The Professional Animal Scientist 31 (2015):485–496; http://dx.doi.org/10.15232/pas.2015-01444

Compositional effects of corn distillers dried grains with solubles with variable oil content on digestible, metabolizable, and net energy values in growing pigs[1]

B. J. Kerr,*[2] N. K. Gabler,† and G. C. Shurson‡
*USDA-ARS-National Laboratory for Agriculture and the Environment, Ames, IA 50011;
†Department of Animal Science, Iowa State University, Ames 50011; and
‡Department of Animal Science, University of Minnesota, St. Paul 55108

ABSTRACT

Two experiments were conducted in growing-finishing pigs to determine the DE and ME (Exp. 1, 96.3 kg of BW) and NE (Exp. 2, 45.4 kg of BW) content of corn distillers dried grains with solubles (C-DDGS), and to refine or develop DE, ME, and NE prediction equations based on chemical composition of C-DDGS. Composition of the 6 C-DDGS sources varied (ash, 4.71 to 5.63%; CP, 29.65 to 32.21%; ether extract, 6.99 to 13.34%; NDF, 38.27 to 39.58%; total dietary fiber, 31.12 to 32.81%; DM basis), with the determined DE ranging from 3,836 to 4,038 kcal/kg of DM, ME from 3,716 to 3,893 kcal/kg of DM, and NE from 2,107 to 2,310 kcal/kg of DM. Regardless of the range in C-DDGS composition and the resulting DE, ME, or NE value, no chemical parameter measured (GE, CP, starch, total dietary fiber, NDF, ADF, hemicellulose, ether extract, or ash) was significant at $P \leq 0.15$ to be retained in the regression model to predict DE, ME, or NE content in the C-DDGS sources evaluated. Apparent total-tract digestibilities of several nutritional components were also measured for comparative purposes but were not included in the prediction model. On average, the C-DDGS used in these studies contained 3,931, 3,793, and 2,207 kcal of DE, ME, and NE per kilogram of DM, respectively. These results suggest that C-DDGS composition and subsequent DE, ME, and NE can be highly variable and that a wider range in ingredient chemical composition and DE, ME, and NE values, as well as more C-DDGS sources, appear to be necessary to generate energy-prediction equations than used in the current experiments.

Key words: corn distillers dried grains with solubles, ether extract, net energy, pig, prediction equation

INTRODUCTION

Corn dried distillers grains with solubles (**C-DDGS**) have typically contained 10 to 11% ether extract (**EE**), with a ME content similar to corn (Stein and Shurson, 2009). However, recent implementations of oil-extraction technologies by most United States ethanol plants have led to the production of C-DDGS with a wider range of energy and nutrient

[1] This research was financially supported by the National Pork Board (Des Moines, IA). Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the USDA, Iowa State University, or the University of Minnesota and does not imply approval to the exclusion of other products that may be suitable. The authors gratefully acknowledge the assistance of K. Ruge, C. Stoffel, and M. Buyck (Iowa State University, Ames) and J. Cook (USDA-ARS, Ames, IA) with sample collection and laboratory analysis. The USDA is an equal opportunity provider and employer.
[2] Corresponding author: brian.kerr@ars.usda.gov

composition (Anderson et al., 2012; Kerr et al., 2013). Because lipids contain 2.25-times more energy than carbohydrates, removal of lipids likely reduces the DE, ME, and NE content in C-DDGS, which can affect its economic value and dietary inclusion rate in swine feed formulations. In addition, removal of lipids would be expected to concurrently concentrate other components in C-DDGS such as fiber and ash, which have been shown to reduce the caloric value of feedstuffs consumed by an animal (Fernandez and Jorgensen, 1986; Degen et al., 2007; Kim et al., 2012).

Several studies have been published (Stein et al., 2006; Jacela et al., 2011; Kerr et al., 2013) that have determined the DE and ME content of C-DDGS. Recent studies have also developed prediction equations based on chemical analysis to estimate DE and ME content (Pedersen et al., 2007; Anderson et al., 2012; Kerr et al., 2013). In addition, Urriola et al. (2014) conducted a cross-study validation of these and other published equations for C-DDGS. Only one study (Gutierrez et al., 2014) has estimated the NE content of C-DDGS, and no study has determined whether prediction equations to estimate NE of C-DDGS content can be based on chemical analysis.

