks anti-nutritional factors, and is generally more economical than soybean-based DDGS. Overall, rice DDGS represents a promising unconventional protein and energy source for poultry diets in India, offering both nutritional value and cost-effectiveness in an industry facing rising feed costs and growing demand.

Materials and Methods

A total of 240 day-old broiler chicks procured from Venkateshwara Hatcheries Pvt. Ltd., Andhra Pradesh, were weighed, wing-banded, and randomly allotted to eight dietary treatment groups in a completely randomized design, each with three replicates of ten chicks. Rice DDGS was obtained from Higain Feeds & Farms Pvt. Ltd., Mandya, while the enzyme mixture Vetzomix® was procured from Bionnar Healthcare Pvt. Ltd., Vijayawada. The chicks were reared under a deep litter system with ad libitum feed and water, following standard managemental practices. Experimental diets comprising pre-starter, starter, and finisher rations were formulated as per BIS (2007)^[3] standards. The control group T1 will be fed with basal diet and the treatment group T2 will be fed with basal diet with enzymes (0.02%). The treatment group T3 will be fed with 2.5% rice DDGS in basal diet. The treatment group T4 will be fed with 2.5% rice DDGS with enzymes (0.02%) in basal diet. The treatment group T5 will be fed with 5% rice DDGS in basal diet. The treatment group T6 will be fed with 5% rice DDGS with enzymes (0.02%) in basal diet. The treatment group T7 will be fed with 7.5% rice DDGS in basal diet. The treatment group T8 will be fed with 7.5% rice DDGS with enzymes (0.02%) in basal diet.

Gut histomorphometry

At the end of the experiment, two birds per each replicate from treatments T1 to T8 were slaughtered, and Tissue samples from the duodenum, jejunum, and ileocaecocolic junction were collected, rinsed in buffered saline, and fixed in 10% neutral buffered formalin on the 42nd day of experiment. The histological slides of cross-sections were prepared by microtome and stained with hematoxyline and eosine for examination. The examination of the stained histological slides was done by optical microscope at 10X magnification for gut histomorphometry (Culling 1974)^[4].

Gut microbial load

At the end of the experiment, two birds per each replicate from treatments T1 to T8 were slaughtered, and small intestinal contents were collected aseptically for microbial analysis, *Escherichia coli* was enumerated on MacConkey agar, and *Lactobacillus* spp. on brain heart infusion agar

using the spread and pour plate methods, respectively (Postgate, 1969; Mackie and McCartney, 1996)^[11]^[9]. Ten-fold serial dilutions were performed, and results were expressed as log CFU/g of intestinal content (Weir, 1990)^[16].

Statistical analysis

The experiment was set up as a completely randomized design (CRD) with one-way analysis. All data linked to the various aspects of the biological trial were analysed using the usual protocols provided by Snedecor and Cochran (1989)^[14] and SPSS 30 statistical software. Tukey's Range Test was used to determine mean differences with a significance level of $p < 0.05$.

Results and Discussion

The results of the study revealed no significant differences ($P > 0.05$) in the gut histomorphometry and gut microbial load of the birds fed with different inclusion levels of rice DDGS with or without enzymes compared to the control group at the end of the experiment. The results of the effect of feeding rice DDGS with or without enzymes on gut histomorphometry and gut microbial load in broilers are presented in Table 1 and Table 2, respectively. The results of the present study are in agreement with Loar *et al.* (2010)^[8], Ranjan *et al.* (2017)^[12], Dinani *et al.* (2020)^[6] and disagreement with Youssef *et al.* (2013)^[17] and Gupta *et al.* (2016)^[7].

