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High quality cassava peel fine mash as replacement for maize in diets of growing pigs: 2. Effects on nutrient and fibre fraction digestibility

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Abstract

Twenty growing pigs with an average initial weight of 53±0.5 kg (± SE) were randomly assigned to five dietary treatments in a completely randomized design with four replicates per treatment and one animal in each replicate. A total tract digestibility trial was carried out to determine the effect of partial replacement of maize with graded levels of high quality cassava peel (HQCP) mash on the nutrient digestibility and fibre fraction digestibility of growing pigs. The control diet T1 had 40% of maize, while the dietary treatments T2, T3, T4 and T5 had 7.5, 15, 22.5 and 30% of HQCP corresponding to replacement of maize by 0, 19, 38, 56 and 75% respectively. There was no significant difference (P>0.05) in apparent nutrient digestibility coefficient of dry matter, nitrogen free extract, organic matter and energy. There were significant (P < 0.05) variations in the apparent digestibility of crude protein, crude fibre and ether extract and the crude protein digestibility decreased as the level of HQCP increased from 7.5 to 30%. Also, there was a significant (P<0.05) increase in acid detergent fibre and acid detergent lignin digestibilities with the inclusion of HQCP compared to the control, whereas there was no significant (P>0.05) influence of HQCP inclusion on hemicellulose digestibility among the treatments. It can thus be concluded that the nutritional potential of high quality cassava peel can still be realised when fed up to 30% in growing pig diet.

Keywords: High quality cassava peel, nutrient digestibility, fibre fraction, crude protein, growing pigs

Introduction

Maize is one of the staple food crops for human being particularly in sub-Saharan Africa (SSA) and the major staple in swine diets in many areas around the world (FAOSTAT, 2015). Sixteen of the 22 countries in the world where maize forms the highest percentage of calorie intake in the national diet are in Africa (Nuss and Tanumihardjo, 2011). In Nigeria, maize constitute up to 40 – 60% of the conventional energy source for poultry feeding (Afolayan *et al*., 2012). The low level of maize production in the country has resulted in situation such that greater percentage of the maize used in the country are imported and the competition between man and animal in terms of consumption and other uses has led to substantial increase in the price of the maize. In order to sustain pig production, therefore, there is need to provide alternative to maize as the major energy source for pig. Due to shortage of conventional feedstuffs, Sucharita *et al.* (1998) concluded that effective utilisation of non-conventional feeds should be the major areas of research in the less developed countries. One of the known alternative agro-industrial by product which is also an energy source that has been used to replace maize in pig's diet is cassava peel. Despite the abundance of cassava peel in the country, fresh cassava peel has some constraints that limit its inclusion in pig diet. These include large amount of cyanogenic glycoside, high phytate content and quick spoilage if left unprocessed. Most of the methods that has been used to combat these constraints include soaking, sun-drying and ensiling (Salami and Odunsi, 2003), fermentation and sun drying (Onyimonyi and Okeke, 2005) and sun drying is the more practical and the main method of processing. However, sun drying is only feasible during the dry season of the year and it takes longer for the product to be properly dried. There is also the tendency for cassava peel to be contaminated with fungal growth during the drying period which normally takes 3 – 5 days. The new innovative processing method of fresh cassava peel by International Livestock Research Institute (ILRI) that comprise of grating, dewatering, sieving and drying of the cassava peel has dramatically improved the nutritive value of cassava peel and resulted in a product known as High Quality Cassava Peel (HQCP) fine mash. This has reduced the drying time of cassava peels drastically from 3 to 5 days to about 6 hours, resulting in improvement of the product, in terms of quality and quantity (Okike *et al*., 2015). There is an improvement in the proximate composition of the HQCP when compared with ordinary sundried or fresh cassava peel in nutrient content (Table 1).

Adesehinwa *et al*. (2016) in an earlier study evaluated the effect of graded levels of HQCP finemash as a replacement for maize on the growth performance, cost of production, haematological and serum biochemical indices of growing pigs. In the study, fine mash of HQCP was able to replace 75% of the maize in growing pig diet and thus has a sparing effect on maize which has high demand with potential use as food or feed in poultry sector. Since the digestibility of the nutrients in a fibrous feedstuff depends on the source, nature and level of fibre in the feedstuff and fibre is a major factor in nutrient and energy utilisation, it is important to determine the digestibility of fibrous feedstuffs and diets high in fibrous feedstuffs in order to ascertain their nutritive value. The present work was therefore designed to investigate the effect of graded levels of high quality cassava peel fine mash as a replacement for maize on the nutrients utilisation and fibre fraction digestibility of growing pigs.

