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Enzymatic feather meal as an alternative animal protein source in diets for nursery pigs

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ABSTRACT

The experiments were conducted to evaluate the apparent (AID) and standardized ileal digestibility (SID) of amino acids (AA) and SID AA composition in enzymatic feather meal (EFM), and to determine the effects of EFM as a replacement for spray-dried porcine plasma (SDPP) or dried porcine soluble (DPS) on the performance and intestinal health of nursery piglets. In Exp. 1, six barrows (initial body weight: 38.5 ± 3.0 kg) fitted with ileal T-cannulas were fed 2 diets in a 2-period crossover design to determine AID and SID of AA in EFM. The AID or SID of each indispensable AA was greater than 0.70 or 0.76, respectively. The concentrations of total SID indispensable AA were 310 g/kg, and the concentrations of SID methionine (6.0 g/kg) and tryptophan (6.3 g/kg) were lowest in EFM. In Exp. 2, 120 healthy piglets with an average body weight of 11.2 ± 2.6 kg were assigned into 4 treatments with 5 replicate pens per treatment (3 barrows and 3 gilts per pen) according to sex and weight in a randomized complete block design. Basal animal protein sources of treatments contained 30.0 g/kg of fish meal and 40.0 g/kg of whey powder (Control). The 3 other diets included 15.0 g/kg of SDPP (SDPPD), 20.0 g/kg of DPS (DPSD), or 15.0 g/kg of EFM (EFMD), respectively. The experiment lasted for 4 wk. Piglets fed EFMD improved average daily gain by 0.15 or 0.13 compared with Control or DPSD ($P < 0.05$), and tended to increase feed conversion efficiency ($P = 0.08$). No statistical differences were detected between EFMD and SDPPD in growing performance. The fecal score in Control tended to be higher than the other 3 groups in the first 2 wk ($P = 0.09$). The EFMD improved immune globulin G content ($P < 0.05$) in serum in comparison with Control. The ratio of villus height to crypt depth in duodenum was increased ($P < 0.05$), and villus height in duodenum ($P = 0.06$), jejunum ($P = 0.08$) and ileum ($P = 0.09$) tended to increase for piglets fed EFMD. Total volatile fatty acid (VFA) concentration tended to be higher in the cecum ($P = 0.09$) and colon ($P = 0.08$) of pigs fed EFMD in comparison with the other treatments. Accordingly,

Abbreviations: AA, amino acid; ADFI, average daily feed intake; ADG, average daily gain; AID, apparent ileal digestibility; Ala, alanine; Arg, arginine; Asp, aspartic acid; ATTD, apparent total tract digestibility; BW, body weight; CP, crude protein; Cys, cystine; DM, dry matter; DPS, dried porcine soluble; EFM, enzymatic feather meal; Glu, glutamic; Gly, glycine; His, histidine; Ile, isoleucine; Leu, leucine; Lys, lysine; Met, methionine; Phe, phenylalanine; Pro, proline; SDPP, spray-dried porcine plasma; Ser, serine; SID, standardized ileal digestibility; Thr, threonine; Trp, tryptophan; Tyr, tyrosine; Val, valine; VFA, volatile fatty acid.

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enzymatic feather meal could be an alternative animal protein source in diets for nursery piglets in terms of positive growth performance and intestinal health.

1. Introduction

Animal protein sources are especially significant for nursery piglets and provide nutritional advantages over plant protein sources (Maxwell and Carter, 2001). However, the competition between humans and animals for quality sources of protein is likely to increase in the future (Chiba, 2001; Zhang et al., 2014a). At present, conventional animal protein resources such as spray-dried porcine plasma (SDPP) and dried porcine soluble (DPS) are in short supply (Zhang et al., 2015). Additionally, increasing costs of conventional protein supplements has further generated interest in new and less expensive protein sources (Ncobela and Chimonyo, 2015). It is, therefore, important to explore potential protein sources for successful and sustainable swine production (Brotzge et al., 2014).

