International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 1230-1235

Received: 13-09-2019
Accepted: 15-10-2019

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Effects of feeding different levels of distillers dried grains with solubles (DDGS) on performance of broiler chicken

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Abstract
In the present investigation, a total of 180 day-old broiler chicks were divided into five groups having 36 chicks with 3 replicates of 12 chicks in each group. The birds of T_0, T_1, T_2, T_3 and T_4groups were fed with the diets having 0, 5, 10, 15 and 20% DDGS, respectively. The feeding trial was conducted for a period of 42 days. The total feed consumption per broiler for different experimental groups was highest in T_0 group (4132.55g) and lowest in T_4 group (3477.95g). The final body weight per broiler was highest in T_0 group (2130.68 ± 24.50g) followed by T_1 group (2050.33 ± 18.70g), T_2 (1985.22 ± 19.44g), T_3 (1870.51 ± 19.11g) and T_4 (1711.70 ± 20.69g). The overall FCR of the entire period of the experimental groups was best in T_1 group (1.92) followed by T_0 (1.94), T_2 (1.96), T3 (2.01) and T_0 (2.03) group. The per cent survivability of T_1 and T_2 groups were cent per cent (100) followed by T_3 (97.22), T_0 (94.44) and T_4 (91.67) group. The gross profit per broiler was found to be highest in T_1 group and lowest in T_4 group. From the results obtained it can be concluded that DDGS can be incorporated in broiler ration at the levels of 5%.

Keywords: Distillers dried grains, broiler chicken, FCR

Introduction
The feed cost accounts for about 65-70% of total cost of production in broiler chicken. The maize and soybean meal are the major conventional sources of energy and protein, respectively, in poultry feeds and in India there is a huge gap between demand and availability of these feed ingredients for using in production of poultry feeds. The shortage of conventional poultry feed ingredients is considered as one of the major concern facing poultry producers worldwide especially in the developing countries in near future. So, in the present status of feed resource availability, exhibiting an alarming nutritional crisis, the availability of low-priced quality feed ingredients and the feed is critical for expansion of poultry industry. As an alternative, cheaper byproducts of comparable quality are being evaluated and incorporated into poultry feeding. Distillers dried grains with solubles (DDGS) is one of such product co-produced after extraction of ethanol from fermented grains (Youssef *et al.*, 2013) [27]. It has been identified as a promising feed resource for its use in the ration of poultry as an energy and protein source. It is also a rich source of water soluble vitamins and minerals (Parsons *et al*., 2006) [14]. It contains a substantial amount of total phosphorus (0.72%), out of which 54% is available for poultry (NRC, 1994) [13], xanthophylls (Runnels, 1957) [17] and linoleic acid (Scott, 1965) [19]. Therefore, the present study was undertaken to investigate the effect of dietary incorporation of different levels of distillers dried grains with solubles (DDGS) on the growth performance of broiler chicken.

Materials and method
The study was conducted with a total of one hundred eighty (180) numbers day-old commercial broiler chicks (Hubbard) having similar body weight from a single hatch were procured, weighed and randomly divided into five groups viz. T_0, T_1, T_2, T_3 and T_4 having 36 chicks with 3 replicates of 12 chicks in each group. The chicks were wing banded and reared under deep litter system providing standard feeding and manage mental practices. A basal diet with 23% crude protein for pre-starter, 22% crude protein for starter and 20% crude protein for finisher was formulated as per BIS, 2007. The feeding trial was conducted for a period of 6

weeks using broiler pre-starter (0-7 days), broiler starter (8-21 days) and broiler finisher (22-42 days) rations. During the experiment, the feed consumption, weekly and total body weight and body weight gain, feed conversion ratio (FCR), economics of production *etc.* were studied and recorded. The experiment was conducted in a Completely Randomized Design (CRD). Statistical analysis was done with the help of software SAS system (9.3).

