Research Article

Effect of Feeding Sorghum Distillers Dried Grains with Solubles and Enzyme Supplementation on Performance of Broiler Chickens

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Abstract

The present experiment was conducted on 420 straight run commercial day old (Vencobb-400) broiler chickens from 0-42 days. The chicks were randomly distributed into seven dietary treatments groups with three replicates of 20 birds each. The birds in group A (control group) were offered basal diet adequate in all nutrients as per BIS, 2007. The birds in dietary treatment groups B, C and D were offered diet containing sorghum distillers dried grains with solubles (sDDGS) at 5, 10 and 15% levels and birds in groups E, F and G were offered diet having sDDGS at 5, 10, and 15% levels with enzyme (DSM, Mumbai), respectively. All the diets were isocaloric and iso-nitrogenous and were balanced for amino acids i.e. lysine and methionine. At 6th week of age, the birds in treatment groups recorded comparable live body weights and cumulative weight gain to control group. At 4th week, the inclusion of sDDGS at higher level i.e. 15% with or without enzyme significantly reduced ($P<0.01$) live body weights and cumulative weight gain as compared to control group. The inclusion of sDDGS did not show any significant effect on feed consumption pattern in broilers among different treatment groups. However, there was slight decline in feed intake among all treatment groups compared to control. At 6th week, cumulative FCR at 10 and 15% inclusion level of sDDGS was significantly higher ($P<0.05$) as compared to control group. The different treatment groups having 5 and 10 % sDDGS with enzyme recorded improved FCR than non enzyme supplemented groups, however, it was comparable to control group. The mortality was within normal range in all treatment groups. The cost of production expressed as rupees per kg live weight in groups A to G was 64.40, 65.55, 64.95, 64.74, 64.95, 63.91 and 64.78, respectively. The higher net profit in terms of rupees per kg of live weight was observed in treatment groups F followed by A, D, G, E, C, and B. The result suggested that the inclusion of sDDGS up to 10% level did not adversely affect the performance of broilers. The inclusion of 10% sDDGS with supplementation of enzyme was more beneficial in terms of growth performance and net profit in broiler chickens.

Keywords: sorghum distillers dried grains with solubles, enzyme, broiler chickens, growth performance, economics

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Introduction

In poultry production, the feed cost alone constitutes about 70-75% of the total cost of production of poultry meat and eggs. Distillers Dried grains with solubles (DDGS) are by-products of the spirit industry and of bio-ethanol production. They are obtained as a result of multi-stage concentration and long-lasting drying of cereal mash. These products are constituted by components from initial raw material, being insensitive to fermentation (non-starch carbohydrates, protein, fat, ash and others) and biomass of the multiplied yeasts. Dried grains of cereal distillers are rich in protein, exogenous amino acids, B-group vitamins, biotin and mineral compounds, including phosphorus [1-2]. The quality of DDGS depends upon grain selection, fermentation type and drying temperature and duration [3]. While most of the information gathered to date has focused on corn DDGS, scanty information is available in literature regarding sorghum distillers dried grains with solubles (sDDGS). The production of sorghum accompanied by the rapid increase in demand for ethanol production will result in increased availability of sDDGS. Therefore, research work needs to be conducted to determine its impact on broiler performance. The sDDGS is slightly higher in crude protein, significantly higher in ADF and ash, and lower in crude fat and lysine compared to corn DDGS. Although, the level of methionine and threonine are similar, tryptophan level is substantially higher and lysine and arginine are lower, resulting in a significantly lower lysine to crude protein ratio compared to corn DDGS [4]. These differences in nutrient composition suggest that the energy value and protein quality in sDDGS would be less than corn DDGS in

