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Evaluation of Distiller Dried Grains with Soluble (DDGs) as a Feedstuff in Poultry Diets

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Abstract: Chemical analysis and biological test had been done to evaluate DDGs as an alternative protein source in poultry diets. The chemical analysis included proximate analysis and essential amino acids content. The chemical score (CS) and essential amino acids index (EAAI) values were calculated for the amino acids pattern. The total protein efficiency (TPE) determination was carried out as a biological method to evaluate protein quality.The results of proximate analysis for DDGs recorded values of: 92.20 % dry matter, 26% CP, 17.70 % EE, 7.30 % CF, 4.50 % Ash and 38.14% NFE. DDGs protein appeared to have balanced essential amino acids pattern. The chemical score values cleared that the first limiting amino acid is lysine. EAAI for DDGs protein recorded 59.25 as calculated on whole egg protein base. TPE value for DDGs (1.42) was improved significantly (P<0.01) by adding complementary level of lysine to achieve SBM with no significant difference (2.75 *vs.* 2.72 for SBM and "DDGs + lysine" treatments, respectively).Generally, it can be concluded, from the current study, that DDGs could be considered a poultry feedstuff as an alternative source of protein. It is suggested to not be used as a main source of protein because of its low content of lysine. Therefore, in order to improve the amino acids pattern of DDGs, it can be used either in combination with other protein sources or after dietary supplementation with lysine.

Key words: Poultry · Feedstuff · Ethanol · DDGs · Amino acids · Evaluation · TPE

INTRODUCTION

Feeding cost for poultry is considered to be the most expensive items since it represents about 60-65 % of the total costs [1]. The high prices and limited quantities of protein sources available for using in poultry feeds have resulted in attempts to replace soybean protein in diets by some untraditional plant protein sources.

Due to escalated production of ethanol from corn as biofuel in the U.S.A., the demand for corn is increasing causing a sharp increase in the corn prices [2]. Distillers dried grains with solubles (DDGs) are the major by-products in the fermentation of whole grains to ethanol. Currently, DDGs produced from cereal grains are sold as animal feed.

Nutrient values of DDGs were identified by Spiehs *et al.* [3]. They found that dry matter content of DDGs samples ranged from 88.4 to 90.2% with an average dry matter of 88.9% and average nutrient content for crude fat, crude fiber and crude protein were 10.9%, 8.8% and 30.2%, respectively. They found also that lysine levels are low relative to crude protein in DDGs.

Chemical composition of DDGs was determined by Choi *et al.* [2]. It was 87.52%, 26.53%, 12.50% and 5.79%for dry matter, crude protein, crude fat and crude fiber, respectively. Parsons *et al.* [4] reported that the protein quality of DDGs was comparable to that of Dehulled soybean meal when supplemented with lysine. Parsons [5] recommended supplementation with synthesized amino acids such as lysine, methionine and thrionine when using DDGs in broiler diet. Dong *et al.* [6] found that the amino acid profiles of the whole grains and DDGs were similar. They reported also that chemical scores of DDGs revealed that lysine was the most limiting amino acid.

The protein quality of DDGs produced from corn was assessed by amino acid analysis, protein efficiency ratio (PER) and net protein retention (NPR) bioassays [6].

The objective of this study is to evaluate the quality of DDGs from ethanol production as a feedstuff for poultry.

MATERIALS AND METHODS

The chemical composition was determined according to A.O.A.C. [7] for DDGs and was calculated according to the values tabled by National Research Council, NRC [8] for soybean meal 44 % (SBM). Amino acids in DDGs and

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Table 1: The composition of the basal and tested diets used for the determination of total protein efficiency (TPE)

