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Diet nutrient digestibility and growth performance of weaned pigs fed field pea

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ABSTRACT

Striving for maximum replacement of soybean meal (SBM) with field pea in swine diets is economically important for pork producers. To explore, effects of increasing inclusion of field pea by substituting SBM on diet nutrient digestibility and growth performance of young pigs were evaluated. In total, 260 pigs (8.5 kg) starting 1 week after weaning at 19 days of age were fed Phase 1 diets for 2 weeks (day 1–14) and sequentially Phase 2 diets for 3 weeks (day 15–35). Five pelleted wheat-based diets including 0, 100, 200, 300 and 400 g yellow field pea (*Pisum sativum* L., subsp. *hortense*)/kg in substitution for up to 300 g SBM/kg and 100 g wheat/kg were fed. Phase 1 and 2 diets were formulated to provide 10.2 and 9.8 MJ net energy (NE)/kg, and 1.2 and 1.0 g standardised ileal digestible (SID) Lys/MJ NE, respectively. Diets were balanced for NE by reducing dietary canola oil from 48 to 34 g/kg and from 27 to 12 g/kg for Phase 1 and 2 diets, respectively, and for amino acids by increasing crystalline amino acids. Increasing inclusion of field pea to 400 g/kg linearly reduced ($P<0.001$) the apparent total tract digestibility coefficient (CATTD) of crude protein (CP) by 7% and of gross energy by 2% in Phase 1 diets, but only linearly reduced ($P<0.05$) CATTD of CP by 1% in Phase 2 diets. Increasing inclusion of field pea to 400 g/kg quadratically reduced ($P<0.001$) calculated diet NE values by 0.4 MJ/kg as fed in Phase 1 and linearly reduced ($P<0.001$) calculated diet NE values by 0.2 MJ/kg as fed in Phase 2 diets. The NE value for field pea used for diet formulation was overestimated for pigs immediately after weaning. For day 1–7, increasing inclusion of field pea did not affect average daily feed intake (ADFI) but linearly reduced ($P<0.01$) average daily gain (ADG) and feed efficiency (*G*:*F*). Growth performance was not affected for day 8–14 and 15–21. Increasing inclusion of field pea quadratically increased ($P<0.05$) ADFI and ADG but did not affect *G*:*F* for day 22–28. For day 29–35, increasing inclusion of field pea tended to linearly increase ($P<0.10$) ADFI, linearly increased ($P<0.05$) ADG, but did not affect *G*:*F*. Overall (day 1–35), increasing dietary inclusion of field pea did not affect ADFI, ADG or *G*:*F*. In conclusion, up to 400 g/kg field pea can entirely replace SBM in nursery diets formulated to equal NE value and SID amino acid content without detrimental effects on growth performance after a 7-day adaptation.

Abbreviations: ADF, acid detergent fibre; ADFI, average daily feed intake; ADG, average daily gain; ANF, anti-nutritional factor; BW, body weight; CATTD, apparent total tract digestibility coefficient; CP, crude protein; DE, digestible energy; DM, dry matter; *G*:*F*, feed efficiency; GE, gross energy; Lys, lysine; NE, net energy; SBM, soybean meal; SID, standardised ileal digestible; TIA, trypsin inhibitor activity.

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1. Introduction

Due to high or fluctuating prices of traditional feedstuff commodities, pork producers strive for new strategies to increase dietary inclusion of alternative feedstuffs (Woyengo et al., 2014). Field pea (*Pisum sativum* L., subspecies *hortense*) is one of the cool season, non-oil seed legume crops known as pulses. Field pea production has doubled in Canada over the last 10 years (FAOSTAT, 2014) to 3.8 million metric tons in 2013 (Statistics Canada, 2014) with yellow field pea as the most widely produced (AAFC, 2014). Excess production or non-food grade field pea (splits) are available for feed processing. Field pea contains less crude protein (CP) than soybean meal (SBM; Sauvant et al., 2004). High inclusion of field pea in diets for young pigs concerns feed formulators because anti-nutritional factors (ANF) in field pea, *e.g.*, trypsin inhibitory activity (TIA) and tannins to a lesser extent, depress feed intake and growth (Castell et al., 1996). However, because ANF are relatively low for *P. sativum* L., subspecies *hortense* (Bastianelli et al., 1998), reduced growth performance may have been more related to nutrient imbalances in earlier studies, because diets were not formulated to equal net energy (NE) value and standardised ileal digestible (SID) amino acid content.