Loar *et al.* (2010)^[8] found that feeding DDGS to broilers did not significantly affect cecal *E. coli* or *Clostridium perfringens* counts, though a slight increasing trend of *C. perfringens* was noted at higher levels. Overall, moderate DDGS levels (7.5-15%) were safe for gut health, but higher inclusion could pose risks by slightly increasing microbial load. Ranjan *et al.* (2017)^[12] reported that no significant ($P > 0.05$) difference in villus length and crypt depth in duodenum, jejunum and ileum in duck fed various levels of rice DDGS up to 75% replacement of soybean meal. Dinani *et al.* (2020)^[6] found that including rice DDGS at levels up to 15% in broiler diets did not negatively affect gut health. Cecal microbial balance was maintained, with no significant rise in harmful bacteria. Intestinal morphology, such as villus height and crypt depth, also remained unaffected at these inclusion levels.

Youssef *et al.* (2013)^[17] reported that 10% DDGS improved villus height, crypt depth, and villus height to crypt depth ratio in broilers, supporting better gut morphology. However, higher inclusion levels (15-20%) led to villus shortening, epithelial damage, and increased goblet cells, indicating compromised intestinal health. Gupta *et al.* (2016)^[7] found that rice DDGS at 10% increased villus height and improved the villus height/crypt depth ratio, while higher levels (7.5-10%) also showed reduced crypt depth. Enzyme supplementation further enhanced villus morphology and supported better gut health.

Table 1: Effect of feeding rice DDGS with or without enzymes on intestinal villi height and crypt depth (µm) (Mean ± SE) in broilers

Experimental group	Duodenal villi height	Duodenal crypt depth	Jejunal villi height	Jejunal crypt depth	Ileum villi height	Ileum crypt depth
T1	1174.57 ± 13.94	173.14 ± 11.12	913.71 ± 14.48	168.86 ± 12.64	680.28 ± 7.91	151.57 ± 9.81
T2	1175.00 ± 10.29	160.67 ± 4.92	915.00 ± 10.30	155.17 ± 16.53	677.17 ± 10.28	161.00 ± 12.36
T3	1217.33 ± 8.10	185.67 ± 12.89	913.00 ± 6.04	175.67 ± 12.89	710.83 ± 8.10	166.67 ± 12.89
T4	1221.33 ± 8.37	191.33 ± 11.39	930.17 ± 16.22	181.33 ± 11.39	704.33 ± 8.21	168.67 ± 9.98
T5	1197.67 ± 18.33	170.17 ± 7.89	935.67 ± 10.22	203.00 ± 5.59	680.67 ± 11.91	153.83 ± 10.56
T6	1186.83 ± 8.10	184.17 ± 13.34	926.83 ± 8.10	174.67 ± 13.34	679.83 ± 8.10	165.17 ± 13.34
T7	1167.60 ± 24.36	176.40 ± 9.51	913.20 ± 9.82	189.80 ± 12.44	680.20 ± 6.58	150.40 ± 8.80
T8	1195.33 ± 15.78	169.67 ± 11.70	911.50 ± 10.38	173.67 ± 11.55	709.17 ± 7.61	169.33 ± 13.23

Table 2: Effect of feeding rice DDGS with or without enzymes on gut microbial load ($\log_{10}$ CFU/g) (Mean $\pm$ SE) in broilers

Experimental group	<i>E. coli</i>	<i>Lactobacillus</i> spp.
T1	7.09 $\pm$ 0.042	6.68 $\pm$ 0.049
T2	6.70 $\pm$ 0.026	6.69 $\pm$ 0.048
T3	7.04 $\pm$ 0.047	6.67 $\pm$ 0.060
T4	6.78 $\pm$ 0.016	6.90 $\pm$ 0.035
T5	7.09 $\pm$ 0.042	6.63 $\pm$ 0.076
T6	7.09 $\pm$ 0.042	6.80 $\pm$ 0.080
T7	7.10 $\pm$ 0.046	6.65 $\pm$ 0.079
T8	6.95 $\pm$ 0.056	7.04 $\pm$ 0.077

Conclusion

Thus, it can be concluded that inclusion of rice DDGS up to 7.5%, with or without 0.02% enzyme supplementation in the diet, had no negative impact on gut histomorphometry and gut microbial load in broilers when compared to the control group. Hence, the incorporation of rice DDGS up to 7.5% in broiler diets, with or without enzyme supplementation, can be recommended without any adverse effects.

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