Table 1: Proximate compositions of cassava peel and high quality cassava peel (%)

	Cassava peel					HQCP
Parameters	Devendra (1977)	Ogbonna and Adebowale (1993)	Onyimonyi and Okeke (2005)	Aro *et al.* (2010)	Adesehinwa *et al.* (2011)	Adesehinwa *et al.* (2016)
Dry matter	ND	86.2	ND	17.9	89.2	90.9
Crude protein	4.80	5.10	7.50	4.20	3.15	6.63
Crude fibre	21.1	16.7	17.7	29.6	34.1	8.70
Crude fat	1.20	1.20	7.81	3.26	0.34	2.47
Ash	4.20	9.50	12.8	7.47	1.44	3.28
NFE	68.6	67.5	54.1	55.5	50.4	70.0
Metabolisable energy (kcal/kg)	ND	3210	ND	ND	ND	ND

NFE-Nitrogen Free Extract, HQCP-High Quality Cassava Peel, ND- Not Determined

Materials and methods

The experiment was carried out at the Piggery Unit, Teaching and Research Farm, University of Ibadan, Ibadan. A total of 20 growing cross bred (Large white × Landrace) pigs with an average weight of 53±0.5 kg were used for this study. The pigs were randomized completely into five dietary treatments and each treatment was replicated four times with one pig/replicate. The pigs were allotted individually into a metabolism cage. International Livestock Research Institute (ILRI) supplied the High Quality Cassava Peel (HQCP) fine mash used in this study. Diet 1 (control) contained 40% maize as the main source of energy, while Diet 2 had 32.5% maize and 7.5% HQCP, Diet 3 had 25% maize and 15% HQCP, Diet 4 had 17.5% maize and 22.5% HQCP and Diet 5 had 10% maize and 30% HQCP. Ingredients and chemical composition of the diets are shown in Table 2.

Table 2: Gross composition of the experimental diets

	Treatments				
Ingredients (%)	T1	T2	T3	T4	T5
Maize	40.0	32.5	25.0	17.5	10.0
HQCP	-	7.50	15.0	22.5	30.0
Corn bran	10.0	10.0	10.0	10.0	10.0
Groundnut cake	15.0	15.0	15.0	15.0	15.0
Lysine	0.30	0.30	0.30	0.30	0.30
Fish meal	3.00	3.00	3.00	3.00	3.00
Lime stone	1.20	1.20	1.20	1.20	1.20
Bone meal	2.10	2.10	2.10	2.10	2.10
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50
Rice Bran	7.50	7.50	7.50	7.50	7.50
PKC	20.0	20.0	20.0	20.0	20.0
Methionine	0.15	0.15	0.15	0.15	0.15
TOTAL	100	100	100	100	100
Calculated analysis					
Crude fibre (%)	6.06	6.17	6.28	6.39	6.51
Metabolisable energy (kcal/kg)	2770	2752.	2735	2717	2699
Crude protein (%)	18.4	18.0	17.5	17.0	16.4

Grower premix supplied the following per kg diet: vitamin A 10,000,000 IU; vitamin D 32,000,000 IU; vitamin E 8,000 IU; vitamin K 2,000 mg; vitamin B1 2,000 mg; vitamin B2 5,500 mg; vitamin B6 1,200 mg; vitamin B12 12 mg; biotin 30 mg; folic acid 600 mg;niacin 10,000 mg; pantothenic acid 7,000 mg; Choline chloride 500,000 mg; vitamin C 10,000 mg; iron 60,000 mg; Mn 80,000 mg; Cu 800 mg Zn 50,000 mg; iodine 2,000 mg; cobalt 450 mg; selenium 100 mg; Mg 100,000 mg; anti-oxidant 6,000 mg

Each experimental diet was fed to the pigs twice daily in the morning and evening at the daily rate of 4% of the individual animal live weight and water was provided throughout the period of experiment which lasted for nine days. Daily feed allowances and leftover feeds were measured and recorded. The pigs were kept in the cages for four days to acclimatise. Feed was withdrawn for 24 hours prior to the collection period to clear the gut from the previous meals. This was followed by five days of feeding and faecal collection. Fresh faecal samples were homogenised after collection and samples were taken immediately for moisture determination and approximately 10% of total faeces collected per time was frozen at –18°C for further chemical analysis. The faecal sample was collected twice per day in the morning and evening. The animals were also starved for another 24 hours prior to the end of the collection period to ensure total collection of faeces arising from the diets offered. At the end of the experiment, the moisture content of the faecal samples were determined at 105 ºC for 24 hours using 2g of faecal sample (after thorough homogenisation), while the rest of the samples for each replicate was oven dried at 60 ºC till constant weight and stored for proximate analysis. The gross energy content of feed and faeces was determined using a bomb calorimeter.

