The Professional Animal Scientist 32 (2016):687–694; http://dx.doi.org/10.15232/pas.2016-01524

Concentration of digestible and metabolizable energy and digestibility of energy and nutrients by growing pigs in distillers dried grains with solubles produced in and around Illinois

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ABSTRACT

Illinois is one the major corn producing states in the nation, and much of the corn produced in Illinois is used to produce ethanol. In recent years, ethanol plants have been centrifuging solubles, and the resulting distillers dried grains with solubles (DDGS) contains less fat than conventional DDGS. Therefore, the purpose of this experiment was to determine if the concentration of DE and ME in DDGS produced in and around Illinois varies among plants. Twenty-four barrows (average initial BW: 28.1 ± 1.8 kg) were randomly allotted to 1 of 24 dietary treatments in a 24 × 8 Youden square design with 24 diets and 8 periods. Approximately 250 kg of DDGS was procured from 23 ethanol plants, and a corn diet and 23 corn–DDGS diets were formulated. Results indicated that only 3 of the 23 sources of DDGS could be categorized as conventional DDGS with more than 10% acid hydrolyzed ether extract, whereas the remaining 20 sources of DDGS contained between 5 and 10% acid hydrolyzed ether extract, thus categorizing these sources as low-oil DDGS. The concentration of DE in conventional DDGS was greater ($P < 0.05$) than in low-oil DDGS, and the concentration of ME tended ($P = 0.066$) to be greater in conventional DDGS than in low-oil DDGS. These observations indicate that almost all ethanol plants in and around Illinois remove some of the fat from the solubles, but this practice will reduce the energy value of the DDGS that is produced.

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Key words: distillers dried grains with solubles, energy, pig

INTRODUCTION

Illinois produces approximately 7% of all pigs and approximately 16.5% of the corn in the United States (USDA, 2015). Much of the corn is used for ethanol production, and the resulting distillers dried grains with solubles (**DDGS**) is fed to pigs in Illinois, but swine producers in Illinois may also procure DDGS from ethanol plants located close to the state line in the surrounding states. Conventional DDGS contains approximately 27% CP, 10% fat, 9% ADF, and 25% NDF (Stein and Shurson, 2009), and up to 45% DDGS may be included in diets fed to growing-finishing pigs without major reductions in pig growth performance (Cromwell et al.,

Table 1. Ingredient composition (%) of experimental diets, as-fed basis

	Diet	
Ingredient	Corn	DDGS[1]
Ground corn	97.80	57.80
DDGS	—	40.00
Ground limestone	1.35	1.35
Monocalcium phosphate	0.15	0.15
Sodium chloride	0.40	0.40
Vitamin-mineral premix[2]	0.30	0.30
Total	100.00	100.00

[1]DDGS = distillers dried grains with solubles.

[2]Provided the following per kilogram of complete diet: vitamin A as retinyl acetate, 11,136 IU; vitamin D_3 as cholecalciferol, 2,208 IU; vitamin E as DL-α tocopheryl acetate, 66 IU; vitamin K as menadione dimethylpyrimidinol bisulfite, 1.42 mg; thiamin as thiamine mononitrate, 0.24 mg; riboflavin, 6.59 mg; pyridoxine as pyridoxine hydrochloride, 0.24 mg; vitamin B_{12}, 0.03 mg; D-pantothenic acid as D-calcium pantothenate, 23.5 mg; niacin, 44.1 mg; folic acid, 1.59 mg; biotin, 0.44 mg; Cu as copper sulfate and copper chloride, 20 mg; Fe as ferrous sulfate, 126 mg; I as ethylenediamine dihydroiodide, 1.26 mg; Mn as manganese sulfate, 60.2 mg; Se as sodium selenite and selenium yeast, 0.3 mg; and Zn as zinc sulfate, 125.1 mg.

2011). However, different processing technologies of corn grain are used in the industry, which may result in production of DDGS with different concentrations of energy and nutrients (NRC, 2012). The concentration of DE and ME in conventional sources of DDGS is approximately 3,500 and 3,350 kcal/kg, respectively (Stein and Shurson, 2009), but it is possible that DE and ME differ among sources of DDGS produced using different processing technologies. In recent years, ethanol plants have extracted oil by centrifugation from solubles or from DDGS by solvent extraction using ethanol or hexane (Jacela et al., 2011; Rosentrater et al., 2012; Kerr et al., 2013). This type of processing results in reduced ether extract and possibly reduced concentrations of DE and ME (Kerr et al., 2013). If that is the case, swine producers may purchase DDGS that contains less energy than expected, which may result in inaccuracies in diet formulations. Ultimately, this may also result in poorer performance of pigs fed DDGS-containing diets, which may contribute to a reduced perception among swine producers of the value of DDGS. It was, therefore, the objective of this experiment to determine if the concentrations of DE and ME in DDGS produced in and around Illinois are in agreement with previously obtained values.

MATERIALS AND METHODS

Selection of Distillers Dried Grains with Solubles

Sources of DDGS were procured from 11 ethanol plants in Illinois, 4 ethanol plants in Indiana, 4 ethanol plants in Iowa, 2 ethanol plants in Missouri, and 2 ethanol plants in Wisconsin. Therefore, a total of 23 sources of DDGS were used. The ethanol plants that were not located in Illinois were located within 100 miles from the Illinois state line. Each sample of DDGS (approximately 250 kg) was clearly labeled on arrival at the University of Illinois and stored at approximately 15°C.

Animals, Housing, Experimental Design, and Diets

A total of 24 growing barrows (Genetiporc, Alexandria, MN) with an average initial BW of 28.1 ± 1.8 kg were used in this experiment. Pigs were randomly allotted to 1 of 24 dietary treatments in a 24 × 8 Youden square design with 24 diets and 8 periods. Pigs were placed in metabolism crates that were equipped with a feeder and a nipple drinker, slatted floors, a screen floor, and a urine tray. The crates allow for total, but separate, collection of urine and feces from each individual pig.

A total of 24 diets were formulated, and the basal diet was based on corn, minerals, and vitamins (Tables 1 and 2). Twenty-three additional diets were formulated by mixing corn and 40% of each source of DDGS. Vitamins and minerals were included in all diets to meet current requirements (NRC, 2012). An AA supplement was also formulated to contain 76, 16, and 8% of Lys, Thr, and Trp, respectively.

Feeding and Sample Collection

Diets were provided daily in 2 equal meals in the amount of approximately 90% of ad libitum intake (i.e., 197 kcal ME per $kg^{0.60}$; NRC, 2012). Pigs were allowed ad libitum access to water throughout the experiment. The initial 7 d were considered an adaptation period to the diet. The AA supplement was provided during the adaptation period at 25 g/d and fed in 2 equal portions that were mixed into the meal of each pig. Following the adaptation period, urine and feces were collected during the following 5 d according to standard procedures using the marker-to-marker approach (Adeola, 2001). Urine was collected once daily in urine buckets over a preservative of 50 mL of 3 *N* HCl, the weights of the collected urine were recorded, and 20% of the collected urine was stored at −20°C. Fecal samples were collected twice daily and stored at −20°C. At the conclusion of the experiment, urine samples were thawed and mixed within animal and diet, and subsamples were collected for analysis. Fecal samples were also thawed and mixed within animal and diet, weighed, mixed with water to create a homogenous slurry, weighed