chickens. The estimated MEn (kcal/kg) of bronze and yellow sorghum DDGS was 2,677 and 2,866, respectively [4]. These sorghum DDGS values are similar, but slightly lower than the MEn value of 2827 kcal/kg and for corn DDGS 2,906 kcal/kg reported earlier [5, 6]. The sDDGS contain 28.6% CP, 10.3% ether extract, 5.2% ash, 26.0% total non starch polysaccharides, 5.3% free sugars, 6.2% starch, 0.17% P, 0.72% Ca, 0.46% Lys, and 0.40% Met. [7]. However, the sDDGS was reported to contain approximately 20% non starch polysaccharides, appreciable level of poorly digested protein and a considerable amount of starch not fermented during the process of ethanol production [8]. In general, the DDGS are richer in fibre, protein and fat than the cereal source [9] and also contain significant amounts of non-starch polysaccharides (NSPs). Therefore, the use of most appropriate enzyme to hydrolyze these compounds may increase the nutritional value of DDGS and promote its inclusion at higher levels in broiler diets [10]. In view of the above facts, the present experiment was undertaken to study the effect of feeding sDDGS and enzyme supplementation on performance of broiler chickens.

Materials and Methods

Experimental Design and Management

The experiment was conducted on 420 commercial day-old (Vencobb-400) straight run broiler chicks for 0-42 days. The chicks were randomly distributed into seven dietary treatments groups with three replicates of 20 birds each. The birds in group A (control group) were offered basal diet adequate in all nutrients [11]. The birds in dietary treatment groups B, C and D were offered diets containing sDDGS at 5, 10 and 15% levels and birds in groups E, F and G were offered diets containing sDDGS at 5, 10, and 15% levels with enzyme (DSM, Mumbai) at recommended dose of 400 g/ton of feed, respectively. The standard and uniform managemental practices were followed for all treatment groups throughout the experimental period (**Figures 1** and **2**). The birds were provided *ad-lib* fresh and clean drinking water throughout the experiment.

Figure 1 Experimental chicks

Figure 2 Grownup broilers in experimental pen

Procurement of Ingredients and Feed Formulation

The good quality feed ingredients were procured from local market for preparation of experimental diets. The sDDGS was procured from Grainotch Industries Ltd., Aurangabad – 431109 Maharashtra, India (**Figure 3**). The chemical analysis [12] of sDDGS was carried out and presented in **Table 1**. The metabolizable energy of sDDGS was 2866 kcal/kg [4] and same was considered for the feed formulation. The enzyme was supplied by DSM, Nutritional Products India Pvt. Ltd., Mumbai- 400 098, Maharashtra, India. The enzyme preparation was having Phytase, Protease, Amylase, Xylanase, Endo-1, 3 (4)-Beta-glucanase and other enzyme activities like Pectinase, Pentosanase, Hemicellulase, Mannanase, Cellulase, Amylo-glucosidase and Cellbiase.

Figure 3 Sample of sorghum DDGS

Table 1 Chemical analysis of sorghum DDGS (DM)

Sr. No.	Nutrient	Percent (%)
1	Moisture (%)	8.20
2	Crude Protein (%)	33.23
3	Crude Fat (%)	9.09
4	Total Ash (%)	2.94
5	Crude Fibre (%)	5.04
6	Total Phosphorus (%)	0.98
7	Calcium (%)	0.37

The rations were formulated for pre-starter, starter and finisher phases and all the diets were isocaloric and iso-nitrogenous and also the lysine and methionine levels were balanced [11]. The inclusion of various levels of sDDGS with partial replacement of soybean meal and energy sources in different dietary treatments. The ingredient and nutrient composition of different dietary treatments A, B, C and D has been presented in **Table 2**. The diets for treatment groups E, F and G were prepared adding enzyme at 400g/ton of feed to diets B, C and D, respectively.

Data Collection

Data was collected on weekly weight changes determined by weighing the birds on weekly basis and replicate wise weight gain was calculated by subtracting the weight of the previous week from that of the current week. The feed intake was determined by subtracting the left-over feed from the feed offered, while feed conversion ratio was calculated as average feed intake divided by average weight gain taking into consideration of mortality, if any. The cost of rearing the birds for experiment was calculated by considering the prevailing costs of chicks, feed, litter and vaccine, etc.

Statistical Analysis

All the data generated was subjected to statistical analysis by using Complete Randomized Design [13]. The treatment means were compared by Critical Differences (CD) and Analysis of Variance.

