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Nutrient utilization in grower pigs fed boiled, ensiled or milled sweet potato roots blended with a wheat-based protein concentrate

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ABSTRACT

Sweet potato (SP) roots are highly palatable and digestible for pigs as fresh, boiled, ensiled or dried feed. The form of presentation and blending with other highly digestible protein ingredients could improve nutrient utilization by grower pigs. A metabolic experiment was conducted utilising a 4 × 4 Latin Square design with four (Landrace × Large White) × Duroc pigs at nine weeks of age (26.5 ± 1.4 kg), where four dietary treatments offered ad libitum over four consecutive eight-day feeding periods tested the hypothesis that there would be no difference in nutrient digestibility and utilization in pigs fed SP roots when prepared as boiled (BR), ensiled (ER) or milled roots (MR) and blended with a complementary protein concentrate, and compared against a standard wheat-based pig feed (STD). SP products were blended with protein concentrate at 43%:57% DM, and provided total lysine:DE ratios of 0.57, 0.58, 0.60 and 0.58 g/MJ DE for BR43, ER43, MR43 and STD respectively. DM intake, ADG and FCR were similar ($p > 0.05$) among treatments. Coefficient of apparent total tract digestibility (CATTD) of DM, OM, fibre, calcium, total phosphorus and energy retention (%) in SP root diets were superior to STD ($p < 0.05$). Ash CATTD of ER43 and MR43 were improved over STD whereas BR43 was similar to all three diets. CATTD of fats (EE) was similar. Protein (CP) CATTD of BR43 was superior to MR43 and STD whereas ER43 was similar to the other three diets. N intake (g/d), N digestibility (% intake) and N utilization (% digested) were similar. N retained on STD (30.6 g N/d) and MR43 (30.4 g N/d) were similar. The much higher N retained on BR43 (35.4 g N/d) and ER43 (35.8 g N/d) was due to a significant shift in N loss from urine (8.2 and 7.0 g N/d) to faeces (13.7 and 10.1 g N/d) which, combined with greater OM digestibility and energy retention, suggested increased microbial use of N in the hindgut. The SP diets were highly digestible and provided improved nutrient utilization, ADG and FCR in pigs compared to the wheat-based commercial feed.

1. Introduction

Sweet potato (*Ipomoea batatas* L. (Lam)) is a common feed supplement for growing pigs in tropical countries and is economically important in Asia and the Pacific region, e.g., in China, Vietnam, Philippines, Tonga and Solomon Islands

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(Ochetim, 1993; Peters et al., 2001). In Papua New Guinea (PNG) sweet potato (SP) is a major staple crop in predominant farming systems practiced by about 360,000 rural farming households using SP roots and foliage as livestock feed. SP feed use is influenced by its seasonal availability to rural farmers, shifting food consumption patterns from roots to grains and by the need to replace costly imported feed grains such as wheat and soybean (Scott, 1992; Scott et al., 2000). Current research is aimed at addressing the need to establish appropriate monogastric nutrition for production based on local feed resources by adapting suitable technologies for small-scale farmers. A recent technology advance in PNG was the introduction of ensiled sweet potato for feeding to pigs from techniques adapted and proven in Vietnam (Peters et al., 2001).

Importantly, there is a need to establish benchmark performance for commercial and the local mixed genotype pigs fed local feeds under PNG's varied production environments. Diets based on local feed ingredients may fail to supply the pigs nutrient requirements so benchmarking SP-based diets using commercially bred pigs would provide better assessment of the nutritional requirements of local crossbred pigs fed similar blended diets. A diet containing SP root meal at 35% DM provided nutrient and energy content on par with complex diets of grain feeds (Noblet et al., 1993), and up to 40% provided good carcass results (Manfredini et al., 1993), while 54 and 58% were recommended for grower and fattener phase, respectively (Gonzaléz et al., 2002). Preliminary testing of blended SP diets with either boiled or ensiled roots demonstrated high faecal digestibilities and improved N retained (g/d) at lower protein levels (Dom and Ayalew, 2009). Nevertheless, feeding SP root diets resulted in variable performances in local mixed genotype pigs (Dom and Ayalew, 2010; Dom et al., 2010,2011) similar to those reported in the literature (e.g. An et al., 2004; Gonzaléz et al., 2002; Giang et al., 2004). However, improved grower performance can be ensured by better nutrition through the use of complementary protein concentrates.

A concentrate containing protein meals, synthetic amino acids, vitamins, minerals, mould inhibitors, antioxidants and essential medications was formulated to complement SP roots of a popular and abundantly available cultivar commonly referred to as 'Rachel White'. The blended SP diets used SP roots that were either boiled or ensiled or as dried and milled roots were tested on commercial bred grower pigs for coefficient of apparent total tract digestibility (CATTD) of nutrients, energy utilization, N-balance, growth, and feed efficiency compared against a standard pellet feed. The experiment tested the hypothesis that there would be no difference in nutrient digestibility and utilization in pigs fed 57% dry matter of the diet as SP roots with 43% wheat-based protein concentrate compared to a standard grower pig diet.

2. Methods and materials

2.1. Experiment location and design

This research was conducted at the PNG National Agricultural Research Institute (NARI) Labu Livestock Research Station, Morobe Province (Lat. 6° 40′ 27″ S Long. 146° 54′ 33″ E). The local climate is typically warm and wet with average daily temperatures averaging 30 °C with 84% relative humidity. The metabolic experiment was conducted in a 4 × 4 Latin Square design with four diets as interchanged treatments fed to four grower pigs over four consecutive 8-day feeding periods

2.2. Experiment animals

Four (Landrace × Large White) × Duroc grower pigs with similar body weight (26.5 ± 1.4 kg) were selected and placed into individual metabolic cages for experimental feeding. On d 5 and d 8 of consecutive periods each pig was removed from its cage for weighing to an accuracy of 0.01 kg. Pigs were managed according to the animal welfare guidelines (NHMRC, 2013) prescribed the University of Adelaide Animal Ethics Committee.

2.3. Metabolic cages

Metabolic cages were two double-caged, steel units with dimensions 1.0 m × 1.0 m × 1.5 m on stands 0.7 m above floor level. The cages were equipped with sliding trays to collect faeces. The trays were angled to allow urine to be rapidly drained from the tray. Any solid contaminants from feed, faeces or hair were trapped by a steel coil which allowed urine to drip through a funnel directly into a 2.5 L sealed brown glass bottle through a fine metal-sieve. Each cage was placed in the centre of a concrete pig pen in an open-sided shed. Four fans were placed at the head of each cage to provide cooling air movement for the pigs for the duration of the experiment. During the experiment, minimum and maximum shed temperatures were 21 °C and 32 °C, respectively. Relative humidity ranged from 77% to 90% (NARI weather station).

2.4. Treatment diets

The experimental treatments diets were formulated according to available nutritional data from NRC (1998), a nutritional database at Carey Animal Nutrition. Wheat grain, soybean meal and essential amino acids and micronutrients were imported products. All other ingredients were available locally to the feed producer. A commercial grower pig pellet feed was used as the standard diet (STD) for comparison with nutritionally balanced diets made from SP blended with Pig Conc.1. Blended diets consisted of 57% SP feed and 43% Pig Conc.1 on a DM basis. SP roots from an identified local cultivar, Rachel White, were sourced from Lae Town Main Market. Chemical analysis of the blended ingredients confirmed the nutrient content of the formulated rations (Table 1). Leucine, lysine, methionine, methionine + cysteine (Meth + Cyst), threonine and tryptophan and