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Available energy content, nutrients digestibility of chili meal and effects on performance of growing pigs

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ABSTRACT

The objective of this study was to evaluate the digestible energy (DE), metabolizable energy (ME) content, apparent total tract digestibility (ATTD) of nutrients in chili meal (CM), and to determine the effects of CM on the performance of growing pigs. In Exp. 1, 12 barrows (Duroc x Landrace x Yorkshire) with an initial body weight (BW) of 50.9 ± 1.8 kg were allocated to one of two treatments, corn-soybean meal basal diet or diet containing 194.2 g/kg CM, which replaced corn and soybean meal in the basal diet. Pigs were placed in metabolism crates for a 7-d adaptation period followed by a 5-d total collection of feces and urine to detect DE, ME and ATTD of nutrients in CM. Exp. 2 was conducted for 4 wk. to evaluate the effect of CM on performance of growing pigs. 150 growing pigs (58.4 ± 1.2 kg BW) were allocated to 1 of 5 treatments. Treatment 1 was a corn-soybean meal basal diet met the DE requirement for growing pigs recommended by NRC (2012). Treatment 2 or 3 were diets containing 50 g/kg or 100 g/kg CM respectively. Treatment: 4 or 5 were based on treatment 2 or 3, while soybean oil (SBO) was added to improve the DE content to that in treatment 1. In Exp. 1, the DE and ME content of CM were 9.08 and 8.48 MJ/kg. The ATTD of dry matter (DM), gross energy (GE), organic matter (OM) and neutral detergent fiber (NDF) were 0.60, 0.54, 0.66 and 0.38, respectively. In Exp. 2, addition of CM linearly decreased ($P < 0.05$) average daily gain (ADG) and the ATTD of DM, GE and OM while ATTD of crude protein (CP) had a quadratic ($P < 0.05$) change. When SBO was supplemented in diets containing CM, greater values ($P < 0.05$) of ATTD of most nutrients were observed. With the dietary inclusion of CM, the albumin/globulin ratio in serum had a quadratic change ($P < 0.05$), and the level of low-density cholesterol linearly ($P < 0.05$) increased. In treatments with 50 g/kg CM, a significant reduction ($P < 0.05$) of total antioxidant capacity was found in diet formulated with SBO. In treatments with 100 g/kg CM, the level of total cholesterol was lower ($P < 0.05$) in the diet with SBO. In conclusion, CM had moderate energy density and nutrients digestibility in pig diets. 50 g/kg CM with SBO in diets could be fed to growing pigs with no significant negative effects.

1. Introduction

Chili, the capsicum fruit, is a kind of popular vegetables. It can be eaten freshly or processed to chili powder and chili jam etc. The

Abbreviations: ADFI, average daily feed intake; ADG, average daily gain; ALB, albumin; ALP, alkaline phosphatase; ALT, glutamic-pyruvic transaminase; AST, glutamic oxalacetic transaminase; CM, chili mea; CREA, creatinine; F:G, feed gain ratio; CLB, globulin; GLU, glucose; HDL-C, high-density cholesterol; LDL-C, low-density cholesterol; MDA, malondialdehyde; aNDF, neutral detergent fiber; SBO, soybean oil; SOD, superoxide dismutase; T-AOC, total antioxidant capacity; TC, total cholesterol; TG, total triglyceride; TP, total protein; UREA, serum urea nitrogen

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chemical composition of chili has been reasonably well documented. Abundant nutrients in chili include vitamins (C, E), β-carotene and carotenoid pigments (Palevitch and Craker, 1996), which appear to be critically important in preventing chronic and age-related diseases (Minguez-Mosquera and Hornero-Mendez, 1994). In recent years, a growing number of chili was processed deeply to extract capsaicinoids, because they are important in the pharmaceutical industry for treatment of neurological disorders. Chili meal (CM), as the by-product of capsicum oleoresin extraction, is a potential source of feed material for abundant nutrients and increasing output.