Chemical and statistical analyses

The proximate composition of the test ingredients, experimental diets and faecal samples were carried out as described by Association of Official Analytical Chemists (AOAC, 1990)

Apparent nutrient digestibility was calculated as

$$\text{Nutrient digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient excreted}}{\text{Nutrient intake}} \times 100$$

Data were subjected to analysis of variance (ANOVA) procedures using the general linear model procedures of SAS (2013). The means among variables were separated using Duncan Multiple Range Test. Statistical significance was assessed at $P < 0.05$ (95% confidence interval).

Results and discussion

The proximate composition of the nutrients and fibre fraction of the test ingredients and experimental diets are shown in Tables 3 and 4. The nutrients content particularly protein and dry matter of the HQCP were higher than that of the ordinary sundried or fresh cassava peel while fibre content of the HQCP was lower than that of the sundried or fresh cassava peel. Chemical analytical values of the diets were in good agreement with the calculated values. There were linear increases in the crude fibre, nitrogen free extract and dry matter as the HQCP quantity increased from diet 2 to diet 5 and crude protein linearly decreased from diet 1 to diet 5. The percentage of neutral detergent fibre, acid detergent fibre and acid detergent lignin ranged from 44.35 (T1) - 49.54 (T3); 19.86 (T1) - 25.46 (T3) and 7.13 (T1) – 11.16 (T3) respectively.

Table 3: Proximate composition and energy contents of test ingredients and experimental diets (%)

Parameters	T1	T2	T3	T4	T5	Maize	HQCP
Dry matter (%)	91.0	90.6	90.5	90.4	90.4	90.7	90.9
Crude protein (%)	17.9	14.7	14.4	13.9	13.8	11.2	6.6
Crude fibre (%)	5.88	6.43	6.47	6.45	6.50	1.27	8.70
Crude fat (%)	3.40	3.57	3.48	3.52	3.50	4.12	2.47
Ash (%)	6.31	6.45	6.37	6.48	6.43	3.76	3.28
NFE (%)	57.2	59.4	59.8	60.0	60.1	70.3	70.0
Gross energy (kcal/kg)	3993	3985	3964	3955	3894	3784	2985

NB: HQCP – High Quality Cassava Peel; NFE – Nitrogen free extract

Table 4: Fibre fraction of test ingredients and experimental diets (%)

Parameters (%)	T1	T2	T3	T4	T5	Maize	HQCP
NDF	44.4	49.2	49.5	48.9	48.5	9.59	42.1
ADF	19.9	25.3	25.5	25.1	25.0	6.88	20.7
ADL	7.13	11.1	11.2	10.8	11.0	0.19	6.77
Hemicellulose	24.5	23.9	24.1	23.9	23.6	2.71	21.4
Cellulose	12.7	14.2	14.3	14.6	14.0	6.69	13.9

NDF- Neutral Detergent Fibre, ADF- Acid Detergent Fibre, ADL- Acid Detergent Lignin

Table 5 shows the apparent nutrient digestibility coefficient of growing pigs fed varying levels of HQCP fine mash. There was no significant difference (P>0.05) in apparent nutrient digestibility of dry matter, nitrogen free extract, organic matter and metabolisable energy. Dry matter which is an indicator of the amount of nutrient available to the animal in a particular feed, ranged from 63.85% **(T5) -** 67.45% (**T3**). The moderately high digestibility of dry matter in the diets of growing pigs in this study indicated that the dietary crude fibre levels did not induce excessive production of mucin to increase the viscosity of the digesta within the gastrointestinal tract (Hon *et al*., 2009).

There were no significant variations in the dry matter, organic matter, nitrogen free extract and energy digestibility of all the treatments irrespective of the level of HQCP inclusion. However, Okumura *et al.* (1982) stated that digestibility of dry matter is highly influenced by the cellulose level and the higher the cellulose content of the diet, the higher will be the apparent digestibility of the dry matter.This was also corroborated by the report of Siri *et al*. (1992) who fed 5 to 20% cellulose to chicken and observed that dry matter digestibility increased linearly as cellulose increased from 5 to 15%.

