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Effects of feeding incremental levels of maize cob meal on physicochemical properties of bulkiness in digesta in growing pigs

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ABSTRACT

The objective of the study was to assess the influence of inclusion levels of maize cob meal on the physicochemical measurements of feed bulk of digesta in different gastrointestinal tract segments of growing pigs. Eighteen pigs were allocated to each of six diets containing maize cob levels at 0, 80, 160, 240, 320 and 400 g/kg DM inclusion levels. The initial mean body weight (BW) was 14 ± 1.2 kg and the pigs were fed *ad libitum*. After four weeks, weights of the gastrointestinal tract (GIT) segments were recorded and the contents of digesta from the stomach and intestines were sampled for analyses of water holding capacity (WHC) and swelling capacity (SWC). In general, the WHC of digesta increased ($P < 0.05$) from the stomach to ileum then decreased as the digesta moved through the hindgut. The WHC of digesta in the stomach, ileum and caecum decreased ($P < 0.05$) with maize cob inclusion level. The SWC in the stomach decreased with the inclusion level of maize cob meal. The SWC of caecal digesta increased with maize cob inclusion level ($P < 0.05$). Maize cob inclusion level had no effect on pH of all segments, except in the distal colon. Changes in the bulkiness of digesta along the GIT are, therefore, influenced by maize cob inclusion level in pig diets.

1. Introduction

There is a growing need for exploring use of fibrous feedstuffs in pig diets due to increasing prices of cereal grains. The grains are utilized for human consumption and in the production of biofuels (Wenk, 2001; Metzler and Mosenthin, 2008). Fibrous feedstuffs have multiple benefits. They promote pig welfare, gut health and some fibre sources are fermentable (Ndou et al., 2013a). Better knowledge of how pigs utilize fibrous feedstuffs increase the ability of nutritionists to identify alternative ingredients for feeding pigs. Maize cob meal, a by-product of maize is produced in great quantities across most parts of Southern Africa, where maize is the staple crop. It has a low water holding capacity (WHC) and is a highly soluble fibrous source. As a result, when included in pig diets, it does not greatly depress feed intake and growth performance (Ndou et al., 2013b). Maize cob is also a ready source of available non-starch polysaccharides for microbial fermentation (Ndou et al., 2013a).

Whilst focus has been put on how dietary fibre affects nutrient digestion (May et al., 1994; Freire et al., 2000; Len et al., 2009), little emphasis has been placed on its effect on physicochemical properties of bulkiness in digesta. Examples of common physicochemical properties that can be used to

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measure bulkiness of digesta are water holding capacity (WHC) and swelling capacity (Bindelle et al., 2008). Physicochemical properties of dietary fibre (DF) are expected to change as the digesta passes along the gut (Anguita et al., 2007). The extent of fibre fermentation depends on the type and inclusion level of fibre (Montagne et al., 2003). For example, Canibe and Bach Knudsen (2002) reported that barley and pea fibres had different effects on hydration properties of digesta from segment to segment, thus different ileal digestibility and ceacal fermentation. Diets with high neutral detergent fibre (NDF) content increase digesta WHC from the stomach to the ileum, and decrease hydration properties as the digesta passes through the hindgut (Anguita et al., 2007). Besides influencing voluntary feed intake, physicochemical properties affect the feeding behaviour of pigs (Asp, 1996; Bindelle et al., 2008; Bakare et al., 2013). To fully understand the influence of dietary fibre on performance, health and welfare of pigs, it is necessary to determine changes in the physicochemical properties of the digesta as it moves along the gut (Anguita et al., 2007). In addition, weight of gut segments should be estimated, so as to understand the physiological and anatomical responses of pigs fed on fibrous feeds. Knowledge of changes in the physicochemical properties of bulkiness of digesta during gut transit enables feed compounders to appropriately formulate fibrous diets to maximise the wellbeing of growing pigs. Assessment of digesta has, thus far, received little attention because of the need to sacrifice many animals for research purposes.