Table 1: Composition of Experimental Broiler Pre- Starter, Starter and Finisher Rations

Ingredients	Treatment groups														
	Pre-starter					Starter					Finisher				
	T_0 (Control)	T_1 (DDGS 5%)	T_2 (DDGS 10%)	T_3 (DDGS 15%)	T_4 (DDGS 20%)	T_0 (Control)	T_1 (DDGS 5%)	T_2 (DDGS 10%)	T_3 (DDGS 15%)	T_4 (DDGS 20%)	T_0 (Control)	T_1 (DDGS 5%)	T_2 (DDGS 10%)	T_3 (DDGS 15%)	T_4 (DDGS 20%)
Maize (%)	54.00	53.00	52.00	49.00	48.00	58.00	56.00	54.00	52.00	50.00	60.00	59.00	58.00	55.00	54.00
Soybean meal (%)	38.00	34.00	30.00	28.00	25.00	33.00	30.00	27.00	24.00	21.00	30.00	26.00	22.00	20.00	16.00
DDGS (%)	0	5.00	10.00	15.00	20.00	0	5.00	10.00	15.00	20.00	0	5.00	10.00	15.00	20.00
Di-calcium phosphate (%)	1.26	1.58	1.66	1.48	0.53	1.38	1.27	1.25	1.16	1.08	1.32	1.39	1.10	1.04	0.98
Limestone powder (%)	1.50	1.40	1.40	1.50	1.50	1.30	1.40	1.40	1.50	1.50	1.30	1.30	1.50	1.50	1.60
Veg. oils (%)	2.50	2.20	2.10	2.10	2.00	3.60	3.61	3.50	3.50	3.50	4.70	4.60	4.60	4.60	4.50
Methionine (%)	0.13	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.12	0.12	0.16	0.16	0.18	0.18	0.18
Lysine (%)	0.09	0.15	0.17	0.25	0.30	0.05	0.05	0.17	0.20	0.28	0	0.03	0.10	0.16	0.22
Salt (%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vita pmx (%)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Mineral mixture*(%)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
CP (%)	23.06	23.25	23.10	23.12	22.98	22.08	22.13	21.96	21.93	22.03	19.95	20.24	20.18	20.12	20.26
ME (Kcal. Kg)	3003	3005	3002	2997	3002	3102	3100	3104	3101	3098	3204	3205	3202	3203	3201

*Mineral mixture contains (per 1.2 kg): Calcium- 255 g, Phosphorous- 127.5 g, Magnesium- 6 g, Manganese- 1.5 g, Iron- 1.5 g, Iodine- 325 mg, Copper- 4.2 g, zinc-9.6 g, Cobalt- 150 mg, Sulphur- 7.2 g, Potassium- 100 mg, Sodium- 6mg, Selenium- 10 mg, Vitamin A- 700000 IU, Vitamin D3- 70000 IU, Vitamin E- 250 mg, Nicotinamide- 1000 mg & Chromium- 78 mg.
** Calculated value

All the bio security measures were adopted during the experimental period. Chicks were vaccinated against Ranikhet Disease (RD) and Infectious Bursal Disease (IBD) as per standard schedule. The average cost of production per broiler in various treatment groups was calculated by formula (Table 2) described by Narahari and Kumararaj (2008) [12] and the profitability was assessed based on the current market price during the study period.

Table 2: Calculation of Cost of production per broiler

Cost of Chick (A)	**1.05 × cost of one day-old chick**
Feed cost (B)	Live weight in Kg × FCR × Cost of one Kg feed
Miscellaneous expenditure (C)	15% of (A+B)
Total cost of Production per broiler (T)	A+B+C
N.B FCR=Feed Conversion Ratio 1.05 =Fixed constant	

Results and Discussion

Weekly feed intake and total feed consumption

The mean weekly feed intake and total feed consumption per broiler has been presented in Table 3. The average weekly feed consumption for the first week was recorded to be highest in T_2 group and lowest in T_4 group whereas for second week lowest feed intake was recorded in the group $T_1$and highest in T_0 group. At the end of the third week, the average weekly feed intake was lowest in T_2 group and highest in the T_1group.The mean weekly feed consumption in the fourth week was recorded to be highest in T_0 group and lowest in the T_4 group. On fifth week feed consumption was highest in T_3 group and lowest in the T_4 group. At the end of the sixth week, the average weekly feed consumption was highest in T_0group and lowest in T_3group.The total feed consumption per broiler for different experimental group was recorded to be highest in T_0 group (4132.55g) followed by T_1 (3926.39g), T_2 (3893.90g) and T_3 (3753.85g) and lowest in T_4 (3477.95 g) group.

