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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effect of Adding Different Dietary Levels of Distillers Dried Grains with Solubles (DDGS) on Productive Performance of Broiler Chicks

S.M. Hassan and A.A. Al Aqil
Department of Animal and Fish Production, College of Agriculture and Food Sciences,
King Faisal University, P.O. Box-402, Al-Ahsa-31982, Kingdom of Saudi Arabia

Abstract: Using distillers dried grains with solubles (DDGS) as a feed ingredient in poultry nutrition has lately been increased. This study was conducted to evaluate the effect of adding different dietary levels of DDGS on the productive performance of broiler chicks from 1 to 35 d of age. Two hundred forty one-d-old broiler chicks were randomly distributed among 3 treatment groups with eight replicates of 10 chicks each. Chicks were fed a broiler diet containing 0.0, 5.0, or 10.0% DDGS. Results obtained from the present study showed no significant differences in body weight, body weight gain, feed intake and mortality rate among dietary treatments from 1-35 d of age. Feed conversion ratio and performance index were significantly better for chicks fed diet containing 5.0% DDGS than those fed diet containing 0.0% DDGS from 8 to 14 d of age only, but were no differences between chicks fed 10.0% and those fed either 0.0 or 5.0% DDGS. These results indicated that adding 5.0% DDGS into broiler diets showed a beneficial effect on feed conversion ratio with the best performance index from 8-14 d of age. Therefore, results suggest that DDGS can be safely added into diet as an alternative source of protein and energy from 1 to 35 d of age up to 10.0% without negative effect on productive performance of broiler chicks.

Key words: Broiler chicks, distillers dried grains with solubles (DDGS), growth rate, productive performance

INTRODUCTION

In the next years, corn will be not completely available for using as a natural energy source to produce ethanol in the most produced countries. Therefore, the price of the corn in the feedstuff market will be increased. So, poultry nutritionists over the world have been searched intensively for feed ingredient alternatives to replace partially with corn and soybean meal in poultry diet. Distiller dried grains with solubles (DDGS) are a by-product obtained from ethanol production of cereal grains. Previous studies has demonstrated that DDGS becoming available now in reasonable prices and quantities. Therefore, DDGS now is recognized as an acceptable, attractive and potentially valuable feed ingredient substitute for poultry to replace partially with expensive soybean meal recognized as the main protein source to produce less expensive diets (Runnels, 1966; Aleniier and Combs, 1981; Parsons *et al*., 1983; Batal and Dale, 2003; Rausch and Belyea, 2006; Noll *et al*., 2007; Swiatkiewicz and Korelski, 2008; Wu-Haan *et al*., 2010).

DDGS contains about 3-fold increase in protein, fat and minerals compared with corn (Liu, 2011). DDGS are mainly source of crude protein (CP) (Belyea *et al*., 2004) containing about 26.0 to 53.39% CP (Cromwell *et al*., 1993; Spiehs *et al*., 2002; Kim *et al*., 2008; Applegate *et al*., 2009) and approximately 2146 to 3554 kcal ME/kg (NRC, 1994; Batal and Dale, 2006; Fastinger *et al*., 2006; Parsons *et al*., 2006; Rochell *et al*., 2011). The amino acid profile of DDGS is very similar to that of corn. Therefore, DDGS is limiting in lysine content ranged from 0.48 to 1.02% (Cromwell *et al*., 1993; Spiehs *et al*., 2002). In addition to protein and energy, DDGS contains crude fat ranged from 2.0 to 14.1% (Cromwell *et al*., 1993; Spiehs *et al*., 2002; Liu, 2008; Saunders and Rosentrater, 2009; Rochell *et al*., 2011) and a beneficial unidentified growth factor (Jensen, 1981). In addition to that, DDGS also is recognized as a useful source of the water-soluble vitamins for poultry (Morrison, 1954; Matterson *et al*., 1966). However, the main problems in the limitation of the use of DDGS for poultry are their considerable variability of nutrient composition content among different DDGS sources and low quality of some nutrients (Cromwell *et al*., 1993; Spiehs *et al*., 2002; Lumpkins *et al*., 2004; Batal and Dale, 2006; Fastinger *et al*., 2006; Swiatkiewicz and Koreleski, 2008).

