Energy utilization of oil extracted-dried distillers grains with solubles (OE-DDGS) in turkeys

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Executive Summary

Six samples of dried distillers grains with solubles (DDGS) were obtained from Brian Kerr (USDA-ARS, Ames, Iowa) and originated from commercial ethanol plants and varied in crude fat content with de-oiling. Samples were provided to different research labs for determination of metabolizable energy (ME) value in three different species – swine, broilers, and turkeys. This report deals with the results of the ME determination in turkeys. Each sample underwent extensive chemical analyses (Kerr, USDA-ARS, Ames, Iowa). Crude fat content ranged from 7 to 13.3% on a dry matter basis. Composition of the DDGS varied in measures of protein, amino acid digestibility, fiber and minerals. Metabolizable energy (ME) content was determined in young turkeys using two methodologies – apparent metabolizable energy (AME) and true metabolizable energy (TME). No statistical differences were observed among DDGS sources for ME measured as apparent metabolizable energy. Statistically significant differences were observed among DDGS sources for ME measured as true metabolizable energy. Metabolizable energy measured as TMEn ranged from 2747 to 3138 kcal/kg (dm basis). Weak correlations of TMEn were observed with DDGS composition for crude protein, crude fat, gross energy, and lysine digestibility coefficient. With such weak correlations, prediction equations using different subsets of composition variables did not generate any valid predictive equations. Numerical ranking of the ME content of the DDGS samples matched that generated with swine (Kerr, USDA-ARS, Ames, Iowa) with the exception of two of six samples. Metabolizable energy content of DDGS for turkeys measured as TMEn tended to be correlated with ME measured in swine, keeping in mind that the data set is limited in number of observations (n=6 DDGS samples). The research project indicated that extraction of oil from DDGS resulted in DDGS with varying composition. Metabolizable energy value tended to decrease with oil content but the decrease in ME was not strongly related to any particular DDGS component including fat content.

Introduction

The ethanol industry has in the past produced primarily DDGS which has contained approximately 31% CP, 12% ether extract (oil), and 44% neutral detergent fiber (NDF) on a DM basis. However, removal of a portion of the oil prior to manufacturing DDGS has become common place. Corn oil in DDGS is high in energy. As the oil content of DDGS is reduced, the energy value is suspected to be reduced. However, the extent of energy reduction at various DDGS fat levels is unknown, but will likely vary among food animal species. Nutritionists need to know the extent of energy reduction in DDGS containing various levels of oil and need methods (e.g. prediction equations) to accurately estimate energy content of DDGS containing various levels of oil for use in animal diets.

As oil in DDGS is removed, both nutritive and non-nutritive components will be concentrated in the DDGS, including protein and fiber, respectively. The potential exists for a greater negative impact of de-oiling on ME for poultry due to decreased ability to digest fiber as compared to swine. Some evidence of such was presented by Rochelle et al. (2011) who determined the energy value of an oil extracted (OE) DDGS to be 2,146 kcal ME/kg DM for broiler chickens, which was substantially less than the 2,781 kcal ME/kg DM for DDGS. Meloche et al. (2013) also noted a negative effect of total dietary fiber on the ME of DDGS for chicken broilers.

Currently, no information is available on the impact of oil extraction on metabolizable energy content of DDGS for turkeys. The main of objective of this study was to determine the metabolizable energy content of DDGS samples that varied in ether extract (crude fat) content using two different methodologies.

Objectives

The overall objective was to determine the impact of decreasing levels of crude fat in DDGS on ME content in young turkeys as related to composition and amino acid quality with the intent to develop ME prediction equations. Comparison was made to ME as determined in swine for the same source material of DDGS.

Description of work performed

Six samples of DDGS were obtained from Brian Kerr (USDA ARS, Ames, Iowa), identified as samples A, B, C, D, E, and F in this report. The analyses were conducted at USDA-ARS or samples were submitted to commercial laboratories. The analyses are presented in Table 1 as provided by Kerr. The six samples were obtained from six different commercial ethanol plants in IA, IL, MN, MO, and SD. Ether extraction was completed to determine the crude fat content of the DDGS. The range in fat content (dry matter basis, dm) was 6.99 to 13.31% with an average crude fat content of 9.9%. Samples A, B, and F had higher fat content. Samples varied in composition as well in terms of protein, lysine, fiber, and mineral content.

