Animal Feed Science and Technology xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Diet nutrient digestibility and growth performance of weaned pigs fed sugar beet pulp

L.F. Wang[a], E. Beltranena[a,b], R.T. Zijlstra[a,*]

[a] Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta T6G 2P5, Canada
[b] Alberta Agriculture and Rural Development, Edmonton, Alberta T6H 5T6, Canada

ARTICLE INFO

Article history:
Received 24 June 2015
Received in revised form 6 November 2015
Accepted 7 November 2015
Available online xxx

Keywords:
Digestibility
Growth
Performance
Pig
Sugar beet pulp

ABSTRACT

Dietary inclusion of fibrous alternative feedstuffs in swine diets to replace cereal grains can be economically important for pork producers; however, limits for young pigs to ingest high-fibre diets are not well established. The effects of increasing inclusion of sugar beet pulp (SBP) by substituting wheat grain on diet nutrient digestibility and growth performance of young pigs were evaluated. In total, 220 pigs (initial body weight 7.5 kg) were fed Phase 1 diets for 2 weeks (day 1–14) starting 1 week after weaning at 19 days of age and sequentially Phase 2 diets for 3 weeks (day 15–35). Five pelleted wheat-based diets including 0, 60, 120, 180 and 240 g SBP/kg were fed. The SBP contained (as-fed) 90 g crude protein (CP) and 249 g acid detergent fibre (ADF)/kg. Phase 1 and 2 diets were formulated to provide 9.6 and 9.4 MJ NE/kg and 1.3 and 1.2 g standardised ileal digestible (SID) Lys/MJ NE, respectively. Diets were balanced for NE by increasing canola oil from 5 to 50 g/kg for Phase 1 and 2 diets and for AA by increasing crystalline AA. Increasing dietary inclusion of SBP up to 240 g/kg increased ADF content of diets to 101 g/kg, linearly reduced ($P < 0.001$) apparent total tract digestibility coefficient (CATTD) of gross energy (GE) by 0.04 and of CP by 0.08 feeding Phase 1 diets, quadratically reduced ($P < 0.001$) CATTD of GE by 0.01 and linearly reduced ($P < 0.001$) CATTD of CP by 0.06 feeding Phase 2 diets. Increasing inclusion of SBP up to 240 g/kg linearly reduced ($P < 0.001$) calculated diet NE value by 0.35 MJ/kg in Phase 1 and quadratically increased ($P < 0.001$) calculated diet NE value by 0.29 MJ/kg in Phase 2. Increasing inclusion of SBP quadratically reduced ADFI ($P < 0.05$) for day 29–35 and linearly reduced average daily gain (ADG; $P < 0.05$) for day 15–35. The G:F was linearly increased ($P < 0.05$) for day 1–7, linearly reduced ($P = 0.01$) for day 15–21 and quadratically reduced ($P < 0.05$) for day 15–28. Overall (day 1–35), increasing dietary inclusion of SBP up to 240 g/kg linearly reduced ($P < 0.05$) ADFI and ADG by 46 g/d, quadratically reduced ($P < 0.01$) G:F and linearly reduced ($P < 0.05$) final BW at day 35 by 1.1 kg. However, growth performance did not differ ($P > 0.05$) between pigs fed diets containing 0 or 60 g SBP/kg. In conclusion, weaned pigs maintained growth performance with diets containing 65 g ADF/kg, but not for diets containing up to 101 g ADF/kg.

Abbreviations: ADF, acid detergent fibre; ADFI, average daily feed intake; ADG, average daily gain; BW, body weight; CATTD, apparent total tract digestibility coefficient; CP, crude protein; DE, digestible energy; DM, dry matter; G:F, feed efficiency (gain to feed ratio); GE, gross energy; Lys, lysine; NDF, neutral detergent fibre; NE, net energy; NSP, non-starch polysaccharides; SBP, sugar beet pulp; SID, standardised ileal digestible.

* Corresponding author.
E-mail address: ruurd.zijlstra@ualberta.ca (R.T. Zijlstra).

http://dx.doi.org/10.1016/j.anifeedsci.2015.11.005

1. Introduction

Increasing cost for cereal grains and soybean meal has made dietary inclusion of alternative feedstuffs more acceptable to pork producers (Zijlstra and Beltranena, 2013; Woyengo et al., 2014). Many alternative feedstuffs contain more fibre than traditional feedstuffs they replace so their inclusion increases dietary fibre content. Increased dietary fibre is a concern, because young pigs have a limited capacity to digest fibre (Bach Knudsen and Jørgensen, 2000). However, increasing dietary acid detergent fibre (ADF) content by 22 g/kg by replacing soybean meal with canola meal did not reduce feed intake in weaned pigs (Landero et al., 2011). Moreover, increased dietary ADF content by 15 g/kg by replacing oat groats with barley increased feed intake (Beaulieu et al., 2006). Thus, the paradigm that young pigs eating high fibrous diets cannot maintain feed intake might be dependent on fibre type and requires validation to maximise opportunities to use fibrous feedstuffs.