There were significant (P < 0.05) variations among the treatments in the apparent digestibility of crude protein, crude fibre and ether extract. Crude protein digestibility ranged from 77.14% (T5) – 81.93% (**T1**), with the highest value recorded in treatment 1 and the least in treatment 5. Apart from treatment 3, there was linear decrease in apparent crude protein digestibility from treatment 1 to 5 as the fibre level increased. This showed that the higher the fibre level of the diet, the lower the apparent crude protein digestibility. The results of this experiment supported the observations of Noblet and Perez (1993) that an increase in the dietary level of fibre decreased protein digestibility. Hansen *et al.* (2007) explained that fibrous diets influenced nitrogen excretion due to nitrogen repartitioning from urine to faeces, which invariably affects apparent digestibility coefficient of crude protein. The digestibility of a feed for both ruminants and non-ruminants tends to decrease with increase in crude fibre content (Aderemi and Nworgu, 2007). Typically, a 1% increase in crude fibre content brings a 1% decrease in digestibility for ruminants and a 2% decrease for pigs (Aderolu *et al.*, 2002). Growing pigs used in the present study had similar apparent crude fibre digestibility values from 7.5% HQCP (T2) to 30% HQCP (T5) inclusion in their diets. The digestibility of fibre in swine diets can vary depending on the source of fibre (Bach Knudsen and Hansen, 1991), processing method (Fadel *et al*., 1989) and concentration in the diet (Goodlad and Mathers, 1991). It has also been reported that fibre utilisation by pigs can be influenced by the physical and chemical composition of the diet, level of feeding, age and weight of animal, adaptation to the fibre diet and individual variation among the pigs (Morel *et al.*, 2006). The apparent ether extract digestibility was significantly highest in treatment 1 and lowest in treatment 3.

Table 5: Apparent nutrient digestibility coefficient (%) of growing pigs fed experimental diets (%)

Parameters	T1	T2	T3	T4	T5	±SEM
Dry Matter	64.3	64.9	67.5	64.7	63.9	0.60
Crude Protein	81.9^{a}	79.0^{bc}	80.6^{ab}	77.8^{c}	77.1^{c}	0.53
Organic Matter	86.8	88.6	87.8	88.9	86.5	0.54
Crude Fibre	15.9^{b}	24.6^{ab}	29.6^{a}	23.8^{ab}	22.9^{ab}	1.52
Ether Extract	80.7^{a}	69.0^{b}	63.3^{b}	69.5^{b}	70.4^{ab}	1.87
NFE	88.2	90.8	89.4	91.5	91.7	0.70
ME	88.9	89.0	89.7	88.8	88.4	0.20

Note: SEM -- standard error of mean, NFE - Nitrogen Free Extract, ME- Metabolisable energy

Table 6: Apparent fibre fraction digestibility coefficient of growing pigs fed experimental diets (%)

Parameters	T1	T2	T3	T4	T5	±SEM
NDF	71.1^{b}	74.3^{ab}	76.4^{a}	74.0^{ab}	73.3^{ab}	0.55
ADF	69.6^{b}	76.5^{a}	78.3^{a}	76.3^{b}	75.6^{a}	0.78
ADL	69.3^{b}	82.4^{a}	82.4^{a}	80.3^{a}	79.9^{a}	1.17
Hemicellulose	72.2	72.0	74.4	71.6	70.8	0.51
Cellulose	69.8^{b}	72.9^{ab}	75.1^{a}	73.4^{ab}	72.2^{ab}	0.59

Note: SEM - Standard error of mean, NDF-Neutral Detergent Fibre, ADF-Acid Detergent Fibre, ADL-Acid Detergent Lignin

Table 6 shows the apparent digestibility coefficient of fibre fraction by growing pigs fed experimental diets. There was significant ($P<0.05$) influence of the HQCP inclusion on apparent nutrient digestibility of neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and cellulose, whereas there was no significant ($P>0.05$) influence of HQCP inclusion on hemicellulose among the treatments. Apparent NDF digestibility coefficient ranged from 71.07% in diet 1 to 76.41% in diet 3. The least ADF apparent digestibility was recorded in diets 1 and 4, while, no significant variation was observed in diets 2, 3 and 5. Similar trend was observed in the digestibilities of ADL and cellulose. The results of this work revealed that nutrients digestibilities of growing pigs could still be maintained with up to 30% inclusion of HQCP in the diet. The nutrient digestibility of high quality cassava peel fine mash as a replacement for maize in growing pigs were highest for all nutrients up to 30% inclusion in diet (T5). This might have been due to highly digestible carbohydrates in the high quality cassava peel meal resulting in a digestibility of metabolisable energy of approximately 90% at the inclusion rate of 30% from the present study.

Conclusion

It can thus be concluded that the proximate constituents and the fibre fractions of the high quality cassava peel was well digested when fed to growing pig up to 30% inclusion level.

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