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Nutritive Value of Distillers Dried Grains with Soluble and Broiler Performance at Starter Period

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Abstract: Three experiments were conducted to evaluate nutritive value of Distillers Dried Grains with Solubles (DDGS) in starter broiler diets using different levels (0, 6, 9 or 12%). Exp. I was design to determine the digestibility coefficients of nutrients for DDGS using 16 cockerels, 40 weeks old compared to a mixture of yellow corn and DDGS 1:1 or 100% DDGS. Feeding cockerels 100% DDGS reduced Crude Protein (CP) from 93.60-92.17%, Ether Extract (EE) from 82.37-75.52%, Crude Fiber (CF) from 27.30-23.47, NFE from 82.85-55.45%) and Organic Matter (OM) from 83.30-69.30%) compared to those fed 50% DDGS. Exp. II was designed to evaluate the nutritive value of DDGS protein using Total Protein Efficiency (TPE) technique. A total number of 80 unsexed one-day old Arbor Acers broiler chicks were distributed between 2 treatments of 40 chicks each in four replicates (10 chicks each) and fed commercial diet (22% CP and 3000 Kcal ME/Kg) for two weeks. On the 14th day, the chicks were fed experimental diets (18% CP) in which cereals (yellow corn and fine wheat bran) provided 6% of dietary CP, while the test material (DDGS) provided 12%, from 14 up to 28 days of age. Significant reduction took place in body weight gain, feed intake, protein intake and T.P.E. value for chicks fed diets containing DDGS compared with those fed diets containing soybean meal as a source of protein. Exp. III, was design to evaluate DDGS at different levels: 0, 6, 9 or 12% in starter broiler diets. A total number of 240 unsexed one-week old Arbor Acers broiler chicks were distributed into 4 treatments of 60 chicks each in six replicates (10 chicks each). Diets were formulated to contain 22% CP and 3070 Kcal ME/Kg at starter period (1-4wks of age). Performance and Relative Economic Efficiency (REE) of chicks fed diets with 6% DDGS approximately equaled those fed control diet (corn/soy). However, reduction in body weight and body weight gain. Took place in both 9 and 12% DDGS supplemental diets, being significant in the 12% diet. A noticeable reduction in REE values took place between treatments. The 6% DDGS level equal almost the control performance. The 9 and 12% DDGS treatments showed lower REE than both control and the 6% level. Inclusion of DDGS in the broiler diets had no effect on mortality rate.

Key words: Distillers dried grains with solubles, broiler diets, soybean meal

INTRODUCTION

Recently, ethanol production has been encouraged to provide more energy than petroleum and is a partially renewable resource. Ethanol producers responded to this emphasis mid to late 1990 by building new plants. Most of the increase in ethanol production capacity is expected to come from new dry grind corn plants. The increase in ethanol production will result in an excess of Distillers Dried Grains with Solubles (DDGS) that will likely provide producers a less expensive and possibly a better quality DDGS. It has long been recognized that DDGS from alcohol beverage industry is a valuable source of energy, protein, water-soluble vitamins and minerals for poultry (Waldroup *et al*., 1981; Wang *et al*., 2007). It is important to reevaluate the content of nutrients and variation in digestibility of some nutrients in DDGS for poultry. It is apparent that there is considerable variability in many of the essential nutrients (Batal and Dale, 2003). Because corn itself varies in nutrient content, concentrating these nutrients approximately three-fold exacerbates the variability in the residual DDGS. In addition, the ratio of blending the distiller's solubles with the residual grains to produce DDGS may vary among producers. Some producers add all of the solubles back, while some divert a portion for other uses including use as a fuel source for the ethanol plant. For most of major nutrients, Spiehs *et al*. (2002) reported almost as much variation within a source as between different plants. Thus, a continual quality control program to characterize the product will be essential if optimum usage is to be made of DDGS in a poultry formula.