Therefore, the objectives of this study were to determine whether the chemical composition of C-DDGS samples varying in energy and nutrient content could be used to develop or refine DE, ME, and NE prediction equations.

MATERIALS AND METHODS

Animal Management

The Institutional Animal Care and Use Committee at Iowa State University (Ames) approved all experimental protocols. Two experiments (Exp. 1 and Exp. 2) were conducted using gilts that were offspring of PIC Camborough 22 sows × L337 boars (Pig Improvement Company, Hendersonville, TN). In each experiment, gilts were fed a standard diet based on corn and soybean meal before being assigned to experimental diets. Gilts were weighed at the beginning of the adaptation period and end of each collection period for both experiments.

Exp. 1

In Exp. 1, 2 groups of 24 and 1 group of 20 gilts (n = 68; final BW = 96.3 kg, SD = 10.1 kg) were housed individually in metabolism crates (0.7 × 1.5 m) that allowed for separate but total collection of feces and urine. Crates were equipped with a stainless steel feeder and a nipple waterer, to which the pigs had ad libitum access. Based on past experience in digestibility studies (Lammers et al., 2008; Kerr et al., 2009, 2013; Anderson et al., 2012), each pig was used as their own control (i.e., fed the basal diet), and thus, 2 feeding periods were used within each group. To accomplish this, a switch-back design was used. During period 1, pigs in crates 1 through 12 were first fed the basal diet while pigs in crates 13 through 24 were first fed the 60% basal plus 40% C-DDGS dietary treatments. In contrast, during period 2, pigs in crates 1 through 12 were fed the 60% basal plus 40% C-DDGS treatments while pigs in crates 13 through 24 were fed the basal diet. Use of this experimental design concept is supported by Jacobs et al. (2013), who reported that use of covariates in digestibility studies are one way to reduce animal-to-animal variation. Within this design, gilts were assigned randomly to either the basal or a C-DDGS-containing diet, resulting in a total of 68 observations for pigs fed the basal diet and 8 or 12 observations for pigs fed the C-DDGS sources. Feed was offered at approximately 3% of BW during each 9-d adaption and 4-d collection period.

During the time-based, 4-d total fecal and urine collection period, stainless steel screens were placed under each metabolism crate for total fecal collection and stainless steel buckets containing 25 mL of 6 *N* HCl were placed under each crate for the total urine collection. Feces and urine were collected twice daily and stored at 0°C until the end of the collection period. Feces were pooled by pig over the 4-d period, dried in a 70°C forced-air oven, weighed, and ground through a 1-mm screen, with a subsample taken for analysis. Likewise, urine samples were pooled by pig over the 4-d period, thawed at the end of the collection period, and weighed, with a subsample collected for analysis.

Exp. 2

For Exp. 2, a separate group of 79 gilts was used in a 35-d feeding trial. Pigs (initial BW = 45.3 kg, SD = 4.2 kg) were allotted randomly to individual pens (0.57 × 2.21 m), allowed free access to feed and water, and maintained in rooms with 24-h lighting.

Whole body composition, lean, lipid, and bone mineral contents were predicted using a Hologic Discovery A Dual Energy x-ray Absorptiometry (**DXA**; Bedford, MA) as described by Suster et al. (2003, 2004). The daily NE_m for each pig was calculated as 179 kcal/kg of $BW^{0.60} \cdot d^{-1}$ (Noblet et al., 1994), with protein assumed to contain 5.54 kcal/g and lipid assumed to contain 9.34 kcal/g (Birkett and DeLange, 2001). Conversion of whole body DXA-predicted lean to whole body predicted protein was calculated as 4.59 g of lean = 1 g of whole body protein based on body composition and DXA calibration data determined previously (N. Gabler, unpublished data). Initial and final (d-35) body composition was obtained on each pig using DXA following an overnight feed withdrawal and short transport to the scanning room. For each scan, pigs were weighed, anesthetized with an i.m. injection of telazol:ketamine:xylazine (2:1:2, 4.4 mg/kg, 2.2 mg/kg, 4.4 mg/kg, respectively) at a dose of 1 mL per 45.5 kg of BW and placed prone on the scan table with hind legs and fore legs extended. Each pig was then DXA scanned and allowed to recover