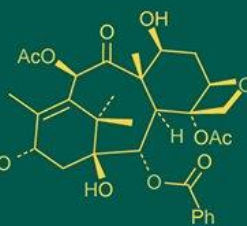
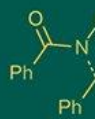


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Effect of feeding Corn Distillers Dried Grains with Solubles (CDDGS) on the growth performance & serum biochemical parameters of broiler chicken

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Abstract

An experiment was conducted to evaluate the effects of feeding corn distillers dried grains with solubles (cDDGS) on the performance of broiler chicken. A total of 300day old Cobb 430Y broiler chicks were randomly assigned to six dietary treatments, each with 10 replicates of five birds. Treatments included a corn-soybean meal based control diet and diets containing 0, 10 and 20% corn DDGS, with or without multi enzymes supplementation (xylanase 20 g/tonne, acid protease 50 g/tonne, phytase 35 g/tonne, and mannanase 50 g/tonne). Birds were reared under uniform management conditions from 1-42 days, with feed and water provided *ad libitum*. Results showed that cumulative body weight gain was significantly affected ($p < 0.05$) only during 1-7 and 1-28 days and highest body weight gain was observed in the control diet supplemented with multi enzymes (2532.40 g). Cumulative feed intake and FCR were significantly influenced ($p < 0.05$) by treatments, with the best FCR recorded in the multienzymes supplemented Control group (1.485). Mortality remained within acceptable limits. Immune parameters and serum albumin and cholesterol were not significantly influenced, whereas serum glucose and total protein showed significant changes in multi enzyme supplemented 10 and 20% DDGS groups. In conclusion, corn DDGS can be included in broiler diets up to 20% with multi enzymes supplementation without adverse effects on growth and serum biochemical parameters.

Keywords: Corn DDGS, Multienzymes, growth, feed conversion ratio

Introduction

The poultry sector is one of the fastest growing segments of Indian agriculture, contributing significantly to the country's food security and rural economy. However, the continued expansion of the poultry industry is challenged by the rising cost and limited availability of conventional feed ingredients, particularly maize and soybean meal, which constitute the major energy and protein sources in poultry diets.

In this context, agro-industrial by-products such as distillers dried grains with solubles (DDGS) have gained attention as potential substitutes for conventional feed ingredients. Corn distillers dried grains with solubles (cDDGS), a by-product of the ethanol industry obtained after fermentation of corn starch, has emerged as a promising feed ingredient due to the rapid growth of global ethanol production (Ray and Ramachandran, 2018). Corn DDGS is rich in protein, energy, and phosphorus, and typically contains about 29-30% crude protein, metabolizable energy of 2400-2800 kcal/kg, and appreciable levels of essential amino acids, although its nutrient composition may vary depending on processing conditions (Kim *et al.*, 2010) [13].

Previous studies have demonstrated that cDDGS can partially replace maize and soybean meal in broiler diets without adversely affecting growth performance, feed conversion ratio, or carcass characteristics when included at appropriate levels (Swiatkiewicz and Koreleski, 2007; Thacker and Widyaratne, 2007; Swiatkiewicz and Koreleski, 2008) [7, 19, 8]. The use of exogenous enzymes such as xylanase, phytase, and mannanase has also been reported to improve nutrient utilization of DDGS-based diets by degrading non-starch polysaccharides and reducing the anti-nutritional effects of fibre, thereby enhancing performance in monogastric animals.

Despite this growth, location-specific data on the nutrient composition, metabolizable energy, amino acid availability, and safe inclusion levels of corn DDGS in broiler diets remain limited under Indian conditions. Therefore, the present study was undertaken to evaluate the effect of dietary inclusion of corn DDGS, with or without enzyme supplementation, on growth performance and feed efficiency in broiler chickens.