Ndou et al. (2013b) assessed a number of fibrous sources for inclusion in pig diets. These included sunflower husk, grass hay, maize cobs, lucerne hay and maize stover. Of these, maize cobs had the least influence on depressing feed intake at high inclusion levels. Maize cob meal is produced in large quantities in Southern Africa, where maize is the staple crop. It has a low water holding capacity (WHC) and is highly soluble. As a result, when included in pig diets, it does not greatly depress feed intake and growth performance (Ndou et al., 2013b). Maize cob is also a ready source of non-starch polysaccharides for microbial fermentation (Ndou et al., 2013a). Its influence on changes in the physicochemical properties of bulkiness in digesta is not known. Water holding capacity, viscosity and swelling capacity (SWC) induce direct effects on digestibility and absorption of nutrients (Högberg and Lindberg, 2004; Ngoc et al., 2013). The objective of the study was, therefore, to determine effect of feeding incremental levels of maize cob on physicochemical properties of bulkiness in digesta and the size of gut segments in growing pigs. It was hypothesized that bulkiness of digesta are influenced by inclusion levels of maize cobs.

2. Materials and methods

2.1. Ethical consideration

The trial was performed according to the conduct by the Certification of Authorization to Experiment on Living Animals provided by the University of KwaZulu-Natal Animal Ethics Committee (Reference Number 096/12/Animal).

2.2. Study site

The study was conducted at Ukulinga Research Farm, UKZN, Pietermaritzburg, South Africa. The farm is located in the subtropical hinterland. Ukulinga Research Farm lies at 30°24′S, 29°24′E and is approximately 700 m above sea level. Climatic conditions are characterized by an annual rainfall of 735 mm, and mean annual maximum and minimum temperatures of 25.7 °C and 8.9 °C, respectively.

2.3. Pigs and housing

Eighteen clinically healthy male pigs of the PIC group (Large White × Landrace) with an initial body weight (BW) of 14 ± 1.2 kg were used. The weaner pigs were purchased from Chiltern farm, Cramond, KwaZulu-Natal Province, South Africa. Pigs were ear-tagged for identification and housed in individual cages (1.5 m × 1 m). Each cage had a plastic self-feeder trough (Big Dutchman Lean Machine®) for dry feeding and a separate low-pressure nipple drinker to provide feed and water, respectively. Automated HOBO TEMPERATURE, RH©, 1996 ONSET data loggers were used to record ambient temperature and relative humidity at 15 min intervals throughout the experiment. The average temperature and relative humidity were maintained at 21.1 ± 1.89 °C and 41.4 ± 1.45%, respectively, by use of a single heating, lighting and ventilation system. Periods of darkness and lighting were controlled at 12 h cycles.

2.4. Diets and feeding

Six experimental diets containing 0, 80, 160, 240, 320 and 400 g/kg DM of maize cob were formulated. A commercial feed (Express Weaner, Meadow Feeds Ltd, Pietermaritzburg, South Africa) (50 g/kg DM of total dietary fibre, TDF), formulated to meet the nutritional requirements of growing pigs, was used as a control feed. The basal diet contained per kg DM 425.6 g yellow maize, 175.6 g soybean, 83.8 g soybean oil cake, 100.0 g whole wheat, 100.0 g wheat bran, 75 g sunflower oil cake, 20 g cape fish and 20 g additives. The dilution of the basal feed with maize cob meal was not supplemented in any way. Three pigs were allocated to each diet. After 10 days of acclimatization, data collection continued for 28 days. Feed and water were provided ad libitum. The chemical compositions of the experimental diets are shown in Table 1.

2.5. Measurement of digesta and pig performance

The amount of feed consumed every week was estimated by measuring the weight of feed at the beginning and end of each week. Feed refusals and spillages, air dried; were weighed and subtracted from weekly intakes. After four weeks, average daily feed intake (ADFI) was calculated by dividing the difference between the total feed offered and total of refusals and spillages by 28 days. The body weight (BW) of each pig was determined after four weeks. Average daily gain (ADG) was determined as total weight gained over for weeks divided by 28 days. Feed conversion ratio (FCR) for each pig was calculated as the ratio of the amount of feed consumed to ADG.