Early studies recognized that DDGS can be added into poultry diets at level less than 5.0% (Scott, 1970; Jensen, 1981; Parsons *et al*., 1983). Waldroup *et al*. (1981) reported that DDGS can use in broiler diet up to 25% without harmful effect on body weight gain and feed conversion ratio. In another study, Parsons *et al*. (1983) found that DDGS can replace up to 40% of soybean meal protein in broiler diet. On the other hands, it has

Corresponding Author: S.M. Hassan, Department of Animal and Fish Production, College of Agriculture and Food Sciences, King Faisal University, P.O. Box-402, Al-Ahsa-31982, Kingdom of Saudi Arabia

been observed different effects for adding DDGS to poultry diet in recent years. While some studies reported a reduction in productive performance as a result of adding DDGS into broiler diet (Dale and Batal, 2003), another studies observed no negative effects of adding DDGS in broiler diet on growth performance (Matterson *et al*., 1966; Waldroup *et al*., 1981; Parsons *et al*., 1983; Lumpkins *et al*., 2004; Min *et al*., 2009; Loar *et al*., 2010; Shim *et al*., 2011). In controversy, improvements in body weight gain after adding low levels of DDGS into broiler diets were observed by Day *et al*. (1972) and Couch *et al*. (1957). Therefore, the objective of the present study was to determine the effects of three different levels (0.0, 5.0 and 10.0%) of DDGS into diet from 1-35 d of age on the productive performance of broiler chicks.

MATERIALS AND METHODS

This study was conducted from January till March 2014 at the Experimental Station belonged to Collage of Agriculture and Food Sciences, King Faisal University, Kingdom of Saudi Arabia.

DDGS was obtained from a commercial feed mill. DDGS samples were taken and analyzed for approximate chemical analysis for the percentages of the dry matter, crude protein, crude fiber, ether extract and ash according to the methods of AOAC (1995) before formulating the experimental diets. The energy content of DDGS as kcal ME/kg was calculated according to the following formula reported by Meloche (2013):

ME (kcal/kg) = 3673-(121.35 x crude fiber)+(51.29 x ether extract) - 121.08 x ash)

Experimental design: Two hundred forty unsexed one-d-old unsexed Ross-308 broiler chicks were obtained from a local commercial hatchery. Chicks were weighed and randomly distributed in battery cages equipped with source of heat, a trough feeder and a trough waterer among three treatment groups with eight replicates of 10 chicks per replicate. Chicks were assigned to each feed of one of three broiler diets containing 0.0, 5.0 or 10.0% DDGS. All experimental diets were isocaloric and isonitrogenous and contained 3050 kcal/ME/kg and 22% CP, which met the broiler nutritional requirement according to NRC (1994) from 1-35 d of age as shown in Table 1. Feed and water were provided *ad libitum* and lighting regime was continuous throughout the entire course of the study. The temperature was maintained at 32°C for the first week and then reduced until a temperature of 22°C was achieved by the fourth week, gradually. Body weight, body weight gain, feed intake, feed conversion ratio, mortality rate and performance index were weekly recorded from 1-35 d of age. Performance index (PI) was calculated according to the following equation reported by North (1981):

PI = [(body weight (kg)/feed conversion ratio) x 100]

Table 1: Composition[1] of isocaloric and isonitrogenous broiler diets containing 0.0, 5.0, or 10.0% DDGS from 1-35 d of age

	----- DDGS level (%) in broiler diet -----		
Ingredients (%)	0.0	5.0	10.0
Yellow corn	63.70	61.70	59.90
DDGS[2]	0.00	5.00	10.00
Dehulled soybean meal (48.5% CP)	29.50	26.50	23.30
Barley	3.00	3.00	3.00
DL-Methionine	0.10	0.10	0.10
Limestone	1.00	1.00	1.00
Dicalcium PO_4	2.00	2.00	2.00
Salt	0.20	0.20	0.20
Trace minerals[3]	0.25	0.25	0.25
Vitamins[4]	0.25	0.25	0.25