Materials and Methods

Three hundred (300) day old broiler chicks were randomly allocated to five dietary treatment groups with twelve (12) replicates of five (5) birds each and all the experimental groups were reared under uniform managemental conditions. The birds were vaccinated against RD with a live vaccine of La Sota on 7th and 28th day and against IBD on 14th and 21st day of the experiment. Corn and Soyabean meal based basal diet was formulated for birds to meet the BIS 2007 nutrient requirements during pre-starter, starter and finisher phases. T₁ includes Control diet (CD) consisted of maize and soyabean meal and T₂ comprised the Control diet supplemented with multi enzymes (xylanase @ 20 g/metric tonne; acid protease 50 g/metric tonne; phytase @ 35 g/metric tonne; and mannanase 50 g/metric tonne); T₃ includes 10% corn DDGS; while T₄ included the diet with 10% corn DDGS supplemented with multi enzymes (xylanase @ 20 g/metric tonne; acid protease 50 g/metric tonne; phytase @ 35 g/metric tonne; and mannanase 50 g/metric tonne); T₅ consisted of a diet containing 20% corn DDGS, and T₆ received the diet with 20% corn DDGS supplemented with multi enzymes (xylanase @ 20 g/metric tonne; acid protease 50 g/metric tonne; phytase @ 35 g/metric tonne; and mannanase 50 g/metric tonne). Broiler pre starter, starter and finisher diets of crude protein were 22%, 20.5% and 19%, whereas Metabolizable energy of 3000 kcal/kg, 3125 kcal/kg and 3200 kcal/kg diet respectively.

Procurement of Ingredients and Feed Formulation

The corn DDGS was procured from Jurala Organic Farms, Gadwal District, Telangana State. The chemical analysis of corn DDGS was carried out and presented in Table.1 and the Metabolizable energy obtained of 2946 kcal/kg. All the diets were isocaloric and iso-nitrogenous. Various levels of

cDDGS were included with partial replacement of soybean meal and energy sources in different dietary treatments. The ingredients and nutrient composition of dietary treatments have been prepared in Table 2.

Table 1: Chemical analysis of Corn DDGS (cDDGS)

S. No	Nutrient	Percent (%)
1	Moisture	13.28
2	Crude protein	36
3	Crude fat	11.33
4	Total ash	5.54
5	Nitrogen Free Extract	34.51
6	Crude fiber	10.20
7	Calcium	0.2
8	Available Phosphorus	0.65

Performance parameters

The data of body weight was recorded on a weekly basis, while the cumulative feed consumption of each replicate was recorded at weekly intervals up to 6 weeks of age. Mortality was recorded throughout experimental period for calculating the percent of livability. The feed conversion ratio (FCR) was calculated (feed intake/body weight gain) considering mortality, to maintain accuracy in the data collection by weighing back the feed on the day of mortality in that group.

Serum Biochemical Parameters

On the 35th day, blood samples were collected from six birds per treatment group into clean, sterilized tubes and left at room temperature in a slanted position to allow serum separation. The samples were then centrifuged at 3,000 rpm for 20 minutes to separate the serum, which was subsequently transferred to labelled 5 ml Eppendorf tubes and stored at -20 °C until analysis. Total Protein, Serum albumin, total cholesterol, and serum glucose were spectrophotometrically assessed by using commercial kits in the laboratory.

Statistical Analysis

Comparison of means was done using Duncan's multiple range test (Duncan) and significance was considered at $p < 0.05$.

Table 2: Ingredient and nutrient composition of various rations containing cDDGS at different levels for commercial broiler.

Ingredient	Pre starter						Starter						Finisher					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Maize	55.2	55.2	53.3	53.3	51.3	51.3	56.9	56.9	55.1	55.1	53.2	53.2	60.6	60.6	58.8	58.8	56.9	56.9
Oil	3.6	3.6	3.1	3.1	2.7	2.7	5.3	5.3	4.8	4.8	4.4	4.4	5.81	5.81	5.3	5.3	4.87	4.87
SBM	36.5	36.5	28.6	28.6	20.7	20.7	33.1	33.1	25.2	25.2	17.3	17.3	29.1	29.1	21.2	21.2	13.4	13.4
Corn DDGS	0	0	10	10	20	20	0	0	10	10	20	20	0	0	10	10	20	20
DCP	1.9	1.9	1.87	1.87	1.85	1.85	1.75	1.75	1.73	1.73	1.71	1.71	1.67	1.67	1.65	1.65	1.63	1.63
LSP	1.45	1.45	1.47	1.47	1.5	1.5	1.52	1.52	1.54	1.54	1.57	1.57	1.38	1.38	1.40	1.40	1.42	1.42
Salt	0.37	0.37	0.37	0.37	0.27	0.27	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
DL- Methionine	0.27	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.22	0.22	0.21	0.21	0.21	0.21	0.20	0.20	0.18	0.18
L Lysine	0.21	0.21	0.41	0.41	0.60	0.60	0.13	0.13	0.32	0.32	0.52	0.52	0.13	0.13	0.32	0.32	0.51	0.51
Threonine	0.01	0.01	0.05	0.05	0.09	0.09	0	0	0.04	0.04	0.08	0.08	0	0	0.04	0.04	0.08	0.08
Growth Promoter	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Choline Chloride	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Toxin Binder	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
#TMM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Liver tonic	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Coccidiostat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
##Vitpremix	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Na ₂ CO ₃	0	0	0	0	0.15	0.15	-	-	-	-	-	-	-	-	-	-	-	-
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

