



Influence of physicochemical properties of fibrous diets on behavioural reactions of individually housed pigs



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ABSTRACT

The objective of the study was to predict time spent on different behavioural activities of individually housed growing pigs from physicochemical properties of feeds. Maize cob, maize stover, sunflower hulls, veld grass, sawdust and lucerne were used to provide a wide range of physicochemical properties. The fibre sources were included at 0, 80, 160, 240, 320, 400 g/kg inclusion levels in pig diets. Time spent eating, drinking, lying down, sitting/standing and other activities was observed using video cameras. Pigs spent most of their time lying down (71.4%) followed by time spent eating (23%), drinking (3.2%) and sitting/standing (2.4%). Digestible energy (DE), bulk density (BD), acid detergent fibre (ADF) and water holding capacity (WHC) were the most important variables for predicting time spent on different behavioural activities ($P < 0.001$). Bulk density and ADF produced linear responses with time spent eating and drinking ($P < 0.001$). There was a quadratic response between time spent lying down and ADF content of feed ($P < 0.001$). Water holding capacity was the most important physicochemical property of feeds for predicting number of visits made by the pig to the feeder. Total time spent on each visit by a pig per day was best predicted by ADF. In conclusion, physicochemical properties of diets alter behaviour of penned growing pigs.

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1. Introduction

The search for cheap alternative feed ingredients for pigs (*Sus scrofa*) is receiving attention mainly because of the increased global demand for grains for both human and livestock consumption (McCalla, 2009). Alternative feed ingredients that can be used to feed pigs are crop by-products: maize cob, maize stover, sunflower husks and, also grasses and sawdust. These fibre sources are readily available, cheap and can be consumed by pigs (Ferguson et al., 2003; Kyriazakis and Emmans, 1995; Ndindana et al., 2002; Owen and Ridgman, 1967, 1968). Fibres have been reported as diluents in previous studies (Len et al., 2007;

Whittemore et al., 2002). Their use, depending on the inclusion level in a diet, improves welfare of pigs by reducing stereotypic behaviours, chronic colitis, dysentery and constipation (Day et al., 1996; Filer et al., 1986; Metzler and Mosenthin, 2008; Thomson, 2009).

As fibre content of diets increase, the dilution of the resultant diets alters the time that pigs spend on various behavioural activities. For example, pigs fed on fibrous diets have an increased motivation to eat (D'Eath et al., 2009). Ramonet et al. (1999) reported that increasing fibre level in sow diets increases time spent eating. High-fibre diets also increased time spent eating in non-pregnant nulliparous gilts (Robert et al., 1997). Behavioural reactions of growing pigs subjected to the fibrous diets, however, remain unclear. Apart from assessing feed intake and growth performance, behavioural responses of the pigs need to be considered in the determination of appropriate fibre inclusion levels.

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Physicochemical characteristics of fibrous feeds might play a key role in influencing behaviour of pigs. These include water holding capacity (WHC), bulk density (BD), acid detergent fibre (ADF), neutral detergent fibre (NDF) and crude fibre (CF). The physicochemical characteristics vary across fibre sources (Ndou, 2012). Fibres with a high WHC, for example, will absorb more water, swell and occupy more space in the stomach. Consecutive stimulation of stretch receptors due to distension of the gut will lead to satiety (De Leeuw, 2004; Lepionka et al., 1997). Satiety is the state of being satisfactorily full and unable to take on more feed. This affects feeding behaviour and, consequently, performance of growing pigs.

Although physicochemical properties have been demonstrated to predict feed intake (Kyriazakis and Emmans, 1995; Ndou et al., 2013), their effect on time spent on different behavioural activities in growing pigs is still unclear. For example, Whittemore et al. (2002) conducted a study with few fibrous sources with a narrow range of physicochemical properties. Use of more fibrous feedstuff at varying inclusion levels provides a wider variation of physicochemical properties to generate more accurate predictions of behavioural activities exhibited by growing pigs. For close monitoring of pigs and to avoid the effects of association which can affect normal behavioural activities when in groups, it is necessary to house pigs individually. Time spent on different behavioural activities might be a first step in providing an insight on how specific physicochemical characteristics of different fibre sources affect satiety levels in pigs. The objective of the study was, therefore, to predict the influence of physicochemical properties of feeds on time spent on different behavioural activities in growing pigs; the hypothesis being that there is no relationship between the physicochemical properties and time spent on different behavioural activities.