Increasing global meat production is accompanied by an increase in the amount of by-products such as poultry feather (Cedrola et al., 2012; Zhang et al., 2014a). Feather accounts up to 50–70 g/kg of the live weight and is composed of over 900 g/kg of crude protein (CP) for a mature chicken (Zhang et al., 2014b). At present, most feather by-products are converted to hydrolyzed feather meal using physical and chemical treatment using a steam-hydrolyzation process (Riffel and Brandelli, 2002). Unfortunately, these physico-chemical conversion methods involving costly treatments under harsh temperature and pressure conditions result in a loss of certain heat sensitive amino acids (AA) such as methionine (Met), lysine (Lys) and tryptophan (Trp; Queiroga et al., 2012). In addition, agitation and humidity also negatively affect the nutritive value of feather meal (Papadopoulos et al., 1986; Moritz and Latshaw, 2001).

Considering the thermo energetic cost of steam treatment processing and its detrimental effects on nutritive value, biological processes with microbial keratinase is being developed as an alternative technology (Onifade et al., 1998; Lo et al., 2012). Enzymatic feather meal (EFM) is being increasingly considered as a viable source of dietary protein in food and feed supplements (Jeevana Lakshmi et al., 2013). Furthermore, not only the degraded feather but also the biomass of the enzyme producing bacterial strain could be used as protein for animal food (Lo et al., 2012). Such biological processes are mutually beneficial for successful and sustainable poultry and pig production with advantages for environmental friendliness, nutritional enhancement, bio-resource optimization and cost effectiveness. We hypothesized that EFM could provide high quality protein to improve growing performance of nursery piglets. Accordingly, the experiments were conducted to evaluate the apparent (AID) and standardized ileal digestibility (SID) of AA and SID AA composition in EFM, and then to determine the effects of EFM as a replacement for conventional animal protein (SDPP or DPS) in nursery piglet diet on growing performance and intestinal health.

2. Materials and methods

All procedures used in these experiments were approved by the China Agricultural University Institutional Animal Care and Use Committee (Beijing, China). In the experiments, EFM was supplied by Qinhuangdao YiEr Bio-Tech CO., Ltd. (Qinhuangdao, China), and SDPP and DPS were provided by the NP Protein Company (Tianjin, China) and ZKJM Company (Beijing, China), respectively. The analyzed nutrient composition of the protein ingredients is presented in Table 1.

2.1. Animals, diets and experimental designs

Exp. 1 was conducted to evaluate the AID and SID of CP and AA and SID AA composition in EFM. Six crossbred barrows [Duroc × (Landrace × Large White)], with an average body weight (BW) of 38.5 ± 3.0 kg, were surgically fitted with T-cannulas at the distal ileum using procedures adapted from Stein et al. (1998). After 14 days of recovery, pigs were divided into 3 blocks of 2 pigs each using weight as a blocking factor. They were fed 2 diets in a 2-period crossover design so that each pig received 2 different diets over a period of 2 wk rotation with 6 pigs per dietary treatment. The diet was formulated to contain 200 g/kg of EFM protein ingredient as the only AA source. A N-free diet was also included to determine the basal endogenous losses of CP and AA. The formulation of the N-free diet (Table 2) was adapted from Stein et al. (2007). Vitamins and minerals were supplemented to meet or exceed the estimated nutrient requirements for nursery pigs as recommended by the NRC (1998). Diets also contained 3.0 g/kg of chromic oxide as an indigestible marker. The analyzed composition of the experimental diets is shown in Table 2.

Pigs were housed in individual pens in an environmentally controlled room (26 °C, 70% humidity). A feeder and a nipple drinker were installed in each pen. Body weight was recorded at the beginning and at the end of each period. Feed allowance was equivalent to 40 g/kg of BW and divided into 2 equal meals fed at 0800 and 1700 h each day. Water was available at all times throughout the experiment. Each period consisted of a 5-d adaptation period followed by 2-d collection of ileal digesta from 0800 to 1700 h. A 200 ml plastic bag was attached to the open cannula using a cable tie. Bags were removed whenever they were filled with digesta, or at least every 30 min and stored at −20 °C to prevent bacterial degradation of AA in the digesta.