T₁- Control, T₂- Control+ Multienzymes, T₃- 10% cDDGS, T₄- 10%cDDGS+ Multienzymes, T₅-20%cDDGS, T₆- 20%cDDGS+ Multienzymes

#TMM- Trace mineral mixture provided per kg diet: Manganese 80gm, Zinc 80gm, Iron 60gm, Copper 4gm, Iodine 1gm, Cobalt 0.1gm, Chromium 0.2gm and Selenium 100 ppm.

##Vitamin premix provided per kg diet: Vitamin A 25000000 IU, Vitamin D3 7000000 IU, Vitamin E 8gm, Vitamin K 4 gm, Riboflavin 10gm, Vitamin B1 1.6gm, Vitamin B6 3.2 gm, Vitamin B12 30 mg, Niacin 24 gm, Folic Acid 1.6 gm and Biotin 100 mg.

Multienzymes -Xylanase (20 gm/MT), Phytase (35 gm/MT), Mannanase (50 gm/MT) and Acid Protease (50 gm/MT).

Table 3: Nutrient composition of different dietary treatments fed during different phases of broiler diet.

Nutrients	Pre starter	Starter	Finisher
ME (Kcal/kg)	3000	3125	3200
CP%	22	20.5	19
Dig. lysine%	1.25	1.10	1.0
Dig. Methionine%	0.57	0.528	0.49
Calcium%	0.94	0.92	0.85
Avail. Phosphorus%	0.45	0.42	0.40
Sodium%	0.16	0.18	0.18
Dig. Threonine%	0.775	0.711	0.66

Results and Discussion

Body weight gain

Supplementation of the various dietary treatments had no significant effect ($p > 0.05$) on body weight gain of broilers during the overall growth periods. However, during the first week (1-7 days), a significantly higher ($p < 0.05$) body weight gain was recorded in the control diet supplemented with multi-enzymes (165.68 g). Similarly, during the 1-28 day period, dietary treatments significantly influenced ($p < 0.05$) body weight gain, with the control diet with multi-enzymes showing the highest gain (1493.13 g). These findings are similar to the results of Hussain *et al.*, (2019) [9] who also demonstrated that supplementation of exogenous enzymes improved body weight gain, particularly during the starter phase, likely due to enhanced nutrient digestibility and feed utilization. Abd El-Hack *et al.*, (2015) [1], who reported that replacing soybean meal with DDGS up to 16.5% had no significant ($p > 0.05$) effect on final body weight over the experimental period. Likewise, Fries-Craft and Bobeck (2019) [1] observed that inclusion of corn DDGS at 20% did not significantly affect body weight gain throughout the 42-day feeding period.

Feed intake

Supplementation of different dietary treatments had a significant effect ($p < 0.05$) on feed intake of broilers during the 1-7, 1-35, and 1-42 days of age, whereas feed intake during 1-14, 1-21, 1-28 days was not significant ($p > 0.05$). During the overall experimental period (0-42 days), broilers fed experimental diets exhibited significantly ($p < 0.05$) higher feed intake in the 20% Corn DDGS + multi enzymes supplementation group (4073.51 g) of age. Similarly, Kairalla *et al.* (2025) [10] reported that the birds fed with a 30% DDGS basal diet exhibited a significant increase in FI during the finisher phase and overall period. Damasceno *et al.* (2020) [3] recorded increased Feed Consumption in 160g/kg DDGS diet when compared to control during finisher phase. Barekatin *et al.* (2013) [2] reported a significant increase in feed intake when broiler chicks fed sorghum DDGS at 10, 20 and 30% with or without

Xylanase enzyme in the diets. However, Ravindran & Singh (2024) [14] found that as mDDGS inclusion levels at 20% increased feed intake in broilers. Khose *et al.* (2017) [12] reported that with 5% cDDGS with or without multienzyme exhibited significantly ($p < 0.05$) higher feed intake than all other treatment groups. The increased feed intake in Corn DDGS and enzyme supplemented groups might be due to higher percentage of protein in the Corn DDGS and also xylanase, protease and phytase supplementation in the diets.

