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Prediction of voluntary feed intake from physicochemical properties of bulky feeds in finishing pigs

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ABSTRACT

The objective of the current study was to determine the physicochemical properties that can be used to predict scaled feed intake (SFI) in finishing pigs. A total of 84 pigs weighing 65 ± 1.37 kg body weight were given, ad libitum, each of the 21 diets containing a basal feed diluted with 80, 160, 240, 320 and 400 g/kg of lucerne hay, maize cob, sawdust or sunflower husks. Each of the 21 diets was given to four pigs, in individual pens, for 21 days. Physicochemical properties of the feeds measured were dry matter (DM), crude protein (CP; g/kg DM), ether extract (g/kg DM), ash (g/kg DM), water holding capacity (WHC; g water/g DM), bulk density (g DM/ml), crude fibre (CF; g/kg DM), neutral detergent fibre (NDF; g/kg DM) and acid detergent fibre (ADF; g/kg DM). The most important predictors of scaled feed intake (SFI) were NDF (R^2=0.76; P<0.05), CF (R^2=0.76; P<0.05), CP (R^2=0.75; P<0.001) and WHC (R^2=0.73; P<0.001). There was a quadratic relationship between SFI and NDF given by the function SFI=82.0 (±5.30)–0.18 (±0.03) NDF+0.0002 (±0.00004) NDF^2 (P<0.01). The SFI was related to CF and CP by quadratic functions; SFI=63.4 (±2.22)–0.16 (±0.03) CF+0.0003 (±0.00007) CF^2 (P<0.001) and SFI=61.8 (±9.68)–0.39 (±0.16) CP+0.002 (±0.0006) CP^2 (P<0.01), respectively. The SFI was related to WHC by linear function; SFI=77.3 (±4.37)–7.43 (±1.77) WHC (P<0.001). It can be concluded that WHC, CF and NDF content provide relationships with SFI in finishing pigs. These physicochemical properties, however, did not provide threshold values that mark breaking points were intake of bulky feeds is reduced due to gut fill.

1. Introduction

Sufficient evidence exist that as pigs grow, their ability to utilise fibrous feeds is enhanced (Bindelle et al., 2008). There is, however, lack of information on how much fibre should be included in the feed without compromising potential growth of pigs. Incorporation of fibrous ingredients alters the physicochemical nature of pig diets. For example, water holding capacity (WHC) has been identified as the most reliable measure of bulkiness that can be used to estimate gut capacity in weaner pigs (Tsaras et al., 1998; Whittemore et al., 2003a, 2003b). Other physicochemical measures of feed bulk that are likely to influence gut capacity are crude fibre (CF), acid detergent fibre (ADF), neutral detergent fibre (NDF) and bulk density. Due to the development of their large intestines and caecum, finishing pigs have the ability to ferment fibrous ingredients that escape digestion in the foregut (Bindelle et al., 2008; Renteria-Flores et al., 2008). Therefore, the influence of WHC, CF, ADF, NDF and bulk density in predicting gut capacity between weaner and finishing pigs is likely to be different. This, therefore, warrants further investigations on how physicochemical properties of fibres might influence voluntary feed intake (VFI) in finishing pigs.

If the physicochemical properties of these bulky feeds are not quantified, their usefulness in feeds may be

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incorrectly judged and may impose undesirable effects on feed intake, digestibility and, subsequently, growth performance of pigs. Together with performance characteristics, knowledge of how much feed of a particular type has been consumed can be used to estimate the economic value of an individual pig at any given stage of growth (Ndou et al., 2013). Maize cob, sunflower husk, lucerne hay and sawdust were the fibre sources used in the current study. The use of these fibre sources will provide a wide range of physicochemical properties. The objective of the study was, therefore, to determine if the physicochemical measurements of fibrous feed can be used to predict feed intake in finishing pigs. It was hypothesised that physicochemical measures of a feed adequately describes the gut capacity of finishing pigs.