Two methodologies were used to determine the metabolizable energy content of the DDGS samples in young turkeys. Using the methodology as published by Rochell et al. (2011) with turkey poults in place of chicks, the turkey poults were raised to 8 days of age in cages. At 8 days of age, turkeys were sorted based on body weight into cage units (6/cage) such that the body weight and weight distribution was similar among cages. Poults were fed the dietary treatments for a 6 day acclimation period followed by 48-hr energy balance assay such that feed inputs and excreta outputs were measured over the 48 hr time period. The collected excreta and diets were processed and analyzed for acid insoluble ash (AIA), gross energy and nitrogen. AMEn (nitrogen corrected) was calculated following the methodologies of Rochell et al 2011 using feed intake and excreta outputs. The other calculation used AIA as a digestibility marker and AMEn was calculated using the methodology of Scott and Hall (1998). The dietary treatments were composed of a corn-soy basal diet with appropriate supplements and containing 15% dextrose. The DDGS material was substituted for the 15% dextrose. Presented results are based on ME calculations from feed intake and excreta output. Use of AIA to determine ME based on digestibility ratio resulted in more variable values due to low levels of AIA in the feed.

In addition to determination of energy value using AME, energy was also determined as true metabolizable energy (TMEn, nitrogen corrected) using the methodology developed by Sibbald and adapted for young turkeys. Turkeys (7 wks old) were housed in individual cages, and were quantitatively fed 30 g of DDGS after a 24 hr fasting period. Excreta was collected underneath the cages for a 48 hr time period and analyzed for gross energy and nitrogen.

Determined AMEn and TMEn (dm) were statistically analyzed using analyses of variance. Treatment means were separated by the LSD procedure when treatment effect was significant ($P<.05$). Results of the ME assays are presented in Table 2. No significant differences were observed in AMEn values for the DDGS samples. For the TMEn, some differences were noted among DDGS samples, such that Sample F had the highest TMEn value, followed by Sample A which was intermediate in value to Sample F and the remaining samples. Sample A and F had numerically higher crude fat contents than the remaining samples. The ability of the TMEn assay to detect differences among the DDGS samples as compared to the AMEn assay may be partly due to the DDGS being the sole source of energy in the TME assay and only accounting for 15% of the diet in the AMEn assay.

Amino acid quality was assessed by determining amino acid digestibility of each DDGS sample using a cecectomized chicken rooster model at the University of Illinois. The methodology is similar to that described for the TME assay. Digestible amino acid content is presented in Table 3. Lysine digestibility

coefficient ranged from 62 to 73%. The average lysine digestibility coefficient of 66.7% was very similar to that reported in previous surveys (Waldroup et al., 2007) of 68%. Sample F had the numerically highest lysine digestibility coefficient.

Correlations (Pearson's) of nutrient composition to the determined ME values were determined with calculated probability. Nutrient composition was not correlated with DDGS AMEn content. As no differences existed among DDGS AMEn, it is not surprising that no significant correlations were found. For TMEn, weak correlations were found with crude protein (-.30, P<.0004), crude fat (.24, P <.02), gross energy (.25, P<.02), and lysine digestibility coefficient (.36, P<.0005). Prediction models using different subsets of composition did not generate a predictive equation with an R^2 greater than .12.

Metabolizable determination was performed in swine with the same material and reported by Kerr et al (2013). Similar to the results of the turkey study, no differences in metabolizable energy content was observed among the six DDGS samples. Swine ME of the DDGS was on average greater than the AME obtained in young turkeys (3798 vs 3276 kcal/kg, dm). Correlations (Pearsons) of swine ME values with turkey AMEn and TMEn tended to be only significant with TMEn (r=.79, P <.06). The ME content of the DDGS samples were ranked using the swine ME values and then compared to the turkey TMEn values (Table 4). The ranking of samples using turkey TMEn was similar to DDGS samples for swine ME with the exception of two samples (C and E). It should be noted that the database for this analyses is small (n=6 samples of DDGs) and needs to be explored further.