Feed Conversion Ratio

Supplementation of different dietary treatments had a significant effect ($p < 0.05$) on the feed conversion ratio of broilers during 1-7, 1-21, 1-28, 1-35, and 1-42 d of age. During the entire experimental period of 42 days, poorer feed conversion ratio was observed in the 20% corn DDGS + multi enzymes group. Shams-Eldin *et al.* (2025) [16], reported significantly poor FCR in groups supplemented with 20% DDGS without enzymes and 10% DDGS with or without enzyme. Similar results were reported by Wang *et al.* (2007) [20], who noticed that feed conversion ratio was worsened by the inclusion of 30% corn DDGS in the diet. Fries-Craft & Bobeck (2019) [1] reported that the negative effects on FCR for the entire 42-d period were only observed in birds fed diets containing 15% and 20% High Protein corn DDGS. Damasceno *et al.* (2020) [3] reported that inclusion of 16% corn DDGS in the diet significantly worsened the FCR. The reduced feed efficiency and negative effect of FCR might be due to poor energy availability, or presence of antinutritional factors in higher percentage of cDDGS.

Mortality

The mortality rate was within the standard limits among all the cDDGS at different inclusion levels (0%, 10%, and 20%), with or without enzymes supplementation of multi enzymes. Similar observations on broiler survivability were reported by Khose *et al.* (2017) [12], Hassan & Al-Aqil (2015) [8].

Table 4: Effect of dietary inclusion of Corn DDGS (cDDGS) on Growth Performance and Serum Biochemical Parameters of commercial broiler chicken.

Treatment	BWG	FI	FCR	Glucose (mg/dl)	Total protein (g/dl)	Albumin (g/dl)	Cholesterol (mg/dl)
Control Diet (CD)	2488.34	3875.14 ^{bc}	1.558 ^c	135.4 ^{bc}	3.772 ^d	2.834	104.3
CD+multienzymes*	2532.42	3752.91 ^c	1.485 ^d	178.4 ^a	4.909 ^a	2.794	109.9
Basal Diet (BD) +10% cDDGS	2477.93	3883.83 ^{bc}	1.572 ^{bc}	158.2 ^{ab}	4.800 ^a	2.820	97.48
BD+10% cDDGS + multienzymes*	2482.86	3981.63 ^{ab}	1.605 ^{ab}	105.2 ^c	4.071 ^{cd}	2.814	94.29
BD+20% cDDGS	2407.13	3937.12 ^{ab}	1.638 ^a	131.8 ^{bc}	4.298 ^{bc}	2.834	96.07
BD+20% cDDGS + multienzymes*	2471.97	4073.51 ^a	1.650 ^a	110.0 ^c	4.675 ^{ab}	2.706	93.14
P Value	0.599	0.04	0.001	0.001	0.001	0.995	0.434
N	10	10	10	10	10	10	10
SEM	18.97	24.79	0.009	5.65	0.07	0.066	2.68

^{a,b,c} Means having different superscripts within a column are significantly ($p < 0.05$) different

P value = probability value;

N = number of replicates (5 birds in each replicate);

SEM = Standard Error Mean

*multienzymes -Xylanase (20 gm/MT), Phytase (35 gm/MT), Mannanase (50 gm/MT) and Acid Protease (50 gm/MT).

Serum Biochemical Parameters

Serum glucose and total protein levels were significantly affected ($p < 0.05$) by dietary treatments, whereas serum albumin and total cholesterol concentrations did not differ significantly ($p > 0.05$). Serum glucose concentration was significantly ($p < 0.05$) higher in the Control + multi enzymes group (178.40 mg/dl). Similarly, total serum protein concentration was significantly ($p < 0.05$) higher in the control + multi enzymes group (4.90 g/dl).

Ghaly *et al.* (2017) [7] reported significant effect ($p < 0.01$) on serum total protein and glucose concentrations at 15% cDDGS inclusion. Kaya and Sahin (2013) [11] reported that Total serum protein increased significantly in birds fed with 5% and 15% cDDGS, with the highest values observed at 10% cDDGS, indicating enhanced protein metabolism whereas total cholesterol remained unaffected by dietary treatments. The observed reduction in serum glucose levels in broilers fed diets containing 20% cDDGS may be attributed to the lower starch content and higher fiber concentration of cDDGS compared with maize-based control diets.

Conclusion

- Based on the results, it was concluded that of corn DDGS did not significantly affect overall body weight gain but significantly influenced cumulative feed intake and feed conversion ratio ($p < 0.05$).
- Inclusion of corn DDGS even at 20% levels did not have any significant ($p > 0.05$) difference in serum albumin and serum cholesterol levels, but showed a significant effect ($p > 0.05$) in serum glucose and total protein concentration.

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