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Comparative amino acid digestibility in US blood products fed to weanling pigs

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ABSTRACT

Blood products are commonly used in diets for weanling pigs, but the different processing techniques that are used in the production of different blood products may result in differences in amino acid (AA) digestibility among products. There are, however, no comparative data on the standardized ileal digestibility (SID) of AA among different blood products when fed to weanling pigs. Thus, the objective of this experiment was to compare values for the SID of crude protein (CP) and AA in spray-dried animal blood (SDAB), spray-dried blood cells (SDBC), spray-dried plasma protein (SDPP), avian blood meal (ABM), and in porcine blood meal (PBM), when fed to weanling pigs. Seven weanling barrows (initial body weight: 11.5 ± 1.1 kg) were equipped with a T-cannula in the distal ileum and allotted to a 7×7 Latin Square design with 7 diets and 7 periods in each square. One of the diets was based on casein, and 5 diets were based on a mixture of casein and each blood product. A nitrogen-free diet was used to measure basal endogenous losses of AA and CP. The SID of CP in SDAB, SDBC, and SDPP were greater ($P<0.01$) than the SID of CP in ABM and PBM (1.040, 0.945, 0.995, 0.704, and 0.689, respectively). The SID of lysine was also greater ($P<0.01$) in SDAB (0.998), SDBC (0.976), and SDPP (0.981) than in ABM (0.740) and in PBM (0.786), but the SID of lysine in ABM was not different ($P>0.05$) from the SID of lysine in PBM. The mean SID of indispensable AA was greater ($P<0.01$) in SDAB, SDBC, and SDPP than in ABM and in PBM. The mean SID of total AA was also greater ($P<0.01$) in SDAB, SDBC, and SDPP than in ABM and in PBM. In conclusion, the SID of AA in SDAB, SDBC, and SDPP is greater than the SID of AA in ABM and PBM, which indicates that inclusion of spray dried blood products in diets to weanling pigs may be preferred over inclusion of blood meal. No differences exist in the SID of AA between blood meal from avian or porcine species when fed to weanling pigs.

1. Introduction

The US slaughter industry produces blood products that may be used in diets for weanling pigs because of the high nutritional qualities of blood protein (DeRouchey et al., 2002). Variations in performance of pigs fed blood products, however, have been observed (Steidinger et al., 2000). Although rich in crude protein (CP) and amino acids (AA), the quality of blood

Abbreviations: AA, amino acids; ABM, avian blood meal; AID, coefficient of ileal apparent digestibility; CP, crude protein; PBM, porcine blood meal; SDAB, spray dried animal blood; SDBC, spray dried blood cells; SDPP, spray dried plasma protein; SID, coefficient of ileal standardized digestibility.

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products may be affected by processing techniques (Meeker, 2009), which include the application of heat. If products are over-heated, Maillard reactions occur, thus, potentially decreasing the digestibility of AA, especially lysine (Nursten, 2005).

Spray-dried animal blood (SDAB) is obtained from whole blood collected from slaughtered animals and an anticoagulant is added to the blood at the time of collection (Ockerman and Hansen, 2000). The spray drying process is characterized by an average inlet temperature of 225°C and a relatively low outlet temperature of less than 70°C (Ockerman and Hansen, 2000). Spray-dried blood cells (SDBC) and spray-dried plasma protein (SDPP) are also manufactured from blood that is collected from animals at slaughter plants, and sodium citrate is added as an anticoagulant before the blood is centrifuged and blood cells are separated from plasma. Each fraction is then spray dried, yielding SDBC and SDPP, respectively (Ockerman and Hansen, 2000; vanDijk et al., 2001). Blood meal is produced by drying whole blood using flash driers, roller driers or drum driers. The process involves several steps including decantation, cooking, pressing, drying, and grinding. Moisture is removed in the cooking process and dryers are used to bring the product to the desired dry matter. The drying process may affect the nutritional quality of blood meal because it may lead to the condensation of lysine with reducing sugars through the Maillard reactions, and thus decrease the availability (*i.e.*, use of lysine for protein synthesis) of lysine to pigs (Bellaver, 2005).