Recent studies demonstrated that there may be a high degree of variation in the nutrient content of DDGS. Batal and Dale (2006) reported that CP values ranged between 24-30% with average 27%. This value is similar to the value which reported by NRC (1994). Moreover, Knott *et al*. (2004) demonstrated that the crude protein level in distillers grains may range from 25-35%, with variation also observed in fat (10-12%), NDF (8-10) and

phosphorus (0.8-1%). The Metabolizable Energy (ME) value of DDGS was 2480 kcal ME/kg as reported by NRC (1994). However, Batal and Dale (2006) reported that the true metabolizable energy value of DDGS ranged between 2490-3190 kcal/kg (86%DM basis) and had a mean of 2820 kcal/kg. DDGS can be incorporated in broiler diets if dietary energy is held constant (Waldroup *et al*., 1981). Dale and Batal (2003) suggested a maximum level of 6% DDGS from ethanol production in starter diets and 12% in grower-finisher diets, while Lumpkins *et al*. (2004) indicated that DDGS from modern ethanol plants could be safely used at 6% in the starter period and 12-15% in the grower and finisher periods.

In Egypt, lack of information on DDGS as feed ingredient in poultry diets. Therefore, the present study was design to evaluate nutritive value and using different levels (0, 6, 9 or 12% DDGS) of distillers dried grains with solubles (DDGS) in broiler diets.

MATERIALS AND METHODS

Three experiments were carried out at El-Takmoly, Poultry Project, El-Fayoum Governorate, by Poultry Nutrition Department, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Egypt.

Experiment I: This study was design to determine the digestibility coefficients of nutrients for DDGS using 16 cockerels (40 week old) of two breeds (Shaver and Fayoum) nutrient digestibility was carried out to compare DDGS (100%) with a mixture of yellow corn and DDGS 50:50 (or 1:1). Samples of tested material and dried excreta were assigned for proximate chemical composition according to Official Methods of Analysis (A.O.A.C, 1990). Faecal nitrogen was determined according to method outlined by Ekman *et al*. (1949), while the urinary organic matter fraction was calculated according to Abou-Raya and Galal (1971).

Experiment II: Chick growth test was carried out to evaluate the protein quality of Distillers Dried Grains with Solubles (DDGS) using Total Protein Efficiency (TPE) technique according to the procedure described by Woodham (1968) and Woodham and Deans (1973). A total number of 80 unsexed one-day old Arbor Acers broiler chicks were distributed into 2 treatments of 40 chicks each in four replicates (10 chicks each) and fed commercial diet containing 22% CP and 3000 Kcal ME/Kg lasted for two weeks. On the 14th day, the chicks were weighted and allotted to the experimental treatments from 14 up to 28 days of age. The experimental diets (Table 1) containing 18.5% CP were formulated in which cereals (yellow corn and fine wheat bran) provided 6.2% of dietary CP, while the test material (DDGS) and soybean meal provided 12.3%. At the end of experimental period (14 days) feed consumption and weight gain of each replicate were recorded and TPE was calculated as the following formula:

Table 1: Composition of (TPE) experimental diets (Exp. II)

Ingredients	Control diet (1-14d)	DDGS (14-28 d)	Soybean meal (14-28d)
Yellow Corn	58.84	25.50	59.65
Soybean meal 44%	24.50	-	27.35
Corn gluten meal 60%	9.00		
DDGS		44.45	-
Wheat bran		25.60	8.00
Soybean oil	2.50		
Mono-calcium phosphate	1.82	1.74	1.70
Limestone	1.73	2.05	2.05
Salt	0.49	-	0.50
Premix*	0.30	0.30	0.30
Dried yeast		1.10	0.50
DL-methionine 99%	0.24		
L-Lysine HCl 98%	0.58		
Total	100	100	100
Calculated:			
CP%	22.04	18.50	18.50
ME Kcal/ kg	3090	2314	2723
CF%	3.12	7.43	4.11
EE%	5.15	6.04	2.82
DL-methionine	0.62	0.38	0.30
Methionine + Cystine	0.97	0.69	0.60
L-Lysine	1.35	0.59	0.95
Ca%	1.00	1.04	1.12
Av.P%	0.50	0.50	0.50
Na%	0.20	0.23	0.21

TPE = Total weight gain ÷ total protein consumed

Results of the TPE experiment showed that DDGS may be used as a source of energy and protein, therefore, the second experiment was design to test the possibility of applying DDGS in broiler's diets at starter period.