2. Materials and methods

2.1. Pigs and housing

A total of 124 clinically-healthy, castrated, male growing pigs were used. The care and use of the animals was performed according to the Certificate of Authorization to Experiment on Living Animals provided by the University of KwaZulu-Natal (Reference number: 061/12/Animal). Initial body weight for the pigs used in the experiment was 22.4 ± 3.12 kg. Each pig was used as an experimental unit. They were put in individual pens measuring $1.5 \text{ m} \times 1 \text{ m}$ and had a slatted floor. The space in the pens allowed the pigs to turn around and have limited exercise. The pens contained a plastic tube feeder (Big Dutchman Lean Machine®) and a low-pressure nipple drinker providing clean water ad-libitum. The individual pens were not in total isolation because a pig had visual contact with the pig in adjacent pens and could hear and communicate with each other. Pigs were put in individual pens for five weeks including the adaptation period of one week. The ambient temperature and relative humidity were recorded automatically throughout the trial using HOBO data loggers (Onset Computer Corporation, Pocasset, MA, USA). The average temperature and humidity were 21.15 ± 2.74 °C and $42.64 \pm 1.56\%$, respectively.

2.2. Diets

A premium commercial feed (Express Weaner, Meadow feeds Ltd.) with a low level of crude fibre (CF) was used as the basal feed. Six fibre sources, namely maize cob, maize stover, sunflower hulls, grass hay, lucerne and saw dust were selected to dilute the basal diet. Maize cobs used in the experiment were remains left after removal of kernels from the cob. Maize stover, on the other hand, consisted of the leaves and stalks of maize (*Zea mays*) plants left after removal of the cob. Sunflower hulls were the by-products from sunflower oil seeds after removal of kernels whilst sawdust or wood dust was the by-product of cutting, grinding, drilling; it is composed of fine particles of wood. Grass hay and lucerne were plants that have been cut, dried, and stored for use as animal fodder. All the fibre sources were used in the experiment to increase the range of physicochemical properties. Maize cob, maize stover, sunflower hulls, grass hay and lucerne hay were ground to pass through a 3 mm screen. The fibre sources were then included at different inclusion levels of 0, 80, 160, 240, 320 and 400 g/kg in diet of pigs. It was assumed that the pigs would increase their feed intake proportionately to the degree of dilution of the basal feed with the fibre source. Hence, all pigs would get nutrients that met requirements for growth. Each of the 31 diets (i.e. one control diet and 30 fibre-based diets) was fed to four randomly selected pigs in their own pens.

2.3. Analyses of physicochemical properties of diets

Tables 1–3 show composition of ingredients and physicochemical properties of diets used in the experiment. Ash was determined by combusting the sample in a furnace for 4 h at 550 °C according to method 942.05 of AOAC (2005). The dry matter (DM) was determined in an oven at 65 °C for 48 h according to the method 2001.12 of AOAC (2005). Crude protein (CP) was determined by using a Truspec N analyser (Leco, MI, USA) based on Dumas Combustion method 990.03 (AOAC, 2005). Crude fibre (CF) was determined according to the method 2001.12 of AOAC (2005). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analysed using filter bags by means of a fibre analyser (Ankom 220; Ankom Technology Corp., Macedon, NY, USA). Gross energy (GE) was determined using a bomb calorimeter. Digestible energy (DE) of feeds

Table 1
Composition of ingredients in a basal diet (B).

Ingredients	Composition (%)
Yellow maize whole	42.6
Full fat soya	17.6
Whole wheat	10.0
Wheat bran middlings	10.0
Soyabean oil cake	8.4
Sunflower oil cake	7.5
Fish meal	2.0
Vitamin mineral mix	1.9

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