Ingredients %	Diets		
	SBM	DDGs	DDGs+lysine
Yellow corn	40	33.60	33.65
Soybean meal (44%)	27.27	-	-
Corn gluten meal (62%)	3	5.40	4.55
Wheat bran	6	-	-
DDGs (26%)	-	46.15	46.15
L- lysine HCl	-	-	0.555
Di-calcium phosphate	1.75	1.25	1.26
Lime stone	1.225	1.65	1.635
Starch	20	11.65	11.90
Salt	0.455	-	-
Vit. Min. mixture	0.30	0.30	0.30
Total	100	100	100
Calculated analysis *			
Crud protein %	18.20	18.20	18.20
ME (Kcal/ Kg)	2937	2937	2937
Calcium %	0.95	0.94	0.94
Phosphorus%	0.45	0.45	0.45
Methionine %	0.30	0.30	0.29
Methionine +Cystine %	0.63	0.64	0.61
Lysine	0.90	0.48	0.90
Sodium	0.20	0.24	0.24

* Calculated according to values of NRC [8] or determined values of DDGs

SBM were determined according to the method described by Duranti and Cerlietti [9] using the Spackman amino acid analyzer model 118/119 CL [10]. Methionine and cystine were detected by the procedure described by Moore [11]. The chemical score values (CS) were calculated according to the modified method of Mitchell and Block [12] using amino acids requirement for chicks growth (0-3week) according to National Research Council, NRC [8]. The essential amino acids index (EAAI) was calculated according to Oser [13]. The method of Woodham [14] that had been modified by Woodham *et al.* [15] was employed to determine the total protein efficiency (TPE) as criterion for evaluating the protein quality of this seeds.

Ninety, one-day-old commercial broiler chicks were used in this experiment. Birds were housed in wire battery brooders provided with a thermostatically controlled heating unit. They were given a commercial starter diet for two weeks. At the 14th day of age, the birds were individually weighed to the nearest gram. The birds were randomly divided into three equal groups of approximately similar initial body weight. Birds of each group were subdivided into three replicates of ten birds each. The experimental diets contained 18.22% crude protein, which was consisted of 12% crude protein provided from SBM or DDGs. The composition of the basal (SBM) and tested diets (DDGs or DDGs + lysine) is shown in Table 1.

The experimental diets were given *ad-labium* to the experimental groups from 14 to 28 days of age. The birds in each group were individually weighed and total feed consumption was recorded at the 28th day. The values of body weight gain, feed conversion and total protein consumed were calculated. Then the total protein efficiency was calculated as follows:

$$\text{TPE} = \frac{\text{Weight gain of all birds in each group}}{\text{Protein consumed by each group}}$$

Data were statistically analyzed using the linear model [16]. A simple one-way classification analysis was used followed by LSD test for testing the significance between means.

RESULTS AND DISCUSSION

The chemical composition of DDGs and SBM are presented in Table 2. The results of proximate analysis, for DDGs recorded values of 7.80% moisture, 26% crude protein (CP), 17.70% ether extract (EE), 7.30 % crude fibers (CF), 3.06% ash and 38.14% nitrogen free extract (NFE). It is clear that its moisture content was less than 10%, indicating the possibility of storing DDGs for a long time without deleterious effect.

Crude protein value of DDGs was approximately the same that recorded (26.53%) by Choi *et al.* [2] and lower than recorded (30%) by Spiehs *et al.* [3]. Although DDGs does not contain a high level of CP to be considered as a very rich source of protein as SBM, the DDGs contain a reasonable value of CP, which is comparable to some legume seeds that are used in poultry diets such as Faba bean (23.3%), Pinto bean (16.4%), Black bean (17.98%) and Mungbean seeds (26%) as reported by Iqtidar and Saleem [17] and Hemid *et al.* [18]. However, Annem and Rolland [19] claimed that some legume seeds such as alfalfa seeds (35.1%) and soybean seeds (38.2%) contain higher CP values compared to that of DDGs.

Ether extract (EE) value of DDGs obtained in this study (17.70%) was higher than those reported by Mitchell and Block [12] "9%", Spiehs *et al.* [3] "10.50%",

Table 2: The chemical composition of Distiller Dried Grains with solubles (DDGs) as compared with Soybean meal 44% (SBM)

Nutrients	DDGs (1)	SBM 44 % (2)
Moisture %	7.80	11
Crude protein %	26.00	44
Ether extract %	17.70	0.80
Crude fibers %	7.30	7.00
Ash % (1)	3.06	6.50
Nitrogen free extract (NFE) %	38.14	30.70
ME (K.cal. /Kg) (2)	2480	2230
Calcium % (2)	0.06	0.29
Phosphorus (Total) % (2)	0.69	0.65
Phosphorus (available) % (2)	0.39	0.27

(1) Determined.
(2) NRC [8].