We decided to challenge this paradigm by feeding sugar beet pulp (SBP) that is a co-product of processing sugar from sugar beets, a crop with global production of 250 million tonnes (FAOSTAT, 2013). Noticeably, SBP contains 700 g carbohydrates/kg mainly as non-starch polysaccharides (Serena and Knudsen, 2007) and less crude protein (CP) but more lysine (Lys) than wheat grain. Sugar beet pulp contains fibre that is fermentable and has high water-binding capacity that may alter physicochemical properties of digesta (Noblet and Le Goff, 2001; Serena and Knudsen, 2007) and thereby affect feed intake or growth. Dietary inclusion of 300–550 g SBP/kg for growing pigs decreased diet nutrient digestibility, but did not reduce feed intake (Urriola and Stein, 2012; Zhang et al., 2013). For weaned piglets, dietary inclusion of 120 g SBP/kg did not affect growth performance (Schiavon et al., 2004). Growth performance of weaned pigs fed diets with more than 120 g SBP/kg to replace cereal grain and also dose responses of SBP on growth performance and nutrient digestibility have not been reported.

The hypothesis was that pigs offered diets containing up to 240 g SBP/kg and formulated to equal net energy (NE) and standard ileal digestible (SID) amino acid content would have dietary nutrient digestibility and growth performance not different from pigs fed a diet without SBP. The objectives were to determine whether a dose response exists for apparent total tract digestibility coefficients (CATTD) of important dietary nutrients and growth performance of weaned pigs fed diets containing up to 240 g SBP/kg replacing wheat grain.

2. Materials and methods

2.1. Experimental design and diets

Animal procedures were approved by the University of Alberta Animal Care and Use Committee for Livestock and followed principles established by the Canadian Council on Animal Care (CCAC, 2009). The study was conducted at the Swine Research and Technology Centre, University of Alberta (Edmonton, AB, Canada).

In total, 220 pigs (Duroc × Large White/Landrace F_1; Hypor, Regina, SK, Canada) were weaned as three groups at 19 ± 1 days of age. Pigs were selected based on average daily weight gain (ADG) for the first 5 days post-weaning and BW on day 5 after weaning. Pigs were divided within gender into heavy and light BW. One heavy and one light barrow and gilt were randomly placed into one of 55 pens, with four pigs per pen. Pigs received creep-feeding prior to weaning. Immediately after weaning, pigs were fed sequentially non-experimental, commercial pre-starter (228 g CP/kg, 10.3 MJ NE/kg, 13.7 g SID Lys/kg) and starter (203 g CP/kg, 11.0 MJ NE/kg, 12.4 SID Lys/kg) diets (Hi-Pro Feeds, Sherwood Park, AB, Canada) for 2 and 5 days, respectively. Wheat, soybean meal, oat groats, high-lactose whey, highly digestible protein sources such as plasma protein, synthetic amino acids, vitamins and minerals were included in these diets.

Experimental diets were fed thereafter over two phases: Phase 1 test diets were offered to pigs (initial BW: 7.45 ± 0.93 kg) for 2 weeks (day 1–14), starting 1 week after weaning. Phase 2 test diets were fed for 3 weeks (day 15–35). For both feeding phases, a wheat-based control diet and four diets containing 60, 120, 180 or 240 g SBP/kg were formulated by replacing wheat grain with SBP (Table 1). The SBP sample was sourced from a local sugar producer (Rogers Sugar, Taber, AB, Canada). Lactose and soy protein concentrate were included in Phase 1 diets at a constant inclusion rate, but were excluded from Phase 2 diets. Diets were formulated without antimicrobials or growth promoters to provide 9.6 MJ NE/kg and 1.3 g SID Lys/MJ NE for Phase 1, and 9.4 MJ NE/kg and 1.2 g SID Lys/MJ NE for Phase 2. Other amino acids were formulated as a ratio to Lys (NRC, 2012). Tabulated NE values (Noblet et al., 1994) and SID amino acid content (NRC, 2012) were used for all main ingredients. Acid-insoluble ash (Celite 281; World Minerals, Santa Barbara, CA, USA) was included at 8 g/kg in diets as an indigestible marker. Phase 1 test diets were mixed and pelleted without steam in a 30 hp pellet press (model PM1230, Buskirk Engineering, Ossian, IN, USA). Phase 2 diets were mixed and steam-pelleted at 70 °C (70 hp; California Pellet Mill, Crawfordsville, IN, USA).

The study was conducted as a randomised complete block design with 55 pens in three groups filled 2 weeks apart. The rooms were ventilated using negative pressure and were maintained within the thermo-neutral zone for the pigs, with a 12-h light (0600–1800 h), 12-h dark cycle. Pens of pigs, blocked by area within room, were randomly allocated to be fed one of the five experimental diets for the 5-week study, starting 7 days post-weaning for a total of 11 pen-replicates per diet. Pens (1.1 m × 1.5 m) were equipped with a 4-feeding spaces self-feeder, a nipple drinker and plastic slatted flooring. Pigs had free access to feed and water.

Individual pigs, feed added and remaining feed were weighed weekly to calculate ADFI, ADG and G:F for each pen. Freshly voided faeces were collected from 0800 to 1600 h by hand grab-sampling from pen floors and pooled by pen on day 12–13

Please cite this article in press as: Wang, L.F., et al., Diet nutrient digestibility and growth performance of weaned pigs fed sugar beet pulp. Anim. Feed Sci. Tech. (2015), http://dx.doi.org/10.1016/j.anifeedsci.2015.11.005