Experiment III: A total number of 240 unsexed one-week old Arbor Acers broiler chicks were distributed into 4 treatments of 60 chicks each in six replicates (10 chicks each). Diets were formulated (Table 2) to contain 22% CP and 3070 Kcal / Kg at starter period (1-4wks of age). Chicks were housed in gas heated batteries and kept under similar conditions of management during the experimental period that lasted 28 days of age.

The experimental design was as follows:

- Control diet (corn/ soy).
- Diet containing 6% DDGS.
- Diet containing 9% DDGS.
- Diet containing 12% DDGS.

Feed and water were offered *ad-libitum*. Live body weight and feed consumption were weekly recorded and body weight gain and feed conversion (g feed/g gain) were calculated. Mortality rate was daily recorded and

Table 2: Composition of experimental starter diets (Exp. II)

Ingredients	Control diet	Diet containing 6% DDGS	Diet containing 9% DDGS	Diet containing 12% DDGS
Yellow Corn	58.84	56.00	55.04	53.73
Soybean meal 44%	24.50	21.45	19.42	17.77
Corn gluten meal 60%	9.00	9.00	9.00	9.00
DDGS	-	6.00	9.00	12.00
Soybean oil	2.50	2.50	2.50	2.50
Mono-calcium phosphate	1.82	1.74	1.70	1.69
Limestone	1.73	1.71	1.73	1.73
Salt	0.49	0.42	0.40	0.35
Premix*	0.30	0.30	0.30	0.30
DL-methionine 99%	0.24	0.23	0.23	0.22
L-Lysine HCl 98%	0.58	0.65	0.68	0.71
Total	100	100	100	100
Calculated:				
CP%	22.04	22.14	22.00	22.00
ME Kcal/ kg	3090	3080	3077	3070
DL-methionine	0.62	0.62	0.63	0.62
Methionine + Cystine	0.97	0.98	0.98	0.97
L-Lysine	1.35	1.36	1.35	1.35
Ca%	1.00	1.00	1.00	1.00
Av.P%	0.50	0.50	0.50	0.50
Na%	0.20	0.20	0.20	0.20

*Supplied per kg of diet: Vit. A, 12000 IU; Vit. D_3, 2200 ICU; Vit. E, 10 mg; Vit K_3, 2 mg; Vit. B_1, 1mg; Vit. B_2 5 mg; B_6 1.5 MG; B_{12} 10 mcg; Nicotinic acid 30 mg; Folic acid 1 mg, Pantothenic acid 10 mg; Biotein 10 mcg; Choline 250 mg; Copper 10 mg; Iron 30 mg; Manganse 60 mg; Zinc 50 mg; Iodine 1 mg; Selenium 0.1 mg; Cobalt 0.1 mg

the economic efficiency (the net revenue per unit feed cost) was calculated from input-output analysis.

The tested raw material was analyzed for moisture, CP, EE, CF and ash by the methods outlined by Official Methods of Analysis (A.O.A.C, 1990). Amino acid concentrations in DDGS were analyzed with Biochrom 20 amino acid Analyzer based on the described method of Spackman *et al.* (1958). Methionine and cystine were determined in samples oxidized with performic acid.

The data were subjected to one way ANOVA test using General Linear Model of SAS (SAS Institute, 1990). Means separated by Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical and amino acids composition of the experimental ingredients: The chemical and amino acids composition of the distillers dried grains with solubles; yellow corn and soybean meal are summarized in Table 3. Crude protein, ether extract, crude fiber moisture and ash values of DDGS, yellow corn and soybean meal are within the normal range reported by NRC (1994) and Knott *et al.* (2004). However, protein content of DDGS has been reported to vary between 23% and 32% with an average 27.5 %, (Batal and Dale, 2006). This wide range may be due to differences in protein content of the corn grain used to produce DDGS and because of differences in residual starch content (diluting the concentrations of protein and other nutrients) caused by differences in fermentation efficiency. Amino acids profile of SBM is rich in lysine, but deficient in methionine. However, DDGS was lower in methionine and lysine compared with SBM as a source of protein. A reduced concentration of lysine is a characteristic of cereal grains, explaining the reduced concentration of these amino acids in corn co-products when compared with soybean (oilseed) co-products such as SBM. Differences in processing procedures may lead to large variations in the nutritional value of DDGS (Cromwell *et al.*, 1993). In addition, the nutritional value of DDGS is related to its lysine content and is more closely related to acid detergent fiber and acid detergent insoluble nitrogen than to neutral detergent fiber content.