Table 3: The essential amino acids composition (gm / 16 gm nitrogen) of DDGs as compared with yellow corn

ITEM	DDGs (1)	Corn (2)
Arginine	4.26	4.47
Histidine	2.22	2.71
Lysine	2.85	3.06
Phenylalanine	4.63	4.47
Phenylalanine+ Tyrosine	8.70	8.00
Methionine	1.30	2.12
Methionine + Cystine	3.07	4.24
Threonine	3.51	3.41
Isoleucine	2.78	3.41
Leucine	10.22	11.76
Valine	4.19	4.71
Glycine + Serine	8.93	8.23

(1) Determined.
(2) NRC [8].

Waldroup *et al.* [20] "10.08%" and Choi *et al.* [2] "12.50%". This value of EE content of DDGs (17.70%) was, also, higher than the value of 0.8% reported by NRC [8] for soybean meal (44% protein). These differences could be mainly due to the processing technologies conditions [21].

Content of NFE recorded 38.14 % *vs.* 30.70% for DDGs and SBM, respectively. It can be observed from Table (2) also that, ME (K.cal. /Kg) value of DDGs (2480 K.cal. /Kg) is higher than that for SBM 44% (2230 K.cal. /Kg)

Crude fibers (CF) content of DDGs is higher (7.30%) than that reported by Martinez-Amezcua *et al.* [22] "5.30%" and was in agreement with the results of "7.80" % reported by Lumpkins *et al.* [21]. The current results indicated that CF in DDGs was lower than those reported by Mitchell and Block [12].

Table 4: The essential amino acids (gm / 16 gm nitrogen), Chemical Score (CS), First Limiting Amino Acid (FLAA), Second Limiting Amino Acid (SLAA) and Essential Amino Acids Index (EAAI) of DDGs) as compared with Soybean meal (SBM) 44%, whole egg and chick requirements

ITEM	DDGs (1)	SBM (2)	Whole Egg (3)	Chick Requirements (0-3 weeks) (2)
Arginine	4.26	7.14	6.40	5.43
Histidine	2.22	2.66	2.10	1.52
Lysine	2.85	6.11	7.20	4.78
Phenylalanine	4.63	4.91	-	3.13
Phenylalanine+Tyrosine	8.70	9.25	10.80	5.83
Methionine	1.30	1.41	4.10	2.17
Methionine+Cystine	3.07	2.91	6.50	3.91
Threonine	3.51	3.91	4.90	3.48
Isoleucine	2.78	4.45	8.00	3.48
Leucine	10.22	7.70	9.20	5.22
Valine	4.19	4.70	7.30	3.91
Glycine + Serine	8.93	9.52	-	5.43
Total EAAs	50.73	58.35	62.40	45.99
EAAI	59.25	72.07	100	-
CS	59.62	64.98	-	100
FLAA	Lysine	Methionine	-	-
SLAA	Methionine	Methionine +Cystine	-	-

(1) Determined.
(2) NRC [8].
(3) According to Mitchell and Block [12].

The obtained results in Table 2 clearly showed that the ash content in DDGs (3.06%) gave nearly similar results to the values reported by Martinez-Amezcua *et al.* [22] "3.90%", while gave lower value than that reported by Lumpkins *et al.* [21] "4.60" and Waldroup *et al.* [20] "5.15%". It can be observed from table (2) that, although the total phosphorus of DDGs and SBM are nearly similar (0.69% *vs.* 0.65%) available phosphorus value of DDGs was higher (0.39%) than that for SBM (0.27%).

Generally, the proximate analysis of DDGs indicated its good nutritional value in formulating broiler rations due to its CP and NFE or ME content.