Table 3: Mean Weekly Feed Intake (G/Bird) and Total Feed Consumption (G/Bird) Under Different Treatment Groups

Groups / Weeks	T_0 (Control)	T_1 (DDGS- 5%)	T_2 (DDGS- 10%)	T_3 (DDGS- 15%)	T_4 (DDGS- 20%)
1st	93.47	87.44	99.33	78.10	72.36
2nd	453.12	424.02	424.70	445.00	441.11
3rd	688.05	691.39	656.65	665.68	667.23
4th	1028.26	965.49	964.06	893.27	772.25
5th	901.07	941.24	905.23	954.93	766.72
6th	968.58	816.82	843.93	716.87	758.28
Total	4132.55	3926.39	3893.90	3753.85	3477.95

It was found that overall feed intake was gradually decreased as incorporation of DDGS at 5, 10, 15 and 20% level in the broiler diet in comparison with control group. It might be due to burnt (smoky) odour of DDGS (Swiatkiewicz and Koreleski, 2008) [22]. Burnt odour of DDGS was probably caused from overheating during the drying process in ethanol plant. Similar trend of findings with respect to decrease in feed consumption up to 15% inclusion level of DDGS were observed byLukaszewicz and Kowalczyke (2014) [10]. Likewise, Lukasiewicz *et al*. (2012) [9] reported decrease feed consumption when broiler chicks fed DDGS at 5 and 7 percent with broiler ration. These observations were in the same line with the findings of Deniz *et al*. (2013) [5] who stated that the 20% inclusion of corn DDGS into the laying hen diets significantly decreased feed intake (P<0.05). Overheating of DDGS probably resulted in destruction of highly susceptible amino acids such as lysine, which is recognized as the first limited amino acid in DDGS (Swiatkiewicz and Kolreski, 2008) [22]. Pescatore *et al*. (2010) [15] also observed significant reduction in feed intake in Brown Leghorn laying hens, fed 15 or 23% DDGS. Likewise, Cromwell *et al.* (1993) [3] concluded that chicks fed the darkest-colored, burnt-smelling DDGS resulted in decreased feed intake by 13% as compared to chicks fed the lightest-colored DDGS.

Other workers such as Scheideler *et al*. (2008) [18], Youssef *et al.* (2013) [27] and Hassan and Al Aquil (2015) reported that there were no significant differences in feed consumption among different treatment groups with DDGS inclusion levels up to 10-15%.

Weekly body weight and body weight gain

The mean (±SE) weekly body weights (Table 4) of different treatment groups did not differ significantly ($P \geq 0.05$) on 2nd week (14 days) of age. At the end of 1st, 3rd, 4th, 5th and 6th weeks, the body weight of broiler chickens differed significantly ($P \leq 0.01$) among the different experimental groups. There was gradual decrease of body weight from 21 days onward with corresponding increase in inclusion rate of DDGS in comparison to control group. Overall body weight was also least in T_4 group, the birds of which were fed maximum amount of DDGS (20%) in comparison to other groups including the control group. It may be due to gradual deterioration of body weight gains as well as feed conversion ratio at higher inclusion of DDGS in the broiler ration (Swiatkiewicz and Koreleski, 2003) [21]. These results were in agreement with Lukaszewicz and Kowalczyk (2014) [10] who reported that incorporation of DDGS up to 15% in the broiler diet decreased the final body weight.Similarly, Widyaratne and Zijlstra (2007) [25] also found that, diets with 20% wheat DDGS had a decreasing trend on performance and suggested to use 15% wheat DDGS for broilers without negative effects on performance. Accordingly, Dale and Batal (2003) [4] used 0, 6, 12 and 18% DDGS in broiler diets and reported that 12% DDGS resulted in a slight decrease in performance during the starter period while 18% DDGS had a negative impact on body weight. On contradictory to the findings of the present study, Foltyn *et al*. (2013) [6] reported that incorporation of DDGS at 60 and 120 g/kg in the chicken diet improved final body weight. Other researchers such as Lukasiewicz *et al*. (2012) [9] and Hassan and Al Aquil (2015) reported no significant difference in body weight among dietary treatments containing 5%, 7% and 10% DDGS, respectively.