Replacing SBM rather than cereal grains is a main interest for feeding field pea. Including 180 g field pea/kg to replace 60 g SBM/kg and 120 g corn/kg in nursery pig diets did not affect growth performance (Stein et al., 2004). Inclusion of up to 600 g field pea/kg by replacing 200 g SBM/kg and 400 g corn/kg in diets balanced to equal metabolisable energy and SID indispensable AA linearly reduced growth performance of piglets (Stein et al., 2010). For younger pigs with a body weight (BW) of 6 kg, inclusion of up to 300 g field pea/kg by replacing 80 g SBM/kg and 220 g corn/kg reduced average daily feed intake (ADFI) and average daily gain (ADG; Friesen et al., 2006). The greatest replacement rate of SBM was 350 g field pea replacing 170 g SBM/kg but coincided with reduced feed efficiency (gain:feed, *G*:*F*; Owusu-Asiedu et al., 2002). To increase flexibility of feed formulation, replacing more than half of SBM with field pea without reduced growth performance should be the aim. To date, such an aggressive replacement rate has not been reported.

The hypothesis of the present study was that pigs offered diets containing up to 400 g field pea/kg and formulated to equal NE and SID amino acid content would have dietary nutrient digestibility and growth performance not different from pigs fed a diet without field pea, starting 1 week after weaning. The objectives were to determine whether a dose response existed for apparent total tract digestibility coefficients (CATTD) of dietary gross energy (GE) and CP and growth performance of weaned pigs fed diets containing up to 400 g field pea/kg in substitution for 300 g SBM and 100 g wheat/kg.

2. Materials and methods

2.1. Experimental design and diets

The 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, 260 pigs (Duroc × Large White/Landrace F_1; Hypor, Regina, SK, Canada) were weaned in three groups at 19 ± 1 days of age. Pigs were selected for uniformity based on ADG for the first 7 days post weaning and BW on day 7 after weaning (8.5 ± 0.9 kg). Pigs were divided within gender into heavy and light BW, and were randomly placed one heavy and one light barrow and gilt into one of 65 pens, for four pigs per pen. After weaning, pigs were fed sequentially a commercial pre-starter [228 g CP/kg, 10.3 MJ NE/kg, 13.7 g SID lysine (Lys)/kg, 138 g SBM/kg] and starter (203 g CP/kg, 11.0 MJ NE/kg, 12.4 SID Lys/kg, 168 g SBM/kg) diets (Hi-Pro Feeds, Sherwood Park, AB, Canada) for 2 and 5 days, respectively. Wheat, SBM, oat groats, lactose and highly digestible protein sources were included in these diets.

The yellow field pea sample fed (cultivar unknown) was grown in Alberta, Canada during the spring and summer of 2012 and was sourced from a commercial feed supplier (Hi-Pro Feeds, Sherwood Park, AB, Canada). The experimental diets were fed over two phases: Phase 1 test diets were provided to pigs for 2 weeks (day 1–14), starting 1 week after weaning and, sequentially, 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 100, 200, 300 or 400 g field pea/kg were formulated by replacing up to 300 g SBM/kg and 100 g wheat/kg with field pea (Table 1). Lactose, herring meal and canola protein concentrate were included in Phase 1 diets at a constant inclusion, but were excluded from Phase 2 test diets. Diets were formulated without antimicrobials or growth promoters to provide 10.2 MJ NE/kg and 1.2 g SID Lys/MJ NE in Phase 1 and 9.8 MJ NE/kg and 1.0 g SID Lys/MJ NE in Phase 2. Other amino acids were formulated as an ideal ratio to Lys (NRC, 2012). Calculated NE (Noblet et al., 1994) and SID amino acid (NRC, 2012) values for all main ingredients were used. 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 at 63 °C in a 22 kW pellet press (model PM1230, Buskirk Engineering, Ossian, IN, USA). Phase 2 diets were mixed and steam-pelleted at 70 °C (52 kW; California Pellet Mill, Crawfordsville, IN, USA).

The study was conducted as a randomised complete block design with 65 pens in three groups filled two 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 within block representing areas within the room were randomly allocated to be fed one of the five experimental diets during the 5-week study, starting 7 days post weaning for a total of 13 pen-replicates per diet. Pens (1.1 × 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.