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Evaluation of ME predictions and the impact of feeding maize distillers dried grains with solubles with variable oil content on growth performance, carcass composition, and pork fat quality of growing-finishing pigs

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ABSTRACT

A total of 432 pigs (initial BW: 25.8 ± 5.1 kg) were used to evaluate growth performance, carcass characteristics, and pork fat quality of growing-finishing pigs fed maize–soybean meal diets containing 40% distillers dried grains with solubles (DDGS) with variable ether extract (EE) content, but similar predicted ME concentration (3232 to 3315 kcal/kg predicted by a commercial service). Pigs were blocked by initial BW, and within blocks, pens were allotted randomly to 1 of 4 dietary treatments (9 pigs/pen, 12 replicates/treatment) in a 4-phase feeding program (26–50 kg, 50–75 kg, 75–100 kg, and 100–120 kg BW). Dietary treatments consisted of: (1) maize–soybean meal (CON); (2) 40% low-oil DDGS (59 g/kg EE; LOW); (3) 40% medium-oil DDGS (99 g/kg EE; MED); and (4) 40% high-oil DDGS (142 g/kg EE; HIGH). Diets contained similar concentrations of standardized ileal digestible amino acids and standardized total tract digestible *P* within each phase. Overall, ADFI of pigs fed CON was greater ($P < 0.05$) than those fed MED and HIGH, resulting in pigs fed CON having greater ($P < 0.05$) overall ADG than pigs fed LOW, MED, and HIGH diets. However, ADFI and ADG did not differ among DDGS treatments, but pigs fed LOW had reduced ($P < 0.05$) G:F compared with the other treatments. Pigs fed CON had greater ($P < 0.05$) HCW, carcass yield, and LM area than those fed the DDGS diets, but there were no differences among DDGS treatments. No treatment differences were observed for backfat depth and percentage of carcass fat-free lean. Back, belly, and jowl fat iodine value of pigs fed LOW and MED were less ($P < 0.01$) than in pigs fed HIGH but greater ($P < 0.01$) than in pigs fed CON. Based on the observed overall G:F responses, dietary ME content of LOW was less than MED, HIGH, and CON diets, indicating a slight overestimation of predicted ME concentration for the low-oil DDGS source using either the commercial service estimates or the Anderson et al. (2012) equations.

Abbreviations: AA, amino acids; ADF, acid detergent fiber; ADFI, average daily feed intake; ADG, agverage daily gain; BF, backfat; BW, body weight; C18:2, linoleic acid; CP, crude protein; DDGS, maize distillers dried grains with solubles; DE, digestible energy; DM, dry matter; EE, ether extract; FFL, carcass fat-free lean; PUFA, polyunsaturated fatty acids; GF, gross energy; G:F, gain to feed; IV, iodine value; LMA, loin muscle area; ME, metabolizable energy; MUFA, monounsaturated fatty acids; NDF, neutral detergent fiber; SFA, saturated fatty acids; SID, standardized ileal digestible; STTD, standardized total tract digestible; TDF, total dietary fiber.

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In conclusion, including 40% DDGS in maize–soybean meal-based diets negatively impacted the growth performance of growing-finishing pigs. However, reduced EE content of DDGS sources did not affect ADG, ADFI, and carcass composition, and led to improvements in pork fat quality. These results suggest that current ME predictions need to be refined for more accurate estimation of ME content for low-oil DDGS sources for swine.

1. Introduction

Maize dried distillers grains with solubles (DDGS) is a widely used alternative feed ingredient in swine diets, with an metabolizable energy (ME) content comparable to maize (Stein and Shurson, 2009). However in recent years, most ethanol plants have been extracting maize oil, thereby producing reduced-oil DDGS. Oil extraction has resulted in large variability in ether extract (EE; 50–120 g/kg) and ME content among DDGS sources (Kerr et al., 2013), which may increase the risk of inaccurate diet formulations. Although the reduction in oil content was expected to reduce ME content of DDGS, Kerr et al. (2013) showed that EE content was a poor predictor of ME content.

