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Feed preference, nutrient digestibility and colon volatile fatty acid production in growing South African Windsnyer-type indigenous pigs and Large White × Landrace crosses fed diets containing ensiled maize cobs

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ABSTRACT

A study was carried out to evaluate feed preference, nutrient digestibility and colon fermentation in growing South African Windsnyer-type Indigenous pigs (SAWIP) and Large White × Landrace crosses (LW × LR) fed diets containing ensiled maize cobs. Three treatments; CON (control diet without maize cobs), LMC (low maize cob level diet) and HMC (high maize cob level diet) were evaluated. Preference was assessed in 64 LW × LR (45 ± 6.7 kg) and 30 SAWIP (21 ± 3.6 kg) by offering the pigs choices between a common reference diet and a test diet. Apparent total tract digestibility (ATTD) and colon fermentation were determined using 15 LW × LR and 15 SAWIP pigs weighing 70 ± 6.9 kg and 49 ± 8.1 kg, respectively. There were breed by diet interactions ($P < 0.05$) in period 1 (P1; days 0–3) for preference of diets but none in period 2 (P2; days 3–6). The SAWIP's preference for the CON was greater than for the HMC diet ($P < 0.05$). The two breeds' preferences for the LMC and HMC diets were lower ($P < 0.05$) than the 50% preference index in P1. The ATTD coefficients of crude protein (CP), acid detergent fibre (ADF), hemicellulose (Hemi) and amylase determined neutral detergent fibre (αNDF) in the HMC were greater ($P < 0.05$) than in the CON. The SAWIP had greater ($P < 0.05$) NDF digestibility coefficients than the LW × LR. There were breed × diet interactions ($P < 0.05$) for proportions of isobutyric acid (IBA) and butyric acid (BA), IBA concentration and acetic to butyric acid (AA:BA) and BA:IBA ratios. The LW × LR had greater concentrations of total volatile fatty acids (VFA) ($P < 0.05$) than the SAWIP. The results provide a basis to promote ensiling as a way to improve utilisation of maize cobs. The influence of breed of pig needs to be considered when formulating diets containing fibrous ingredients.

1. Introduction

The use of maize cobs as an animal feed on the African continent is motivated by the high competing demands with humans for the grain. An estimated 77%of maize grain is used as food and only 12%serves as animal feed in sub-Saharan Africa (Smale et al., 2013). On the contrary, 70% of maize is used for animal feed, 3%for human consumption, and the remainder for biofuels, industrial products and seed in high-income countries (Smale et al., 2013). The use of maize cobs in pig diets in efforts to offset high feed costs has been evaluated in a number of studies

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(Ndindana et al., 2002, 2008; Kanengoni et al., 2004). It has been shown that maize cobs can be included up to levels of 200 g/kg in pig diets (Kanengoni et al., 2004). The main challenge faced with including maize cobs in pig diets is the high fibre content (930 gNDF/kg DM; 573 gADF/kg DM) (Kanengoni et al., 2002), which reduces digestion of nutrients and affects feed intake.

Ensiling has been reported to reduce non starch polysaccharide (NSP) levels in ingredients (Meeske et al., 1999; Khan et al., 2006) and it is a cost effective technology that can easily be adopted by farmers. It has been hypothesized that ensiling can improve palatability and hence preference in feedstuffs from the volatile fatty acids (VFA) and organic acids produced. Palatability is not generally considered when formulating diets for pigs yet it is a critical component of any feed and directly affects performance (Sola-Oriol et al., 2009a, b). Pigs have been shown to demonstrate preferences for feeds based on texture, particle size, nature of feedstuffs, inclusion rate and freshness (Sola-Oriol et al., 2009a, 2011; Seabolt et al., 2010). It is hypothesized that ensiling will improve preference, digestibility and intestinal fermentation of maize cobs. A lot of South African resource poor farmers keep the indigenous breed, the South African Windsnyer-type Indigenous pigs (SAWIP), under marginal nutritive conditions. These pigs are often fed fibrous diets and nothing has been documented of their feeding behaviour except for anecdotal evidence. It would be important to determine if there are breed differences in relation to preferences for fibrous diets in order to assist in dietary recommendations. The main objective of the current study was therefore to evaluate feed preference, nutrient digestibility and colonic fermentability when ensiled maize cobs were included in indigenous and commercial pig diets.