Results and Discussion

Live body weight and weight gain

At 6th week of age, the birds in all treatment groups recorded comparable body weights to control group. At 4th week, the inclusion of sDDGS at higher level i.e. 15% with or without enzyme reduced live body weights compared to control group (**Table 3**). Similar trend as in live body weights was observed for gain in weights. At 6th week of age, the birds in treatment groups recorded comparable body weight gains to control group. At 4th week, the inclusion of sDDGS at higher level i.e. 15% with or without enzyme significantly reduced (P<0.01) gain in live body weights compared to control group. Similarly, it was reported that the inclusion of sDDGS with xylanase had no effect on live weight and gain in weight [14]. It was also reported that the broiler diet containing up to 10% DDGS did not show significant differences in body weight and body weight gain from 1-35 days of age [15]. The inclusion of 10% and 15% wheat DDG in compound feeds for broiler chickens up to 42 days of age did not have a significant effect on their growth as compared to control group [16]. Thus, the supplementation of enzyme to sDDGS based diets found to improve live body weight and gain in weight in broilers (**Figure 4**). The percent improvement in live body weight was 2.25, 2.10 and 1.85% in enzyme supplemented diets having sDDGS at 5, 10 and 15%, respectively as compared to non enzyme supplemented groups.

Table 3 Weekly live body weight and Weekly cumulative weight gain in broilers fed various levels of sDDGS with or without enzyme in different dietary treatments

Treatment Groups	Age (weeks)					
	Weekly Live body weight					
	I	II	III	IV	V	VI
A (Control)	173.05±2.55	456.45±7.92	975.33±11.68	1597.10±1.55^{a}	2341.83±15.22	2880.68±32.44
B (5% sDDGS)	172.82±0.89	448.02±5.38	954.47±9.32	1571.62±18.41^{ab}	2244.65±32.19	2751.15±51.47
C (10% sDDGS)	179.30±3.09	460.70±6.90	979.20±10.81	1577.52±11.03^{ab}	2262.65±21.49	2769.05±30.80
D (15% sDDGS)	171.73±0.38	440.98±9.28	938.76±15.73	1499.23±10.88^{c}	2178.55±14.54	2717.24±48.64
E (5% sDDGS +Enz.)	184.08±7.38	473.18±9.14	987.27±6.72	1608.20±29.57^{a}	2280.97±55.18	2818.60±38.43
F (10% sDDGS + Enz.)	183.08±0.78	466.47±4.58	981.37±12.25	1585.48±13.53^{ab}	2277.42±35.74	2827.31±44.40
G (15% sDDGS +Enz.)	174.72±2.02	450.80±6.07	956.85±2.01	1541.65±11.18^{bc}	2225.19±17.17	2767.56±10.32
CD	NS	NS	NS	66.825**	NS	NS
CV %	3.227	2.746	1.898	1.753	2.347	2.412
Weekly cumulative weight gain						
A (Control)	124.60±2.28	408.00±7.44	926.88±11.51	1548.65±1.94^{a}	2293.38±14.92	2832.23±31.96
B (5% sDDGS)	124.47±0.92	399.67±5.50	906.12±9.40	1523.27±18.47^{ab}	2196.30±32.26	2702.80±51.50
C (10% sDDGS)	130.68±2.72	412.08±6.61	930.58±10.45	1528.90±10.66^{ab}	2214.03±21.19	2720.43±30.77
D (15% sDDGS)	124.05±0.48	393.30±9.24	891.08±15.66	1451.54±10.85^{c}	2130.87±14.56	2669.55±48.62
E (5% sDDGS +Enz.)	135.80±7.14	424.90±8.82	938.98±7.04	1559.92±29.21^{a}	2232.68±54.82	2770.32±38.07
F (10% sDDGS + Enz.)	134.75±0.64	418.14±4.70	933.03±12.30	1537.15±13.38^{ab}	2229.08±35.62	2778.98±44.29
G (15% sDDGS+Enz.)	126.22±2.07	402.30±6.21	908.35±1.92	1493.15±11.13^{bc}	2176.69±17.21	2719.06±10.30
CD	NS	NS	NS	66.231**	NS	NS
CV %	4.238	3.012	1.989	1.792	2.387	2.447

Means bearing different superscripts differ significantly within a column
* Significant at 5 % level (P<0.05), ** Significant at 1% level (P<0.01), NS - Non-significant, CV – Coefficient of variance, CD – Critical difference, Enz.- Enzyme

