



Nutritional value of whey permeate and egg products in ileal-cannulated grower pigs



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ABSTRACT

Eggs not destined for human consumption from egg-breaking plants have high amino acid (AA) and fat content. In contrast, whey permeate (WP), co-product from dairy industry, has high lactose content. Thus, blends of eggs and WP can be sources of protein and energy in swine diets; however, limited information exists about the nutritional value of such blends. A study was conducted to determine standardized ileal digestibility (SID) coefficient of AA and calculated net energy (NE) value for dried whole egg (EGG) and 2 blends of WP and EGG (700 g WP/kg and 300 g EGG/kg, 7030PE; and 600 g WP/kg and 400 g EGG/kg, 6040PE). Eight ileal-cannulated barrows (35.1 kg body weight) were fed 4 diets in a replicated 4 × 4 Latin square design. The diets were a basal diet including a pre-grower feed and corn starch, and this basal diet with energy- and AA-yielding ingredients replaced with 300 g EGG/kg or 400 g/kg of either 7030PE or 6040PE. Energy and nutrient digestibility in the test products was determined by difference method. The SID coefficient of AA was calculated using published values for basal ileal endogenous AA losses. On dry matter basis, EGG, 7030PE and 6040PE contained 489, 186 and 214 g crude protein/kg; 36.0, 9.80 and 11.7 lysine g/kg; and 393, 88.9 and 124 g ether extract/kg, respectively. The SID coefficient of lysine was greater ($P < 0.05$) for EGG (0.869) than for 7030PE (0.736) or 6040PE (0.708). However, EGG had lower ($P < 0.05$) SID of arginine, histidine, isoleucine and phenylalanine than 7030PE or 6040PE. The 7030PE and 6040PE did not differ in apparent total tract gross energy digestibility and SID coefficient of all AA. The NE (on dry matter basis) for EGG (20.2 MJ/kg) was greater ($P < 0.05$) than that for 7030PE (14.9 MJ/kg), which was lower ($P < 0.05$) than that of 6040PE (16.0 MJ/kg). In conclusion, the proportion of EGG (30 vs. 40%) in the EGG–WP blend did not affect the digestibility of gross energy and of most AA; however, the NE value was greater for the blend with 400 g EGG/kg due to the high fat content in EGG. EGG–WP blends had lower lysine digestibility than EGG, implying that lysine was partly damaged by the blending and drying process. Nonetheless, the EGG–WP blends had high AA digestibility and NE values; hence, these blends can be included in swine diets as source of AA and energy.

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Abbreviations: AA, amino acids; AID, apparent ileal digestibility; ATTD, apparent total tract digestibility; CP, crude protein; DE, digestible energy; EGG, whole egg; SID, standardized ileal digestibility; WP, Whey permeate; 6040PE, 600 g/kg WP and 400 g/kg EGG; 7030PE, 700 g/kg WP and 300 g/kg EGG.

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1. Introduction

Feed is the greatest cost of producing pigs, with energy and amino acids (AA) as most expensive components of swine feeds (Niemi et al., 2010). Thus, energy and AA utilization by swine must be optimized to reduce cost of producing pork. Recently, prices of feedstuffs that are commonly used as sources of energy and AA in swine diets have been increasing (Woyengo et al., 2014a). Consequently, alternative energy and AA feedstuffs are required.

Egg breaking facilities produce various egg co-products including whole egg (EGG) that are not destined for human consumption (James et al., 1999; Schmidt et al., 2003). Whey permeate (WP), a co-product from the dairy industry, is also available in large quantities. For instance, 530,000 t of cheese (Vergé et al., 2013) and hence 265,000 t of dried WP were produced in Canada in 2006, assuming that 10 t of liquid whey permeate is produced for each t of cheese (Pearce, 1992) and that liquid whey permeate contains 950 moisture/kg (Hsieh and Ofori, 2011). Both EGG and WP can be used in livestock feeds after drying. However, WP may crystallize during drying (Ibach and Kind, 2007) hampering dietary inclusion of dried WP in swine diets. Crystallization of WP can be avoided if WP is blended with liquid EGG before drying. Blends of EGG and WP can be sources of protein and energy in swine diets, especially in nursery pig diets, because EGG contains 350 g/kg ether extract and 500 g/kg crude protein (CP) with well-balanced AA, whereas WP contains 800–850 g/kg lactose (NRC, 2012).