[1]Average calculated analysis of isocaloric and isonitrogenous broiler diets was as follows: CP, 22.02%; ME, 3, 065 kcal/kg; EE, 5.07%; CF, 2.78%; Ca, 0.92%; non-phytin p, 0.50

[2]DDGS used was CP, 33.262%; ME, 3070 kcal/kg; EE, 10.50%; CF, 5.01; ash 4.49%

[3]Trace minerals premix added at this rate yields: 149.60 mg Mn, 16.50 mg Fe, 1.70 mg Cu, 125.40 mg Zn, 0.25 mg Se, 1.05 mg I per kg diet

[4]Vitamin premix added at this rate yields: 11,023 IU vitamin A, 46 IU vitamin E, 3, 858 U vitamin D_3, 1.47 mg minadione, 2.94 mg thiamine, 5.85 mg riboflavin, 20.21 mg pantothenic acid, 0.55 mg biotin, 1.75 mg folic acid, 478 mg choline, 16.50 µg vitamin B_{12}, 45.93 mg niacin and 7.17 mg pyridoxine per kg diet

Statistical analysis: Data obtained were subjected to one-way ANOVA using the GLM procedure of a statistical software package (SPSS 18.0, SPSS Inc., Chicago, IL). Experimental units were based on cage averages. Treatment means were separated as Mean±standard error of means (SEM) and separated ($p \leq 0.05$) using the Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

DDGS analyzed and used in the present study contained 90.50% dry matter, 33.26% crude protein, 5.01% crude fiber, 10.50% ether extract, 4.49% ash and 3070 kcal ME/kg. These results were within the values reported by several studies (Cromwell *et al*., 1993; NRC, 1994; Spiehs *et al*., 2002; Batal and Dale, 2006; Fastinger *et al*., 2006; Parsons *et al*., 2006; Kim *et al*., 2008; Liu, 2008; Applegate *et al*., 2009; Saunders and Rosentrater, 2009; Rochell *et al*., 2011).

The initial body weight was similar among dietary treatments. Also, No significant differences in body weight, body weight gain, feed intake and mortality rate were observed among dietary treatments throughout the experimental period (Table 2). The results obtained from the present study noted that there were significant differences in feed conversion ratio and performance index among dietary treatments only from 8 to 14 d of age. At this period, feed conversion ratio and performance index were significantly better for chicks fed diet containing 5.0% DDGS than those fed diet containing 0.0% DDGS, but were no differences between chicks fed 10.0% and those fed either 0.0 or

Table 2: Productive performance of broiler fed a diet containing 0.0, 5.0, or 10.0% DDGS from 1 to 35-d

	DDGS level (%) in broiler diet		
Age (d)	0	5	10
Body weight (g)			
1	41.47±0.43	40.57±0.33	40.87±0.55
7	102.67±1.45	108.67±0.67	104.33±4.63
14	218.67±15.98	249.00±8.33	243.67±5.36
21	487.54±19.45	527.84±33.26	514.33±8.57
28	802.22±33.90	832.59±32.31	846.67±27.29
35	1217.78±18.99	1211.11±11.11	1264.44±34.44
Body weight gain (g)			
1-7	61.20±1.38	68.10±0.93	63.47±5.18
8-14	116.00±16.46	146.10±13.30	139.33±2.85
15-21	256.27±13.21	259.03±6.32	260.43±8.38
22-28	314.68±14.79	204.75±26.27	332.33±24.97
29-35	415.56±28.04	378.52±25.79	417.78±9.69
1-35	1163.70±17.56	1156.50±2.71	1213.34±23.75
Mortality rate (%)			
1-7	0.00± 0.00	1.25±1.25	1.25±1.25
8-14	0.00±0.00	1.25±1.25	1.25±1.25
15-21	2.50±1.64	3.75±1.83	5.00±2.67
22-28	3.75±1.83	3.75±1.83	5.00±2.67
29-35	2.50±1.64	3.75±1.83	5.00±2.67
1-35	2.50±1.64	3.75±1.83	5.00±2.67
Feed intake (g)			
1-7	88.13±1.47	90.80±3.80	90.70±1.41
8-14	255.93±16.83	232.67±17.12	242.17± 0.90
15-21	394.33±19.79	409.00±1.04	411.33±6.36
22-28	633.20±56.05	703.48±23.77	684.43±22.13
29-35	828.16±29.87	740.03±9.07	828.65±29.45
1-35	2199.77±50.23	2175.98± 35.24	2257.28±49.96
Feed conversion ratio (g feed intake: g body weight gain)			
1-7	1.44±0.05	1.33±0.04	1.45±0.13
8-14	2.28±0.31^{a}	1.60±0.04^{b}	1.74±0.03^{ab}
15-21	1.54±0.02	1.58±0.04	1.58±0.03
22-28	2.01±0.17	2.35±0.24	2.07±0.09
29-35	2.00±0.08	1.97±0.12	1.98±0.04
1-35	1.89±0.04	1.88± 0.04	1.86± 0.01
Performance index			
1-7	7.14±0.35	8.17±0.18	7.37±0.99
8-14	10.19±2.34^{b}	15.62±0.83^{a}	14.02±0.49^{ab}
15-21	31.70±1.48	33.52±2.89	32.56±1.04
22-28	40.42±3.75	36.33±4.55	41.11±3.08
29-35	60.97±2.15	61.90±3.73	63.77±1.12