In 2014, the world production of chili was 462955 ton and as the biggest producer, consumer and exporting country, the overall output in China was 32891 ton (FAO). When capsaicin is extracted form dried chili peel, more than 80% CM was left. However, being lack of research, most of the CM was ignored and discarded which leads to severe wasting of resources and environmental pollution. It is very important and necessary to develop CM as a new source of feed, because it can promote the utilization of CM and reduce the feeding cost. The research about CM in swine production seem empty in the world and vast research is needed to exploit potentialities of CM. Firstly, a digestion and metabolism experiment is wanted to provide an essential data about utilizability of CM in swine diet. Furthermore, Goncalves et al. (2012) reported that Brazilian red pepper meal (BRPM) contains tannins thus it needs to be evaluated through liver function and animal performance. When 78.9 g/kg CM was fed to broilers reared under high stocking density, greater growth performance and lower malondialdehyde (MDA) in serum were observed (Thiamhirunsopit et al., 2014). It suggested that CM can enhance antioxidant capacity for broilers. In order to study the effect of CM in swine production, a feeding experiment was conducted to evaluate the growth performance, nutrients digestibility, antioxidant index and conventional physiological and biochemical indexes in serum.

Therefore, the objective of this study was to evaluate the feeding value of CM for growing pigs and played a guidance role when it was applied in production.

2. Materials and methods

All procedures used in these experiments were approved by the Institutional Animal Care and Use Committee of China Agricultural University (Beijing, China). These experiments were conducted in the Metabolism Laboratory and Finishing Facility of the Fengning Pig Experimental Base (Hebei Province, China).

The processing methods of CM in China are similar and the main difference is the organic solvent when capsicum oleoresin was extracted. CM in present experiment was purchased from Chenguang Biotech Group Co., Ltd (Handan, China) and the processing flow was as follows: fresh chili was air dried, ground, and the husk of the chili was pelleted after seed-and-husk separation. Acetone was used with the pelleted chili husks to extract the capsaicin and the residue was dried. The dried residue is referred to as CM. The chemical composition of CM is shown in Table 1.

2.1. Animals, diets and experimental designs

Exp. 1 was conducted to evaluate the digestible energy (DE), metabolizable energy (ME) content and apparent total tract digestibility (ATTD) of nutrients in CM. Twelve barrows (Duroc x Landrace x Yorkshire) with an initial average body weight (BW) of 50.9 ± 1.8 kg were housed individually in stainless steel metabolism crates (1.4 × 0.7 × 0.6 m^3) and randomly allocated to one of two treatments. The basal diet contained 971.0 g/kg corn-soybean meal, and the treatment diet was formulated to contain 194.2 g/kg CM which replaced corn and soybean meal in the basal diet (Table 2). All the pigs were fed at 4% of their initial BW determined 1 day before the trial, and the daily feed allotment was divided into two equal portions which were fed at 08:30 and 15:30 h. All the pigs were allowed *ad libitum* access to water through a nipple waterer located at the front of the crate. The room temperature was maintained at 20 ± 1 °C and this experiment lasted for 12 days.

In Exp. 2, 150 crossbred barrows and gilts (Duroc x Landrace x Yorkshire) weighing 58.4 ± 1.2 kg BW were used in a 28-d experiment. Pigs were allocated to 1 of 5 treatments on the basis of weight and gender in a completely randomized design with 6 replicates (pens) per treatment and 5 pigs per pen. The pigs were housed in pens of 2.6 × 1.8 × 0.9 m^3 with half of the floor cement and the other half woven mesh. All pigs had free access to water and feed throughout the 28-d experiment period. The temperature of the barn was set at 25 °C. Diets composition and nutrients concentration in Exp. 2 are presented in Table 3. Treatment 1 was corn-

Table 1;
Chemical composition of chili meal (g/kg, dry matter basis).

Items	Chili meal
Dry matter	892.5
Crude protein	177.7
Crude fiber	246.8
Neutral detergent fiber	375.4
Acid detergent fiber	313.8
Ash	110.3
Calcium	3.92
Total phosphorus	3.70
Ether extract	4.03
Gross energy (MJ/kg)	18.91