The amino acids composition of DDGs and corn grains are shown in Table (3). In general, the relative amino acids concentrations of the whole grains subjected to fermentation were retained in the DDGs.

The essential amino acids (EAAs) content, the calculated values for chemical score (CS) and essential amino acid index (EAAI), as well as, the limiting amino acids in each tested material (DDGs and SBM) are shown

Table 5: The Total Protein Efficiency (TPE) of Distillers Dried Grains with solubles (DDGs) as compared with Soybean meal (SBM)

	Treatments				
ITEM	SBM	DDGs	DDGs +Lysine	SEM*±	P**
Initial weight (gm/bird)	194.7 ᵃ	199.3 ᵃ	194.7 ᵃ	2.68	0.00
Final weight (gm/bird)	625 ᵃ	309.7 ᵇ	577 ᵃ	50.09	0.0001
Weight gain (gm/bird)	430.3 ᵃ	110.4 ᵇ	382.3 ᵃ	30.39	0.0001
Feed consumption (gm/bird)	859 ᵃ	426.3 ᵇ	772 ᵃ	68.45	0.0003
Feed conversion	1.99 ᵇ	3.86 ᵃ	2.01 ᵇ	0.31	0.00
Protein consumption (gm/bird)	156.3 ᵃ	77. 6 ᵇ	140.5 ᵃ	12.41	0.0003
TPE	2.75ᵃ	1.42 ᵇ	2.72 ᵃ	0.23	0.00

a, b, c… means with different superscript (s) in the same row are significantly different (P< 0.05).

* Standard error mean for comparison.

**Probability

in Table 4. The data showed that DDGs contained reasonable amount of EAAs that compared favorably with SBM. DDGs, also, had contained lower level of lysine (2.85 gm/16gm N) than SBM (6.11gm/16gm N). The total EAAs content of DDGs (50.73%) are, in general, in agreement with those of SBM (58.35%). These results indicated that DDGs protein appeared to have balanced EAAs pattern with low content of lysine. It can be observed also from Table 4 that essential amino acid index (EAAI) of DDGs were 59.25, while that of SBM was 72.07 as calculated on whole egg protein base. These results indicate that DDGs protein is considered a good protein quality. Comparing amino acids content of DDGs with that required for chicks growth, based on NRC [8] values during the first three weeks of age, indicate that arginine, lysine and methionine are lower than that required for optimum growth, while the other amino acids being higher than that recommended for chicks growth. However, the calculated chemical score (SC) values indicated that lysine and methionine were the first limiting amino acids (FLAA) in DDGs and SBM, respectively, while methionine and methionine + cystine were the second limiting amino acids (SLAA) in DDGs and SBM, respectively. These results are in agreement with the finding of Dong *et al.* [6]who reported that chemical score revealed that lysine was the most limiting amino acid of DDGs.

Data on the TPE values are shown in Table 5 indicated that, there were significant differences between the two tested protein sources (DDGs and SBM) in feed conversion ratio and TPE values, as SBM being superior. However TPE value for DDGs was improved significantly (P<0.01) by adding complementary level of lysine to achieve SBM with no significant difference (2.75 *vs.* 2.72 for SBM and "DDGs + lysine" treatments, respectively). These results revealed that TPE were significantly reduced while feed conversion ratio was increased when birds fed DDGs without any supplementation indicating that DDGs protein, as *is,* could not completely replace SBM protein unless the limiting amino acid (s) are covered and on the other hand, supplementation of DDGS with lysine significantly improve TPE value (P<0.01). These results are in agreement with the PER and NPR bioassays trend results of Dong *et al.* [6] who found that DDGs diets supplemented with essential amino acids had higher values of PER and NPR than that unsupplemented DDGs diets.

Generally, it can be concluded, from the current study, that DDGs could be considered a poultry feedstuff as alternative source of protein, but it is suggested to not be used as a main source of protein in poultry rations because of its low content of lysine. Therefore, in order to improve the amino acids pattern of DDGs, it can be used either in combination with other protein sources or after dietary supplementation with lysine.

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