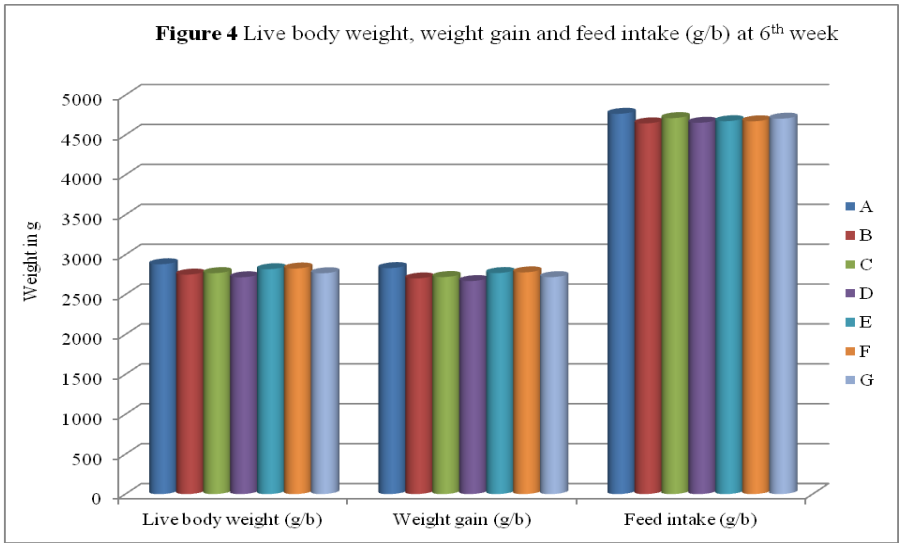

Table 4 Weekly cumulative feed intake and cumulative FCR in broilers fed various levels of sDDGS with or without enzyme in different dietary treatments

Treatment Groups	Age (weeks)					
	Weekly cumulative feed intake					
	I	II	III	IV	V	VI
A (Control)	164.30±3.05	541.00±12.67	1274.82±20.73	2286.13±26.05	3527.40±17.78	4765.93±9.09
B (5% sDDGS)	163.46±0.88	529.39±8.00	1253.08±11.87	2253.70±25.19	3432.71±41.73	4646.31±59.01
C (10% sDDGS)	170.67±2.13	554.33±3.75	1297.07±7.26	2298.50±8.47	3488.47±24.33	4712.17±43.28
D (15% sDDGS)	162.72±2.19	536.95±2.68	1252.46±5.34	2214.98±14.25	3407.77±16.18	4654.06±37.91
E (5% sDDGS+Enz.)	170.68±2.05	552.52±4.44	1275.63±24.69	2287.68±14.55	3460.72±54.52	4673.51±73.83
F (10% sDDGS+ Enz.)	168.22±2.60	544.92±4.65	1273.30±26.97	2267.42±22.83	3463.47±41.86	4672.22±49.29
G (15% sDDGS+Enz.)	164.98±1.36	528.45±6.05	1247.70±1.88	2246.88±11.81	3444.88±24.63	4704.92±34.96
CD	NS	NS	NS	NS	NS	NS
CV %	2.233	2.177	2.305	1.434	1.717	1.765
Cumulative feed conversion ratio (FCR)						
A (Control)	1.32±0.02	1.33±0.02	1.38±0.01	1.48±0.02^{bc}	1.54±0.01^{d}	1.68±0.02^{b}
B (5% sDDGS)	1.31±0.01	1.32±0.01	1.38±0.00	1.48±0.00^{bc}	1.56±0.01^{bcd}	1.72±0.01^{ab}
C (10% sDDGS)	1.31±0.02	1.35±0.02	1.39±0.01	1.50±0.01^{ab}	1.58±0.01^{abc}	1.73±0.01^{a}
D (15% sDDGS)	1.31±0.02	1.37±0.03	1.41±0.02	1.53±0.01^{a}	1.60±0.01^{a}	1.74±0.02^{a}
E (5% sDDGS+Enz.)	1.26±0.07	1.30±0.02	1.36±0.02	1.47±0.02^{c}	1.55±0.01^{d}	1.69±0.01^{b}
F (10% sDDGS+ Enz.)	1.25±0.01	1.30±0.03	1.37±0.05	1.48±0.01^{bc}	1.55±0.01^{cd}	1.68±0.01^{b}
G (15% sDDGS+Enz.)	1.31±0.03	1.31±0.02	1.37±0.00	1.50±0.01^{ab}	1.58±0.00^{ab}	1.73±0.01^{a}
CD	NS	NS	NS	0.042**	0.035**	0.043*
CV %	4.198	3.125	2.605	1.162	0.914	1.425

