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Short communication

Biofuel co-products as swine feed ingredients: Combining corn distillers dried grains with solubles (DDGS) and crude glycerin

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ABSTRACT

The objective of this study was to examine the effects of combining corn DDGS with crude glycerin on growth performance and carcass traits to determine if a high level of crude glycerin supplementation could counteract the impact of corn DDGS on fatty acid profile of pork adipose. The experimental design was a 3 × 2 factorial arrangement of treatments with three levels of corn DDGS (0, 150, or 250 g/kg diet) and two levels of crude glycerin (0 or 100 g/kg diet). Pigs were fed one of six experimental diets over a 3-phase feeding program for 84 d with each diet within phase formulated to be equal in metabolizable energy (ME) and standardized ileal digestible lysine (SID Lys). Pigs and feeders were weighed every 14 d to determine average daily gain (ADG), average daily feed intake (ADFI) and feed efficiency (G:F). On d-84, pigs were weighed and scanned using real-time ultrasound to obtain fat depth and longissimus dorsi muscle (LM) area. Pigs were then harvested at a commercial abattoir and a sample of adipose was collected from the jowl of each pig. Because there was no interaction between level of corn DDGS and crude glycerin fed, only main effects are presented. Pig performance and carcass characteristics were not affected by dietary treatment ($P \geq 0.05$). Differences in fatty acid composition were present due to dietary treatment. Increasing the level of corn DDGS reduced concentration of both saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) and increased the concentration of polyunsaturated fatty acids (PUFA) in pork jowl adipose ($P<0.01$). Pigs fed 100 g crude glycerin/kg diet had higher concentrations of MUFA and lower concentrations of PUFA ($P<0.05$). Diets containing up to 250 g corn DDGS/kg and 100 g crude glycerin/kg support growth of finishing pigs. However, increasing dietary levels of corn DDGS increased the concentration of unsaturated fatty acids in pork jowl adipose and this was not ameliorated by feeding 100 g/kg crude glycerin.

Abbreviations: ADFI, average daily feed intake; ADG, average daily gain; BW, body weight; d, day; CP, crude protein; DDGS, dried distillers grains with solubles; EE, ether extract; G:F, feed efficiency (ADG/ADFI); LM, longissimus dorsi muscle; Lys, lysine; ME, metabolizable energy; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids; SBM, soybean meal; SID, standardized illeal digestibility; Thr, threonine; Trp, tryptophan.

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1. Introduction

Traditional, energy-rich feedstuffs for pigs such as corn and soybean oil are also the most common feedstocks for production of biofuels in the United States. Biofuel production from traditional pig feedstuffs results in generation of co-products that can be fed to pigs, specifically corn distillers dried grains with solubles (DDGS) from ethanol production and crude glycerin from biodiesel refining. As reviewed by Stein and Shurson (2009), the value of corn DDGS as a feedstuff for pigs has been examined for more than 60 years. In most cases, growing-finishing pigs fed diets containing limited amounts (≤250 g/kg) of corn DDGS have similar performance compared to pigs fed diets containing no corn DDGS (Stein and Shurson, 2009). Less research has been conducted examining feeding crude glycerin to pigs. However it has been demonstrated that crude glycerin from biodiesel refineries operating in the United States is a highly available energy source for growing pigs (Lammers et al., 2008b; Kerr et al., 2009). It has also been shown that pigs can be fed up to 100 g crude glycerin/kg diet with little or no effect on performance (Kijora et al., 1995, 1997; Lammers et al., 2008a; Kerr et al., 2011).

Oil is concentrated in corn DDGS and contains large amounts of unsaturated fatty acids (Benz et al., 2010; NRC, 2012). It has been shown that feeding increased amounts of corn DDGS to growing pigs increases the PUFA concentration particularly linoleic acid (C18:2), in pork adipose tissue (Benz et al., 2010,b; Xu et al., 2010a,b; Duttlinger et al., 2012), resulting in softer pork fat which decreases the overall quality of the pork carcass (NPB, 2000; Hilbrands et al., 2013). Feeding 100 g crude glycerin/kg diet to growing pigs has been shown to decrease linoleic acid (C18:2) content of pork adipose (Lammers et al., 2008a). It has also been demonstrated that feeding 80 g crude glycerin/kg diet to pigs 8 wk prior to harvest improves pork belly firmness (Schieck et al., 2010). The objectives of the current study were to examine the effects of combining corn DDGS and crude glycerin on growth performance and carcass traits and to determine if a high level of crude glycerin supplementation could counteract the impact of corn DDGS on fatty acid profile of pork jowl adipose.

2. Materials and methods

2.1. Experimental design

All procedures were approved by the Iowa State University Animal Care and Use Committee. One hundred and forty-four pigs, initial body weight (BW) 39.5 ± 0.5 kg, were allotted to 36 pens (4 pigs/pen) with sex distribution and pen weight balanced at the start of the experiment. One of six dietary treatments was randomly assigned to each pen with six replications per treatment. Diets were corn–soybean meal (SBM) based with different levels of crude glycerin and corn DDGS. The experimental design was a 3 × 2 factorial arrangement of treatments with three levels of corn DDGS (0, 150, 250 g/kg) and two levels of crude glycerin (0 or 100 g/kg).

2.2. Diet formulation

Laboratory analysis was used to estimate standardized ileal digestible (SID) amino acid profile of corn DDGS and to calculate the metabolizable energy (ME) content of corn DDGS and crude glycerin used in the experiment. The corn DDGS laboratory analysis was 114, 112, and 22 g/kg total Lys, Thr, and Trp, respectively on a dry matter (DM) basis. Based on Pahm et al. (2008) it was assumed that the SID of Lys, Thr, and Trp was 68.5%, 74.7%, and 70.8%, respectively. Thus the calculated SID Lys, Thr, and Trp content for the corn DDGS used in this experiment was 78.1, 83.7, and 15.6 g/kg DM. The ME content of corn DDGS used in this experiment was estimated as 14.24 MJ/kg (Honeyman et al., 2007). When corn DDGS was added to the corn–SBM diets the approximate substitution was: add 100 kg corn DDGS, 1.85 kg ground limestone, and 0.15 kg L-lysine–HCl; remove 76 kg corn, 23 kg SBM, and 3 kg dicalcium phosphate.

The crude glycerin used in this experiment was 834 g glycerin/kg and contained 21.1 g sodium/kg on an as fed basis. Based on Lammers et al. (2008b) the ME content of crude glycerin used in this experiment was estimated as 13.22 MJ/kg as fed. When crude glycerin was added to the corn–SBM diets in the current experiment the approximate substitution was: add 100 kg crude glycerin and 8 kg SBM; remove 104 kg corn and 4 kg salt.

2.3. Experimental procedures

Pigs were fed diets over a 3-phase feeding program during the 84 d trial. Diets were offered *ad libitum* and in meal form. Within each phase, diets were formulated to be similar in ME, SID Lys, Thr, and Trp, available phosphorus, and total Na and Cl. Diet formulation and calculated nutrient content by phase are presented as Table 1.

Pigs were individually weighed every other week with feed disappearance recorded at the time of weighing to determine ADG, ADFI, and G:F. Dietary phase changes corresponded with the day pigs were weighed, occurring on the same day for all treatments. Pigs were housed in partially slatted finisher pens (2.7 m × 1.8 m) within a mechanically ventilated finishing room. On d 84, all pigs were weighed (124.7 ± 1.4 kg of BW) and scanned using real-time ultrasound as described by Sullivan