The EGG–WP blends can be produced by mixing EGG and WP followed by drying the resulting mixture using heat. In pigs, the standardized ileal digestibility (SID) of AA for EGG (Heo et al., 2012) and the nutritional value of WP (NRC, 2012) have been reported. However, the nutritional value of EGG–WP blends and the energy value of EGG for pigs have not been reported. We hypothesized that the EGG and WP blends have high digestible nutrient values for pigs and that drying of the blended EGG and WP does not affect energy and nutrient availability of the blend. The objective was to calculate SID coefficient of AA and calculate net energy (NE) values of 2 blends of WP and EGG (700 g WP/kg and 300 g EGG/kg, 7030PE; and 600 g WP/kg and 400 g EGG/kg, 6040PE) in comparison with the EGG.

2. Materials and methods

Experimental procedures were reviewed and approved by the University of Alberta Animal Care and Use Committee for Livestock. Pigs were handled in accordance with the guidelines described by the Canadian Council on Animal Care (CCAC, 2009).

2.1. Experimental animals

Eight crossbred barrows (initial body weight of 35.1 ± 1.5 kg; Duroc \times Large White/Landrace F1; Genex Hybrid, Hypor, Regina, SK, Canada) were surgically fitted with a T-cannula at the distal ileum (Sauer and Ozimek, 1986). Pigs were housed individually in metabolism pens (1.2 m \times 1.2 m) that allowed freedom of movement in a temperature-controlled room (22 ± 2 °C). Pens had plastic-coated expanded metal floor, polyvinyl chloride walls (0.9 m high) fitted with Plexiglas windows (0.3 m \times 0.3 m), a single-space dry feeder and a nipple drinker.

2.2. Experimental diets

Diets included a basal diet composed of pre-grower feed and corn starch and this basal diet with energy- and AA-yielding ingredients replaced with 300 g EGG/kg or with 400 g 7030PE or 6040PE/kg (Table 1). Diets contained 4.0 g Cr₂O₃/kg as an indigestible marker. The energy and nutrient digestibility coefficients in the test products were determined by difference method from the basal diet (Stein et al., 2006). Pre-grower feed was a standard commercial diet (240 g CP/kg, 14.2 MJ digestible energy (DE)/kg and 12.5 g SID lysine/kg) that is fed to pigs in pre-grower phase (15–35 kg body weight) at the Swine Research and Technology Centre of the University of Alberta (Edmonton, AB, Canada). This feed was diluted with corn starch (to form the basal diet) to reduce the dietary nutrient concentration to a level similar to that recommended by NRC (2012) for growing pigs. The EGG-, 7030PE- and 6040PE-containing diets were supplemented with vitamin and mineral premix to meet the dietary vitamin and mineral requirements for growing pigs. The EGG, 7030PE and 6040PE fed were obtained from Vitalus Nutrition Inc. (Abbotsford, BC, Canada). The EGG was whole egg ineligible for processing for human consumption due to various factors such as cracked or weak shell and was pasteurized at 60 °C for 30 min. The 7030PE and 6040PE had been prepared by mixing the EGG and WP (820 g/kg lactose) and drying the resulting mixtures in a drum dryer (Double Drum Atmospheric Buflovak, Buffalo Technologies Corp division of Blaw-Knox Company, Buffalo, NY) at 170 °C for 6 s. The pasteurized EGG was also dried at 170 °C for 6 s before feeding.

2.3. Experimental design and procedure

The experiment was conducted as a replicated 4 \times 4 Latin square design to reach 8 observations per diet. Each period consisted of 9 days: the first 5 days for adaptation, followed subsequently by 2 days of faecal collection and 2 days of ileal digesta collection. Pigs were fed diets at 3 times maintenance energy requirement (3×0.460 MJ DE/kg of body weight^{0.75}; NRC, 2012) based on body weight at the beginning of each period. Daily feed allowance was offered in 2 equal portions at 08:00 and 15:00 h. Faeces were collected continuously in plastic bags fitted around the anus that were replaced a minimum

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