Means±standard errors of mean within a row that do not share a common superscript are significantly different at $p \leq 0.05$

5.0% DDGS. These results indicated that adding 5.0% DDGS into broiler diets showed a beneficial effect on feed conversion ratio with the best performance index from 8-14 d of age (Table 2). The mortality rate was not differed among dietary treatments and was within the normal range values throughout the experimental period (Table 2).

There were differences in the results obtained from adding DDGS into broiler diets on productive performance in the previous studies. Some research observed a reduction in productive performance of poultry after adding DDGS into the broiler diet up to 15.0% (Dale and Batal, 2003). Lumpkins *et al.* (2004) noted that DDGS can be used in high density broiler diets up to 15% from 1-18 d of age without effect on productive performance, but observed a reduction in body weight gain and worse feed conversion ratio at 7 and 14 d of age for broiler fed low density diets containing 15.0% DDGS from 1-21 d of age. Therefore, they recommended using DDGS up to 6.0 and 12.0 to 15.0% into broiler diets from 1 to 21 and from 22 to 42 d of age, respectively.

However, several studies found no negative effects on productive performance of broiler chicks fed diets containing up to 20.0% DDGS (Matterson *et al.*, 1966). Waldroup *et al.* (1981) reported no negative effects on productive performance for adding 25% DDGS into broiler diet. Also, Parsons *et al.* (1983) found that DDGS can replace up to 30% of the soybean meal in starter diet without negative effect on productive performance of broiler. Thacker and Widyaratne (2007) found no significant differences in body weight gain, feed intake and feed conversion ratio with a reduction in productive performance of broiler fed 20.0% wheat DDGS. Therefore, they concluded that wheat DDGS can use into broiler diets up to 15.0% without negative effect on productive performance of broiler chicks. Wang *et al.* (2007a) observed no negative effect on growth rate, but resulted in increase feed intake and consequently worse feed conversion ratio after adding 25.0% DDGS into broiler diet. They concluded that DDGS can be safely added into broiler diets at levels ranged from 15.0 to 20.0% with little negative effect on productive performance. In the same year, Wang *et al.* (2007b) reported no negative effect on productive performance of broiler fed grower and finisher diets containing DDGS up to 15.0% from 1 to 42 d of age. Also, Youssef *et al.* (2008) fed broiler diets containing 0, 5, 10 or 15% DDGS from 12-35 d of age. They noted no significant effects of increased DDGS levels on feed intake and body weight gain, but feed conversion ratio was worse at the highest DDGS level (15.0%). Therefore, they suggested that DDGS can be used as a protein source in broiler diets from 12-35 d up to 10.0-15.0%. In the same year, Swiatkiewicz and Koreleski (2008) suggested that DDGS can be safely added from 5.0 to 8.0% into starter broiler diet and from 12.0 to 15.0% into grower and finisher broiler diets. Other studies reported that DDGS can be used in broiler diets up to 20.0% from 1 to 18 d (Min *et al.*, 2009) and up to 24.0% from 1 to 42 d (Shim *et al.*, 2011) without negative effect on productive performance. Also, Cuevas *et al.* (2012) found no negative effect on productive performance of broiler fed a diet containing 7.0% DDGS from 1 to 49 d of age. Later, Kaya and Sahin (2013) concluded that supplementing diets with DDGS can be safely used up to 15% without negative effect on productive performance of broiler chicks.