Table 3: Chemical and amino acids composition (%)of DDGS, Corn and SBM

Contents (%)	DDGS	Corn *	Soybean meal*
Moisture	11.29	9.20	9.50
Ether extract	10.50	2.50	1.50
Crude fiber	9.27	4.50	6.50
Ash	4.50	1.82	6.50
Crude Protein	27.65	8.10	44.20
Methionine	0.54	0.18	0.62
Cystine	0.60	0.18	0.66
Methionine + Cystine	1.14	0.36	1.28
Lysine	0.84	0.26	2.69
Therionine	0.97	0.29	1.87
Tryptophan	0.24	ND	ND
Arginine	1.20	0.38	3.14
Isoleucine	1.00	0.29	1.96
Leucine	3.00	1.00	3.39
Valine	1.39	0.40	2.07

ND: Not Determined, *Amino acids according to NRC 1994

Nutrient digestibilities (Exp. I): It is apparent from the Table 4 that feeding 100% DDGS significantly reduced

CP, EE, CF, NFE and OM digestibilities compared to those fed on 50% DDGS + 50% Corn. This may be due to DDGS palatability and to it is high fiber content compared corn.

Total protein efficiency (Exp. II): Results in Table 5 indicated that chicks fed diets containing DDGS (test material provided 12%CP) recorded significantly ($p \leq 0.01$) the lowest values of body weight gain, feed intake, protein intake and T.P.E compared with those fed diets containing soybean meal providing also 12% CP) as a source of protein. These results may be due to the high percentage of DDGS (44.45%) in the diet, which provide high percentage of crude fiber, low lysine and is unpalatable. Moreover, high fiber level may increase the rate of passage of the feed through the digestive tract, thereby reducing the time of ingesta exposure to enzymatic degradation and the time of nutrients contact with the absorptive membranes. This postulator agreed with that reported by Abou El-Wafa *et al.* (2002) who found depression in body weight gain and feed conversion of broiler chicks with increasing crude fiber level from 2.5-7 or 9%. In this respect, Wang *et al.* (2007) reported that chicks fed diets with 30% DDGS had significantly reduced body weight gain and feed intake at 35 and 42 d compared to those fed control without DDGS. In addition, soybean protein is known to have a more favorable amino acid pattern for chick growth than DDGS. The poor protein quality of DDGS may limit its use at higher percentage in poultry diets. These results agree with those reported by Hughes and Hauge (1945) who observed that when DDGS was used as the sole source of protein in a broiler diet, there was a marginal deficiency in lysine, causing a slight decrease in performance. Recently Wang *et al.* (2008) reported that low energy density of DDGS diet is probably the limiting factor in meeting the energy needs of the chick.

Growth performance (Exp. III): The growth performance of broiler chicks fed starter diets (1-4wks) containing different levels: 0, 6, 9 or 12% of DDGS is summarized in Table 6. Performance of chicks fed diets with 6% DDGS was equal to those fed the control diet (corn/soy). Increasing the DDGS level to 9 or 12%, in the diet resulted in significantly reduction in body weight and body weight gain and increased in feed intake and feed conversion. However, feed intake was significantly reduced with 12%DDGS. The drop in feed intake compared to 6 or 9 levels observed in broilers fed diet with 12% DDGS, in this trial, significantly affect the gain and feed conversion of the birds. These results are in agreement with those reported by Lumpkins *et al.* (2004) who indicated that DDGS from modern ethanol plants could be safely used at 6% level in the starter period. Moreover, Dale and Batal (2003) suggested a maximum level of 6% DDGS from ethanol production in broiler starter diets and 12% in grower-finisher diets. This may be interpreted based on diets with higher levels of DDGS had a lower bulk density, which may induce the feeling of fullness before meeting their energy needs (Wang *et al.*, 2007). It appeared that the young birds (up to 28 d) were less able to tolerate high levels of DDGS. Mortality rate (Table 5) was within the normal range. Postmortem investigation indicated no relationship between treatments and mortality rate.