2. Materials and methods

2.1. Description of study site

The study was conducted at Ukulinga Research Farm, University of KwaZulu-Natal (UKZN), Pietermaritzburg, situated in a subtropical hinterland, located at 30°24′S, 29°24′E and is approximately 700 m above sea level. The climate is characterised by an annual rainfall of 735 mm, which falls mostly in summer between October and April. Mean annual minimum and maximum temperatures are 8.9 °C and 25.7 °C, respectively. The ambient temperature and relative humidity during the experimental period were recorded automatically every 15 min throughout the trial by a HOBO data logger (Onset Computer Corporation, Pocasset, MA, USA). The average temperature and humidity was 22.2 ± 3.14 °C and 45.6 ± 10.22%, respectively.

2.2. Pigs and housing

The care and use of the pigs were performed according to the ethical needs by Certification of Authorisation to Experiment on Living Animals provided by UKZN Animal Ethics Committee (Reference number: 096/11/Animal). A total of 84 (Large White × Landrace, PIC group, South Africa) clinically healthy male pigs were used in the experiment. Initial body weight for the pigs was 65 ± 1.37 kg. Pigs were randomly allocated to individual pens measuring 2.0×1.1 m^2 in floor area. The individual pens were mounted in a pig house that had a single heating, lighting and ventilation system. The 42 individual pens were arranged in two rows such that there were 21 pens on either side. The pen was equipped with a plastic self-feeder trough (Big Dutchman Lean Machine®, Postfach) designed to minimise spillages and a low-pressure nipple drinker providing water ad libitum.

2.3. Feeds

A high quality commercial feed (Supreme Grower, Meadow feeds Ltd, Pietermaritzburg, South Africa) was used as the basal feed. The basal feed contained approximately 12.9 MJ/kg digestible energy and 160 g CP/kg dry matter (DM). The ingredient composition of the basal diet is given in Table 1. To formulate diets with a wide range of physicochemical properties, four fibrous feedstuffs, namely maize cob, sunflower husks, lucerne hay and sawdust were used. Each of the fibrous diluents was ground through a mill (Thomas Wiley®Mill, New Jersey, USA) using a 2 mm screen. A total of 20 complete diets were formulated by diluting the basal diet with each of the fibre sources at five inclusion levels. Following dilution without addition of supplementary nutrients, each of the complete diets contained 80, 160, 240, 320 and 400 g/kg DM of each fibre source.

Table 1
Ingredient composition of the basal feed.

Ingredient	(kg/100 kg DM)
Yellow maize	50.0
Soybean	15.8
Soybean oil cake	2.02
Wheat bran	16.3
Sunflower oil cake	8.50
Molasses syrup	2.50
Additives	4.88

2.4. Analyses of chemical composition and physical properties of diets

Chemical composition and bulk characteristics of the basal diet and each of the 21 complete diets were performed in the Discipline of Animal and Poultry Science Laboratory at the UKZN. Dry matter (DM), ash, crude (CP), ether extract (EE), and gross energy (GE) were analysed according to the Association of Official Analytical Chemists (AOAC, 1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were determined using ANKOM Fibre Analyser (Ankom, Macedon, NY, USA), according to Van Soest et al. (1991) and Van Soest (1973), respectively. Neutral detergent fibre was assayed using heat stable α-amylase (Sigma A3306; Sigma Chemical Co., St. Louis, MO, USA). Both NDF and ADF were expressed with residual ash content. The bulk densities of the diets were measured according to the water displacement method, as described by Kyriazakis and Emmans (1995). Water holding capacity (WHC) was measured by filtration method (Robertson and Eastwood, 1981). The chemical composition and bulk properties of the fibrous diets are shown in Tables 2 and 3, respectively.

2.5. Experimental design and management of pigs

Four pigs were randomly allocated to each of the treatment diets in two batches, i.e. two pigs per treatment diet per batch. Pigs were offered the diets for an experimental period of 31 days inclusive of a 10 d adaptation period. Pigs were weighed every week throughout the trial. Feed intake was determined every week by weighing the feed trough at the beginning and at the end of each week. Feed spillages were collected by placing a plastic tray under each trough. Feed spillages were dried, weighed and discarded. At the end of the experimental period, pigs in the first batch were moved out of the pig house.