2. Materials and methods

2.1. Ensiling process and diets

Maize cobs (920 g/kg DM) were collected from the Agricultural Research Council—Animal Production Institute fields (ARC-API, Irene, Gauteng, South Africa), and ground to pass through a 10 mm sieve. Irene has an altitude of 1526 m and is located at 25°34′0″S and 28°22′0″E. The maize cobs were mixed with distilled water to lower the dry matter (DM) to 350 g/kg, and ensiled by compacting in 210 l drums lined with a plastic bag, and closed with a rubber lid to prevent damages to the bags by rodents. A packing density of 822 kg/m^3 ± 33.5 was obtained and the drums were stored at 22 to 29 °C. After 3 months of ensiling, drums were opened and sampled for the determination of fermentation characteristics and chemical compositions (Table 1). The silage was then used to formulate diets with inclusion levels of 100 g and 200 g maize cob/kg of diet (as fed) as shown in Table 1. The diets were formulated to provide 14 MJ/kg digestible energy (DE), 180 g crude protein (CP)/kg DM and 11.6 g lysine /kg which meet and exceed the requirements of growing pigs (NRC, 1998). This resulted in 3 treatments namely; a control diet without maize cobs (denoted as CON), a diet containing 100 g maize cobs/kg diet (denoted as LMC), and a diet containing 200 g maize cobs/kg diet (denoted as HMC). The silage drums were opened weekly upon mixing of the diets to prevent spoilage. The effect of these diets on feed preference, nutrient digestibility and colonic fermentation in growing pigs were evaluated in two experiments. The experimental procedures described in this study were approved by the Animal Ethics Committee of the ARC-API (Reference: APIEC12/018).

Table 1
Composition of non-ensiled maize cobs (NEMC), ensiled maize cobs (EMC), experimental diets; control (CON), low maize cob inclusion (LMC) and high maize cob inclusion (HMC) fed to growing South African Windsnyer-type indigenous and Large White × Landrace pigs.

Ingredient (g/kg)			CON	LMC	HMC
Maize meal			667.8	526.1	396.6
Soyabean oilcake			200.0	184.1	173.7
Full fat soyabean cake			70.0	115.0	155.0
Ensiled maize cobs			0	100.0	200.0
Molasses			19.0	19.0	19.0
Sunflower oil			7.0	20.0	20.0
Limestone			6.0	5.0	4.0
Monocalcium phosphate			16.2	17.3	18.2
Chromium oxide			2	2	2
Salt			4.0	3.0	3.0
Lysine HCL			4.0	4.5	4.5
[b]Vitamin-Mineral premix			4.0	4.0	4.0
Calculated composition					
Dry matter			882.2	835.4	787.4
Calcium			7.6	8.8	7.6
Phosphorus			5.7	6.0	6.3
Lysine			13.3	13.8	13.9
Laboratory analyses					
	NEMC	EMC	CON	LMC	HMC
Ether extract	5.0	8.7	40.0	42.0	54.4
Crude protein	27.7	41.2	180.2	186.4	193.8
Neutral detergent fibre	858.0	773.5	149.8	167.1	411.5
Acid detergent fibre	468.6	459.5	65.5	106.3	133.1
GE MJ/kg	18.0	18.1	17.5	17.6	17.8

[b] Provided the following per kg of diet: 6500 IU vitamins A; 1200 IU D_3; 40 IU E; 2 mg K_3; 1 – 5 mg B_1; 4.5 mg B_2; 0.03 mg B_{12}; 2.5 mg B_6; 25 mg niacin; 12 mg calcium pantothenate; 190.5 mg choline; 0.6 mg folic acid; 0.05 mg biotin; 40 mg manganese; 100 mg zinc; 125 mg copper; 1 mg iodine; 100 mg ferrous; 0.3 mg selenium.

2.2. Experiment 1—Effect of diets containing ensiled maize cobs on feed preference

2.2.1. Animals, housing and experimental design

Sixty four Large White × Landrace crossbred pigs (LW × LR) weighing 45 ± 6.7 kg live weight and thirty South African Windsnyer-type Indigenous pigs (SAWIP) weighing 21 ± 3.6 kg, balanced on gender were randomly selected from the ARC-Irene pig breeding units and used in double choice experiments following the design of a study done by Sola-Oriol et al. (2009a). As the SAWIP and LW × LR differ in their mature body weight (140–180 kg vs 300–350 kg respectively), growing pigs of a similar degree of maturity (0.15 of adult body weight) were chosen from each breed for this study. The LW × LR were housed in 2 × 1.5 m pens and the SAWIP were in 1.5 × 0.9 m pens in environmentally controlled houses with the temperature ranging from 22 to 25 °C. The pigs were housed individually in pens containing 2 identical feeders (placed side by side). The feeders were