Results of Economic Efficiency (EEF) and Relative Economic Efficiency (REE) are shown in Table 6 indicated that diets containing 6% DDGS recorded almost equal REE (99.1) compared to the control diet. However, increasing DDGS level to 9 or 12% in the diet reduced REE value to 90.35 and 80.92, respectively, compared to the control diet. The increase in feed cost when high level of DDGS, (9 or 12%) are used may be due to the increase of lysine supplementation and reduction in body weight gain and increased feed conversion.

Table 4: Digestibility coefficients of the nutrients in Distillers Dried Grains with Soluble (DDGS)

Items	CP%	EE%	CF%	NFE%	OM%
Shaver breed (50:50)	93.40±0.50	82.10^{a}±0.60	27.90^{a}±0.46	81.90^{a}±0.50	82.70^{a}±0.50
Fayoum breed (50:50)	93.80±0.63	82.65^{a}±0.50	26.70^{a}±0.35	83.80^{a}±0.30	83.90^{a}±0.50
Shaver breed (100 % DDGS)	92.55±0.55	75.95^{b}±0.65	24.10^{b}±0.50	54.95^{b}±0.75	69.35^{b}±0.55
Fayoum breed (100 % DDGS)	91.35±0.50	75.10^{b}±0.80	22.85^{b}±0.50	55.95^{b}±0.95	69.25^{b}±0.55
Average					
(50% DDGS:50% yellow corn)	93.60^{a}±0.50	82.37^{a}±0.50	27.30^{a}±0.43	83.85^{a}±0.59	83.30^{a}±0.45
(100% DDGS)	91.95^{b}±0.50	75.52^{b}±0.50	23.47^{b}±0.50	55.45^{b}±0.57	69.30^{b}±0.50

Table 5: Protein evaluation of distillers dried grains with solubles (TPE method)

Items	Distillers Dried Grains with Solubles (DDGS)	Soybean meal	p≤0.05
Initial body weight (g) at 14 day	291.75 ±4.98	293.13±4.94	0.84
Final body weight (g) at 28 day	556.73±10.63^{b}	754.80±13.26^{a}	0.0001
Body weight gain (g)	264.97 ±8.76^{b}	461.66±9.99^{a}	0.0001
Feed intake (g)	865±6.39^{b}	1085±1.62^{a}	0.0001
Protein intake (g) PI	160.02±1.18^{b}	200.72±0.30^{a}	0.0001
Total protein efficiency TPE (gain/PI)	1.66±0.06^{b}	2.30±0.05^{a}	0.0001

A,b means with no common superscripts within column are significantly different ($p \leq 0.05$)

Table 6: Effect of feeding Distillers Dried Grains with Solubles (DDGS) on growth performance of broiler chicks at starter period (1-4 wks)

Items	Control diet	DDGS 6%	DDGS 9%	DDGS 12%	p≤0.05
Initial body weight (g) at week	106.80±2.45	104.95±1.44	104.66±1.27	103.16±1.66	0.625
Body weight (g) (1-4 wks)	981.00±25.51^{ab}	990.15±10.52^{a}	974.38±11.47^{ab}	941.80±11.48^{b}	0.026
Body weight gain (g)	874.20±23.81^{ab}	885.20±9.81^{a}	869.71±11.04^{ab}	838.63±10.66^{b}	0.023
Feed intake (g)	1365±9.63^{d}	1405±3.43^{b}	1429±2.54^{a}	1391±2.65^{c}	0.0001
Feed conversion (g feed/g gain)	1.58±0.04^{b}	1.59±0.01^{b}	1.65±0.02^{ab}	1.67±0.02^{a}	0.0220
Mortality rate	0/60	1/60	1/60	0/60	
Economic efficiency	0.299	0.297	0.271	0.243	
Relative economic efficiency	100	99.10	90.35	80.92	

A,b, means with no common superscripts within column are significantly different (p≤0.05)

Conclusion: In conclusion, broiler chicks could be safely fed up to 6% DDGS (during starter period) with equal performance to a corn soy diet.

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