Because of the different processing techniques that are used in production of the blood products, the AA digestibility among blood products may be different. For example, it has been demonstrated that the digestibility of N in 20 sources of blood meal fed to rats is greatly affected by a combination of type of dryer, temperature in the drier, and time in the drier (Moughan et al., 1999). In that experiment the N digestibility coefficient in blood meal that was batch-dried for 210 min at 150°C was 170 compared with 950 in blood meal that was spray-dried for 30 s at 95°C. There are, however, no comparative data on the AA digestibility in different blood products produced in the US when fed to weanling pigs. Thus, the objectives of the present experiment were to determine the apparent ileal digestibility (AID) and the standardized ileal digestibility (SID) of CP and AA in SDAB, SDBC, SDPP, and 2 sources of blood meal when fed to weanling pigs.

2. Materials and methods

The protocol for the experiment was reviewed and approved by the Institutional Animal Care and Use Committee at the University of Illinois. The experiment was conducted at the Swine Research Center at the University of Illinois. Pigs were the offspring of G-performer boars mated to F-25 females (Genetiporc, Alexandria, MN, USA). Blood products used in this experiment included SDAB, SDBC, and SDPP, which were sourced from APC Inc., Ankeny, IA, USA, flash dried avian blood meal (ABM) that was sourced from Griffin Industries LLC, Cold Spring, KY, USA, and porcine blood meal (PBM) that was sourced from Consumers Supply Distributing Co., North Sioux City, SD, USA; casein was procured from International Ingredients Inc., St. Louis, MO, USA (Table 1).

2.1. Animals, diets, and experimental design

Seven weanling barrows (average initial body weight: 11.5 ± 1.1 kg) were equipped with a T-cannula in the distal ileum and allotted to a 7 × 7 Latin square design with 7 diets and 7 periods in each square. Pigs were housed in individual pens (1.2 m × 1.5 m) in an environmentally controlled room (27°C, 76% humidity). A feeder and a nipple drinker were installed in each pen. The average final body weight at the end of the experiment was 17.5 kg ± 1.5 kg.

Seven diets were formulated (Tables 2 and 3). The first diet, which contained casein as the only source of CP and AA, was used to determine the AID and SID of CP and AA in casein and to allow the calculation of AID and SID of CP and AA in blood products by the difference procedure (Fan and Sauer, 1995). Five diets were based on a mixture of casein and each blood product. The final diet was a nitrogen-free diet that was used to measure basal endogenous losses of AA and CP at the ileal level. Vitamins and minerals were included in all diets to meet or exceed current requirement estimates (NRC, 1998). All diets also contained 4 g/kg of chromic oxide as an indigestible marker.

2.2. Feeding and sample collection

Pigs were fed once daily at a level of 3 times the daily maintenance energy requirement, and water was available at all times throughout the experiment. Pig weights were recorded at the beginning of each period and the amount of feed supplied each day (d) was also recorded. The initial 5 d of each period were considered an adaptation period to the diet. Ileal digesta (approximately 30% of the daily flow) were collected for 8 h on d 6 and 7 using standard operating procedures (Almeida et al., 2011).

2.3. Sample analyses and data processing

Digesta samples were lyophilized and ground to pass a 2 mm screen prior to chemical analysis. Diets, ingredients, and ileal samples were analyzed for AA by ion-exchange chromatography with postcolumn derivatization with ninhydrin. Amino acids were oxidized with performic acid, which was neutralized with Na metabisulfite (Llames and Fontaine, 1994; Commission Directive, 1998). Amino acids were liberated from the protein by hydrolysis with 6 *N* HCL for 24 h at 110°C and quantified with the internal standard (Norleucine)by measuring the absorption of reaction products with ninhydrin at