Table 4: Mean ± Se Weekly Body Weight (G) Of Broilers under Different Treatment Groups

Groups / Days	T_0 (Control)	T_1 (DDGS- 5%)	T_2 (DDGS- 10%)	T_3 (DDGS- 15%)	T_4 (DDGS- 20%)
0	$42.44^{a} \pm 0.34$	$42.14^{a} \pm 0.45$	$41.92^{a} \pm 0.32$	$42.31^{a} \pm 0.39$	$41.59^{a} \pm 0.31$
7	$96.47^{b} \pm 1.31$	$92.39^{c} \pm 0.87$	$99.67^{a} \pm 0.75$	$86.94^{d} \pm 0.76$	$82.47^{e} \pm 0.39$
14	$280.67^{a} \pm 1.85$	$264.06^{a} \pm 5.78$	$273.72^{a} \pm 5.95$	$265.66^{a} \pm 8.72$	$256.82^{a} \pm 7.20$
21	$660.81^{a} \pm 10.46$	$650.3^{a} \pm 6.76$	$638.53^{ab} \pm 5.67$	$625.49^{bc} \pm 9.34$	$612.55^{c} \pm 9.05$
28	$1212.80^{a} \pm 11.77$	$1175.03^{b} \pm 6.63$	$1159.64^{b} \pm 6.81$	$1095.63^{c} \pm 14.30$	$1014.76^{d} \pm 9.59$
35	$1690.41^{a} \pm 15.93$	$1670.42^{ab} \pm 7.61$	$1633.58^{b} \pm 9.11$	$1577.91^{c} \pm 15.77$	$1405.94^{d} \pm 9.11$
42	$2130.68^{a} \pm 24.50$	$2050.33^{b} \pm 18.70$	$1985.22^{c} \pm 19.44$	$1870.51^{d} \pm 19.11$	$1711.70^{e} \pm 20.69$

Means with different superscripts within a row differed significantly ($P \leq 0.05$).

The significantly ($p \leq 0.01$) depressed overall body weight gain with increasing the inclusion levels of DDGS in the broiler ration in comparison with the control diet might be due to change in amino acid patterns of the diets as the soyabean meal is known have more favorable amino acid pattern than the rice DDGS for poultry and also might be due to higher crude fibre content of DDGS, which led to decrease in nutrient density of the rations. In DDGS added rations percentage protein from soybean meal was decreased and at lower inclusion rates of DDGS, there appeared to be sufficient amino acids from soybean protein leading to no adverse effect on the growth of the birds. Similar trends of decreased body weight gain was also reported by Lukaszewicz and Kowalczyk (2014) [10], who incorporated DDGS in broiler ration at the levels of 0, 5, 10 and 15%.

Table 5: Mean ± Se Weekly Body Weight gain (g/bird) of Roilers Under Different Treatment Groups