Means bearing different superscripts differ significantly within a column.
* Significant at 5 % level (P<0.05), ** Significant at 1% level (P<0.01), NS - Non-significant, CV – Coefficient of variance, CD – Critical difference, Enz.- Enzyme

Feed Intake

The inclusion of sDDGS did not show any significant effect on feed consumption pattern in broilers among different treatment groups (**Table 4**). However, there was slight decline in feed intake among all treatment groups compared to control (Figure 4). The findings are in accordance with earlier report stating that weight gain, feed intake, and mortality rate were not significantly affected by level of DDGS or enzyme inclusion in the diet or their interactions [17]. The supplementing broiler rations with up to 15% DDGS does not have a negative effect on performance, carcass yield or blood parameters and it can be safely used in broiler rations [18]. The broilers fed increasing levels of wheat DDGS i.e. 5, 10, 15 and 20% levels did not influence on weight gain, feed intake and feed conversion ratio (FCR), however, weight gain and FCR tended to decline when wheat DDGS at 20% level was used [1].

Feed Conversion Ratio (FCR)

At 6th week, cumulative FCR at 10 and 15% inclusion level of sDDGS was significantly higher ($P<0.05$) as compared to control group (Table 4). The different treatment groups having 5 and 10 % sDDGS with enzyme recorded improved FCR than non enzyme supplemented groups which was comparable to control group (**Figure 5**). Similarly, it was reported that FCR deteriorated significantly with the rising level of sorghum DDGS in diets during the first 3 weeks of feeding [14]. Further, they observed that the effect of xylanase supplementation was not significant at up to 20% DDGS inclusion. The birds fed sorghum DDGS had increased feed efficiency during starter and grower phases and enzyme supplementation of sorghum DDGS diets found to improve FCR in broiler diets [7]. There was increase in feed conversion ratio (FCR) in conjunction with the increase in DDGS in the diet [19]. Thus, the result revealed that addition of sDDGS with enzyme could improve non-starch polysaccharides (NSP) availability and reduced the negative impact of undigested residues on digesta viscosity.

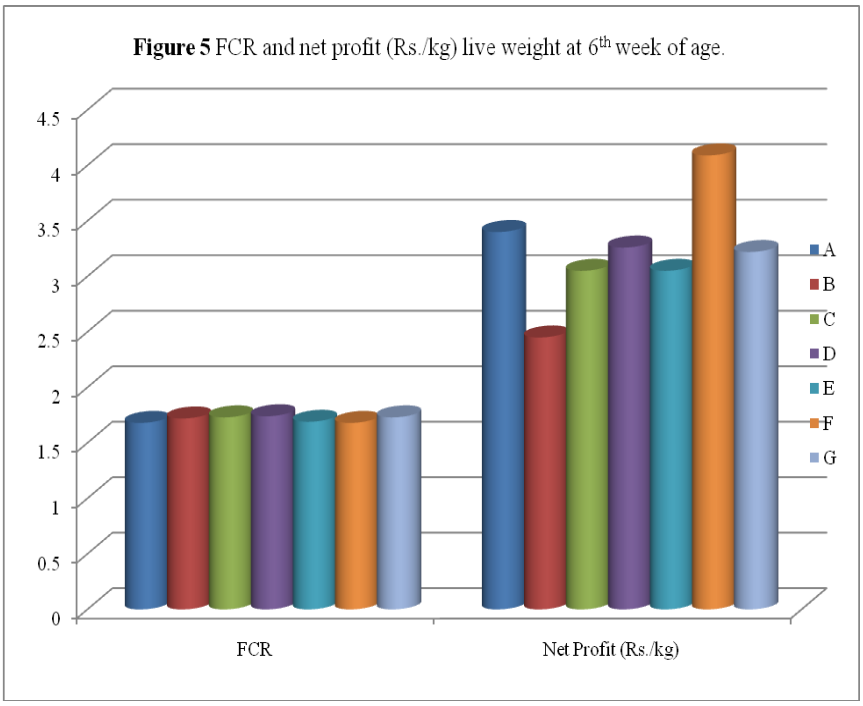

Figure 5 FCR and net profit (Rs./kg) live weight at 6th week of age.