Likewise, Loar *et al.* (2009) found a better growth performance in broilers fed diet containing up to 8.0% DDGS. Also, Loar *et al.* (2010) reported that DDGS can be added into broiler diet up to 8.0% from 1 to 14 d of age and up to 15.0% from 14 to 42 d of age without

negative effect on productive performance. They found that increasing DDGS levels from 7.5, 15.0, 22.5, to 30.0% added into grower diets from 14 to 28 d resulted in a linear decrease in body weight gain. They also noted that chicks consumed feed containing 0.0% DDGS in starter diet exhibited a reduction in feed intake with the higher levels of DDGS used into grower diet, whereas chicks that received 8.0% DDGS in starter diet were unaffected by adding DDGS level in grower diet. They also observed that feed conversion ratio and mortality rate were unaffected by DDGS level in grower diet. Finally, they suggested that the young broiler can be negatively affected with adding 15.0% DDGS or higher up to 28 d of age. Later, Shim *et al.* (2011) recorded higher growth rate of broiler chicks fed DDGS at levels ≥8.0% from 1-18 d of age and without effect on growth rate at 42 d of age.

There are many factors limiting using high levels of DDGS in young broiler chicks diets among them lysine deficiency (Lumpkins *et al.*, 2004; Swiatkiewicz and Kolreleski, 2008), imbalance of essential amino acids (Lumpkins *et al.*, 2004), fiber content (Martinez, 2005) and ability of to digest complex carbohydrates (Montagne *et al.*, 2003). Several studies noted that DDGS can be added at higher levels in broiler diets after adjusting the energy and lysine content of DDGS (Waldroup *et al.*, 1981; Parsons *et al.*, 1983; Wang *et al.*, 2007a,b; Shim *et al.*, 2011). Overheating of DDGS probably resulted in destructing high susceptibility amino acids such as lysine recognized as the first limited amino acid in DDGS (Swiatkiewicz and Kolreleski, 2008).

The reason for the differences observed among the results obtained in the present study for using DDGS in broiler diets and the results recorded in the previous studies might be attributed to the considerable variations in nutrient content, chemical composition among DDGS sources used resulted from the variation in the agronomic and geographical effects, oil extraction, ethanol processing procedures, genetic variation in cereal grains used (Cromwell *et al.*, 1993; NRC, 1994; Leeson *et al.*, 1996; Belyea *et al.*, 1998; Spiehs *et al.*, 2002; Batal and Dale, 2003; Amezcua *et al.*, 2004; Belyea *et al.*, 2004; Lumpkins and Batal, 2005; Batal and Dale, 2006; Fastinger *et al.*, 2006; Parsons *et al.*, 2006; Amezcua and Parsons, 2007; Swiatkiewicz and Koreleski, 2008; Liu, 2009; Kingsly *et al.*, 2010; Dozier III *et al.*, 2011; Liu, 2011; Rochell *et al.*, 2011; Gehring *et al.*, 2013). Variations in metabolizable energy (ME), lysine, phosphorus and sodium content may negatively impact the precision of formulation, resulted in adverse effects on productive performance. Therefore, the nutrient content of DDGS must be recognized to optimize using DDGS in broiler diets. For example, the overestimation or underestimation of energy of DDGS may adversely affect productive performance (Leeson *et al.*, 1996; Saunders and Rosentrater, 2009; Dozier III *et al.*, 2011).

Results obtained from the present study suggest that DDGS can be safely added to diet from 1 to 35 d of age up to 10% without negative effect on productive performance of broiler. However, further studies using dietary higher levels of DDGS with/without exogenous enzymes and amino acids especially lysine on productive performance of broiler may need to be investigated.

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