Groups / Weeks	T_0 (Control)	T_1 (DDGS- 5%)	T_2 (DDGS- 10%)	T_3 (DDGS- 15%)	T_4 (DDGS- 20%)
1st	$54.03^{b} \pm 1.02$	$50.25^{c} \pm 0.59$	$57.75^{a} \pm 0.55$	$44.63^{d} \pm 0.47$	$40.88^{e} \pm 0.23$
2nd	$184.19^{a} \pm 1.01$	$171.67^{a} \pm 5.19$	$174.06^{a} \pm 5.31$	$178.71^{a} \pm 8.03$	$174.35^{a} \pm 6.88$
3rd	$380.14^{a} \pm 9.77$	$386.25^{a} \pm 6.67$	$364.81^{abc} \pm 6.80$	$359.83^{bc} \pm 6.65$	$354.91^{c} \pm 3.15$
4th	$552.83^{a} \pm 6.09$	$524.72^{b} \pm 4.23$	$521.11^{b} \pm 4.34$	$470.14^{c} \pm 8.36$	$402.21^{d} \pm 4.64$
5th	$479.29^{b} \pm 8.32$	$495.39^{a} \pm 4.60$	$473.94^{c} \pm 3.69$	$482.29^{bc} \pm 6.15$	$391.18^{d} \pm 5.88$
6th	$440.26^{a} \pm 11.55$	$379.92^{b} \pm 14.45$	$351.64^{b} \pm 12.14$	$292.60^{c} \pm 8.65$	$305.76^{c} \pm 13.30$

Means with different superscripts within a row differed significantly ($P \leq 0.05$)

Feed conversion ratio

On the first week, the average weekly FCR for the experimental groups showed best FCR in T_2 group and poorest in T_4 group. At the end of the second week T_2 group showed the best FCR result and T_4 group showed the poorest FCR result. In the third week, T_1 group showed the best result whereas T_4 group showed the poorest value. At the end of the fourth week, T_1 group showed the best FCR value as compared to other groups. On the fifth week, the average weekly FCR was best in T_0 group as compared to other groups. The mean weekly FCR during sixth week of age was recorded as 2.20, 2.15, 2.40, 2.45 and 2.48 for T_0, T_1, T_2, T_3 and T_4, respectively. The T_1 group showed the best FCR followed by T_0, T_2, T_3 and T_4 groups. The overall feed conversion ratios (FCR) for different experimental groups was found to be least in T_1 group (1.92), followed by T_0 (1.94), T_2 (1.96), T_3 (2.01) and T_4 (2.03) groups. The Overall FCRs were increased gradually with increasing levels of DDGS at 10, 15 and 20% levels in the rations in comparison to the control group. It might be due to less amounts of various amino acids especially lysine in the rations as DDGS contains fewer amounts of amino acids in comparison to soybean meal (NRC, 1994 and wang *et al*., 2007) [13, 24]. These results were in corroboration with the findings of Youssef *et al*. (2008) [26] who reported that feed conversion ratio was worse at the highest DDGS level (15.0%) when broilers were fed diets containing 0, 5, 10 or 15% DDGS from 12 to 35 days of age. Similar trend of increased FCR due to higher inclusion of DDGS in the broiler ration up to 15% was also found by Lukaszewicz and Kowalczyk (2014) [10]. Other workers like Roberson (2003) [16] reported that inclusion of DDGS up to 10% level in the grower or finisher diets for turkey hens did not have any negative effects on feed conversion.

Table 6: Mean Weekly Feed Conversion Ratio (Fcr) Of Broilers Under Different Treatment Groups

Groups / Weeks	T_0 (Control)	T_1 (DDGS - 5%)	T_2 (DDGS- 10%)	T_3 (DDGS- 15%)	T_4 (DDGS- 20%)
1st	1.73	1.74	1.72	1.75	1.77
2nd	2.46	2.47	2.44	2.49	2.53
3rd	1.81	1.79	1.80	1.85	1.88
4th	1.86	1.84	1.85	1.90	1.92
5th	1.88	1.90	1.91	1.98	1.96
6th	2.20	2.15	2.40	2.45	2.48
Overall	1.94	1.92	1.96	2.01	2.03

Survivability rate

The total survivability per cent of broilers were noted to be 94.44, 100.00, 100.00, 97.22, and 91.67 for T_0, T_1, T_2, T_3 and T_4 groups, respectively. Similar type of finding was reported by Thacker and Widyaratne (2007) [25] who found that mortality during the trial averaged 4.8% with the highest mortality being observed in the diet with the highest level of wheat DDGS. Lukasiewicz *et al.* (2012) [9] reported that a lower DDGS level (5%) reduced the mortality of broilers from 5.5 to 3.0%. Similar observations were recorded by Wang *et al.* (2007) [24], Youssef *et al.* (2008) [26], Shalash*et al.* (2009), Loar *et al*. (2010), Hassan and Al Aquil (2015) and Masa'deh *et al*. (2010) who stated that there was no mortality due to using DDGS in broiler chick diets.