Mortality

The mortality showed normal pattern and was within normal range in all treatment groups. The mortality from groups A to G was 0, 1.67, 0, 3.33, 0, 1.67 and 1.67%, respectively. Similarly, it was reported that the inclusion of DDGS in the broiler diets had no effect on mortality rate [20].

Economics of Broiler Production

The cost of production expressed as rupees per kg live weight in groups A to G was 64.40, 65.55, 64.95, 64.74, 64.95, 63.91 and 64.78, respectively (**Table 5**). The higher net profit in terms of rupees per kg of live weight was observed in treatment groups F followed by A, D, G, E, C, and B (Figure 5). Similarly, it was reported that DDGS up to 10%

can be used in broiler starter and finisher diet [21]. The use of DDGS in broiler diets up to 15% could decrease the feed cost by replacing part of corn and soybean meal, without any negative effect on growth performance and meat qualities [22]. However, it was reported that DDGS can be effectively included at 10% in growing/finishing diets for turkey hens if proper formulation matrix values for all nutrients are used [23]. The use of DDGS along with enzyme and acidifier, either singly or in combination was beneficial for better feed conversion ratio and higher net profits [24]. It was also reported that the corn or wheat DDGS can be included at up to 10% of wheat-based broiler diets without affecting growth performance or breast meat yield [25]. Thus, the result revealed that inclusion of sDDGS at 10% level with enzyme was economically most beneficial as compared to other groups.

Table 5 Economics of broiler production under different dietary treatments.

Sr. No.	Parameters	Treatment Groups						
		A	B	C	D	E	F	G
1	Chick cost (₹)	38	38	38	38	38	38	38
2	Feed intake (g)							
	Pre-starter	300	300	300	300	300	300	300
	Starter	700	700	700	700	700	700	700
	Finisher	3765.93	3646.31	3712.17	3654.06	3673.5	3672.22	3704.92
	Total Feed Intake (g)	4765.93	4646.31	4712.17	4654.06	4673.5	4672.22	4704.92
3	Feed price per kg (₹)							
	Pre-starter	29.31	28.81	28.32	27.82	29.23	28.74	28.24
	Starter	29.51	29.01	28.51	28.01	29.43	28.93	28.43
	Finisher	28.85	28.35	27.85	27.36	28.77	28.27	27.78
4	Feed cost per bird (₹)							
	Pre-starter	8.79	8.64	8.49	8.35	8.77	8.62	8.47
	Starter	20.66	20.31	19.96	19.61	20.60	20.25	19.90
	Finisher	108.66	103.38	103.40	99.96	105.70	103.83	102.91
5	Total feed cost per bird (₹)	138.11	132.34	131.85	127.91	135.07	132.70	131.28
6	Miscellaneous cost per bird (₹)	10	10	10	10	10	10	10
7	Net cost of production per bird (₹)	186.11	180.34	179.85	175.91	183.07	180.70	179.28
8	Cost of production per kg live weight (₹)	64.60	65.55	64.95	64.74	64.95	63.91	64.78
9	Live body weight at the end of 6^{th} week (g)	2880.68	2751.15	2769.05	2717.24	2818.6	2827.31	2767.56
10	Returns on sale @ (₹)90 per kg live body weight	195.89	187.08	188.30	184.77	191.66	192.26	188.19
11	Net profit per bird (₹)	9.78	6.74	8.44	8.86	8.59	11.56	8.92
12	Net profit per kg (₹)	3.40	2.45	3.05	3.26	3.05	4.09	3.22

Conclusion

It may be concluded that the inclusion of sDDGS up to 10% level did not adversely affect the performance of broilers. The inclusion of 10% sDDGS with supplementation of enzyme was more beneficial in terms of growth performance and net profit in broiler chickens.

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