Conclusions

Determination of metabolizable energy using the TMEn method was more sensitive in determining differences among 6 samples of DDGS as compared to determination using AMEn calculation methods. In contrast to previously published work by Rochell et al. (2011) and Meloche et al. (2013) with chicken broilers, AMEn measures in turkeys were not correlated with DDGS composition, while correlations using TMEn values resulted in only weak correlations to content of crude protein, crude fat, and gross energy composition so prediction equations could not be developed. Samples of DDGs with higher fat content tended to have greater TMEn values, those with lower fat content tended to have lower but similar TMEn values. While de-oiling appears to decrease the ME level, the composition of the six DDGS samples was unique and a larger data set of samples may be required to dissect the impact of the different DDGS components on ME content for turkeys.

Future research needs

Future research needs would include expanding the data set of samples; a validation study of ME determinations along with a corresponding performance trial to determine the adequacy of the ME determinations. Because of interactions of ingredients within a diet, several different approaches are needed to assess ME adequacy in poultry diets.

Table 1. Composition of six samples of test distillers dried grains with solubles varying in fat content (dry matter basis) (Kerr et al., 2013).

	Sample ID: Distillers Dried Grains w/solubles					
Component (%)	A	B	C	D	E	F
Dry Matter	88.7	88.9	89.3	89.8	90.5	91.3
Crude Protein	29.6	32.0	31.6	30.6	32.2	29.8
Lysine	1.07	1.14	1.13	1.18	1.15	1.10
TDF	31.5	31.6	31.1	32.4	32.8	32.1
NDF	38.3	38.5	39.6	31.0	31.1	27.8
ADF	11.5	12.1	11.6	8.9	8.55	8.55
Hemicellulose	26.8	26.4	28.0	22.0	22.5	19.3
Ash	4.8	4.7	5.4	5.6	5.5	5.5
Crude fat	13.3	10.4	9.1	8.0	7.0	11.4

Table 2. Metabolizable energy content of test distillers dried grains with solubles for young turkeys determined as apparent metabolizable energy (AMEn) and true metabolizable energy (TMEn) (dry matter basis)

	Metabolizable energy (kcal/kg)	
DDGS Sample ID	Apparent metabolizable energy (AMEn)	True metabolizable energy (TMEn)
A	3526	2947[ab]
B	3453	2747[b]
C	3175	2784[b]
D	2923	2761[b]
E	3486	2810[b]
F	3094	3138[a]
P-value	NS	.007

[a,b] Values within the same column with different superscripts are significantly different (P<.05)

Table 3. Amino acid digestibility coefficients (%) for the test samples of dried distillers grains with solubles.

	Sample ID: Distillers Dried Grains w/solubles					
Amino Acid Coefficient (%)	A	B	C	D	E	F
Threonine	77.73	74.89	73.18	71.48	69.24	78.00
Cysteine	78.20	74.93	75.46	83.47	73.93	84.14
Valine	85.35	81.65	83.04	81.91	79.26	83.40
Methionine	87.87	85.41	84.98	88.14	84.29	88.83
Isoleucine	84.64	81.53	82.03	81.30	80.12	83.80
Lysine	68.48	65.23	64.00	66.51	62.32	73.19
Arginine	88.25	84.48	85.46	85.60	82.77	88.01
Tryptophan	90.43	86.94	87.29	86.29	81.67	90.42

Table 4. Comparison of ranking of metabolizable energy of test distillers dried grains with solubles as determined in swine (Kerr et al 2013) and turkeys (dry matter basis)

	Metabolizable energy (kcal/kg)	
DDGS Sample ID	Swine metabolizable energy	Turkey True metabolizable energy (TMEn)
B	3693	2747
D	3716	2761
E	3739	2810
C	3855	2784
A	3880	2947
F	3906	3138