Table 7: survivability percentage of birds in different treatment groups

Groups	Number of Birds	Number Of Survive Birds	Survivability %
T_0	36	34 (one died on 4th & 5th week)	94.44
T_1	36	36	100.00
T_2	36	36	100.00
T_3	36	35 (one died on 1st week)	97.22
T_4	36	33 (Two died on 1st week & one died 3rd week)	91.67
Total	180	174	96.67

Economics of production

The cost of production and gross profit per broiler for different treatment groups are shown in Table 8. The table indicated that the cost of production per broiler (Table 8) was found to be (Rs.) 193.43, 181.72, 177.05, 169.18 and 155.84 for T_0, T_1, T_2, T_3 and T_4 groups, respectively. The cost of production per broiler was found to be highest in T_0 (Rs. 193.43) group whereas it was lowest in T_4 (155.84) group. The gross profit per broiler was found to be (Rs.) 19.57, 23.28, 21.95, 17.82 and 15.16 for T_0, T_1, T_2, T_3 and T_4 groups, respectively. Hence, gross profit was highest in T_1 group followed by T_2, T_0, T_3 and T_4 group. The results from the present experimental study revealed that production cost per broiler was reduced gradually according to higher inclusion levels of DDGS at 5, 10, 15 and 20% in the rations. It was due to reduction of cost of feed as the price of DDGS was less than soybean and maize. However, the income from selling live birds was decreased gradually from T_0, T_1, T_2, T_3 and T_4

groups due to decreased final body weight of the birds. Thus, among the five experimental groups, the birds of T_1 group showed best result in terms of gross profit per broiler, which received 5% DDGS in their ration, followed by 10% DDGS inclusion level and then the control group. These findings were in agreement with the results of Lukaszewicz and Kowalczyke (2014) [10] who reported that the inclusion of 5-15 % DDGS in grower and finisher chicken broiler diets, led to lower the feed cost in comparison to control group. Similarly, Choi *et al*. (2008) [2] reported that the use of DDGS in broiler diets up to 15% could decreased feed cost by replacing a part of corn and soybean meal, without any negative effect on growth performance.

Table 8: Cost of Production and Gross Profit (Rs.) Per Broiler Under Different Treatment Groups

Parameters \ Groups	T_0 (Control)	T_1 (DDGS- 5%)	T_2 (DDGS- 10%)	T_3 (DDGS- 15%)	T_4 (DDGS- 20%)
Expenditure					
Chick cost (A) = 1.05 x cost of one day-old chick (Rs.)	36.75	36.75	36.75	36.75	36.75
Feed cost (B)= Live weight in Kg x FCR x *Cost per Kg of feed (Rs.)	131.45	121.27	117.21	110.36	98.76
Miscellaneous expenditure (C) = Add 15% of (A+B) (Rs.)	25.23	23.70	23.09	22.07	20.33
Production cost per broiler (A+B+C+D) (Rs.)	193.43	181.72	177.05	169.18	155.84
II. Return					
Sale of one live broiler @ ` 100 per Kg	213.00	205.00	199.00	187.00	171.00
III. Gross profit per broiler(Rs.)	19.57	23.28	21.95	17.82	15.16

*T_0, 31.81; T_1, 30.81; T_2, 30.05; T_3, 29.36; T_4, 28.45

Conclusion

From our experiment it was observed that DDGS can be safely incorporated with broiler ration at 5 and 10 percent level for economical production. Highest profit was found at 5 percent inclusion level, followed by 10 percent. Thus dietary supplementations of DDGS may have a great impact in economic commercial broiler production.

Acknowledgement

The authors thankfully acknowledge the Assam Agricultural University for providing the facilities to conduct the research.

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