Prediction equations (Pedersen et al., 2007; Anderson et al., 2012; Kerr et al., 2013) and a commercial service (ILLUMINATE; Nutriquest, Mason City, IA) have been developed to predict ME content of DDGS sources based on chemical composition. Cross-validation of published equations by Urriola et al. (2014) indicated that using the combination of equations from Anderson et al. (2012): Digestible energy (DE) = −2,161 + (1.39 × gross energy; GE) − (20.7 × neutral detergent fiber; NDF) − (49.3 × EE) and ME = −261 + (1.05 × DE) − (7.89 × crude protein; CP) + (2.47 × NDF) − (4.99 × EE), generated the most accurate and precise ME estimates for DDGS. However, these estimates require validation using growth performance data.

Feeding diets containing a traditional high-oil (>100 g/kg EE) DDGS source reduced belly and pork fat firmness because maize oil contains a high concentration of polyunsaturated fatty acids (PUFA; Stein and Shurson, 2009; Xu et al., 2010a; Davis et al., 2015). Pork fat quality may be improved by feeding DDGS sources with less oil content, but limited data are available to show the magnitude of this improvement. The objectives of this study were to determine the effects of feeding diets containing 40% DDGS with variable oil content on growth performance, carcass traits, and pork fat quality of growing-finishing pigs, and to evaluate the ME predictions for DDGS using the Anderson et al. (2012) equations and ILLUMINATE® estimates.

2. Materials and methods

All experimental procedures in this study were approved by the University of Minnesota Institutional Animal Care and Use Committee (St. Paul, MN).

2.1. Animals and housing

Pigs (416 barrows and 16 gilts) were blocked by initial body weight (BW; 25.8 ± 5.1 kg) and allotted to 12 blocks (4 pens/block; 9 pigs/pen). In blocks 1–4, gender ratio was balanced among pens (8 barrows and 1 gilt), but blocks 5 through 12 were comprised of only barrows. Pigs were housed in an environmentally controlled (20 °C) grower-finisher facility at the University of Minnesota West Central Research and Outreach Center (Morris, MN). Each 1.60 × 4.5 m pen consisted of completely slatted, concrete floors, and was equipped with a nipple waterer and 1 single-sided self-feeder with 4 feeding spaces. Pigs were allowed ad libitum access to feed and water throughout the experiment. Pigs that showed signs of poor health were treated individually with appropriate medication or removed from the experiment.

2.2. Diets and experimental design

ILLUMINATE® (Nutriquest, Mason City, IA) is a proprietary commercial service that uses chemical composition of DDGS sources and prediction equations to estimate DE, ME, net energy (NE), and standardized ileal digestible (SID) amino acid (AA) content of the majority of DDGS sources produced by ethanol plants in the U.S. Results from this ILLUMINATE® service were used to select 3 sources of DDGS with variable oil content, but similar ME concentration, for evaluation in this study. These DDGS sources contained: (1) 58.7 g/kg EE and predicted ME of 3258 kcal/kg for low-oil DDGS (Frontier Ethanol, Gowrie, IA); (2) 98.5 g/kg EE and predicted ME of 3315 kcal/kg for medium-oil DDGS (ADM, Cedar Rapids, IA); and (3) 142.3 g/kg EE and predicted ME of 3232 kcal/kg for high-oil DDGS (Abengoa BioEnergy, Mt. Vernon, IN). All sources of DDGS, maize, and soybean meal were obtained in single lots, and samples were obtained for chemical analyses (Table 1). Results of these analyses were used in diet formulation. Gross energy content of DDGS was determined using bomb calorimetry at the University of Minnesota (Model 1281; Parr Instrument Co., Moline, IL). The estimated ME concentrations for each DDGS source were calculated using the combination of equations from (Anderson et al., 2012): DE = −2,161 + (1.39 × GE) − (20.7 × NDF) − (49.3 × EE) and ME = −261 + (1.05 × DE) − (7.89 × CP) + (2.47 × NDF) − (4.99 × EE). Selection of these equations was based on the results