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Nutrient characterization of processed cassava peels and dietary sludge supplementation on pig performance

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ABSTRACT: The study was carried out to evaluate nutrient characterization of processed cassava peels and dietary sludge supplementation on pig performance. A total of twenty-five (25) crossbred weaner pigs weighing averagely 8.5±2.5 kg were used. They were allotted into five treatments groups with three replicates in a completely randomized design. These pigs were fed twice daily, water and salt lick supplied *ad libitum*. The treatment diets consist of cassava peels and dietary sludge supplementation at 0% (controlled), 15%, 35%, 65% and 85% replacement of maize. Data on live weight, weight gain on a weekly basis, feed intake, body length, heart girth and height at withers were collected to determine the effect of processed cassava peel meal supplemented with dietary sludge on growth performance and economic evaluation of pigs. The data collected were subjected to one way analysis of variance (ANOVA) and significantly different means were separated using the multiple range test. Results revealed that there was a significant ($p<0.05$) difference on all the growth performance parameters measured as well as the economic evaluation of the feed. It can be concluded that dietary sludge mixed with processed cassava peel meal has a significant effect on the growth performance of pigs. It is therefore recommended that pig farmers should use processed cassava peel meal supplemented with dietary sludge feeds on pigs at 85% as it produces higher effects on the daily feed intake of pigs.

Keywords: Cassava peel, dietary sludge, pig performance.

INTRODUCTION

Previous research has established that pig performance in terms of weight and efficiency of gain and carcass leanness is clearly related to the intake levels of energy and protein (Obongekpe, 2020). However, feed stuffs and ingredients used in pig ration formulation such as maize, soy-bean meal, groundnut cake etc have continued to be scarce and costly due to their low production and competition as food by humans and animals. This has resulted in the collapse of many small and large scale pig production, discouraging prospective farmers and curtailing further expansion of small enterprises of piggeries. Nevertheless, the potential of many industrial by-product such as cassava peels, palm kernel meal, dietary sludge, brewers spent grains, wheat offal etc., to serve as alternative, cheaper and readily available nutrient source for pigs has been recognised (Obongekpe, 2020) but unfortunately not fully utilized in Africa especially in Nigeria, it would therefore be economically expedient to explore the use of these non-conventional feed resources (NCFR) or agro-industrial by-product (AIBP) which are abundant and cheap (Okai et al., 2005; Obongekpe, 2020).

Cassava (*Manihot esculenta*) is an all-season crop of the humid tropics and ranks among the top 10 food crops in the world (Oyebimpe et al., 2006). It is the highest supplier of carbohydrates among staple crops (FAO, 1995). Annual production estimate in Nigeria was 34 million tonnes in 2002 (FAO, 2002). Cassava peels contain 30 to 40% dry matter, more than most roots and tubers. This depends on factors such as variety, soil type, moisture, climatic conditions and the age of the root at harvest (Obongekpe, 2020). Starch and sugar are the predominant components of the dry matter, approximately 90%, with starch being the most important (FAO, 2002). Although, the crude protein

content of cassava peel is 2 to 4% in dry matter, the true protein content is less than half this amount due to the fact that 50% of the nitrogen in the peel is in the form of non-protein-nitrogen. Furthermore, the available true protein is deficient in the Sulphur containing amino acids. The peels contain significant amounts of vitamins, particularly vitamin C, thiamine, riboflavin and niacin (FAO, 2002). Cassava products have been in use for a long time as an energy source in place of cereal grains for livestock (Eruvbetine et al., 2003).

According to Oyebimpe et al. (2006), cassava peels continue to constitute waste in the cassava processing industry. It accounts for 10 to 13% of the tuber by weight. Tewe and Iyayi (1995) reported that, among the roots produced in Nigeria, cassava peel obtained constitute 20% of total tubers produced annually. Cassava peel meal could serve as a cheap source of energy for farm animals but should be fortified with additional protein source because of its low protein level (Obioha and Anikwe, 1982). Considerable evidence has emerged for long of the possibility of using processed cassava peel as an energy source for pigs and poultry (Tewe, 1981; Iyayi, 1986). Higher inclusion of the by-product in monogastric feed or formulation of diets with cassava peels, as sole energy source is limited because of its fibrous nature. Aro et al. (2008) have reported the occurrence of high amounts of non-starch polysaccharides (NSPs) in cassava peels. Degradation of these carbohydrate compounds to simple sugars will further increase the energy value of cassava peels, hence, the need for the addition of exogenous enzymes when utilized in replacing cereals in diets for monogastric animals (Adesehinwa, 2004).

Furthermore, dietary sludge has been reported to be supplemented with cereals to increase the performance growth of pigs. Dietary sludge is waste products from the remains of animal diets or feds. Studies have shown that when diet sludge are mixed with other locally made feds, it produces positive effects on the growth performance of monogastrics like birds, pigs and rabbits etc. (Jacob, 2019). However, the study was carried out to determine the nutrient characterization of processed cassava peels and dietary sludge supplementation with concentrate on pig performance.

MATERIALS AND METHODS

Study area

The study was carried out at the Swine Unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State, Nigeria. Akwa Ibom State is located in the coastal southern part of the country, lying between latitudes 4°32'N and 5°33'N, and longitudes 7°25'E and 8°25'E. The state is located in the south-South geographical zone, and is bordered on the east by Cross River State, on the west by Abia State, and on the south by Atlantic Ocean and the southmost tip of Cross Rivers State.

Preparation of cassava peel meal (CPM)

Cassava peels were collected fresh from cassava processing mills in Uyo metropolis, Akwa Ibom State. The peels were dehydrated by sun for 7 days to reduce enzymatic and microbial reactions leading to spoilage and nutrient leaching. The sun drying was also aimed at enhancing the crispness and to reduce anti nutritional factors such as tannin, saponin, oxalate and phytate present in cassava. The dry peels were then milled in a hammer mill before incorporating into the test diets. Thereafter, the cassava peel meal (CPM) was mixed with dietary sludge in the ratio 2:1 to replace maize meal.

Experimental animals

Twenty-five (25) crossbred weaner pigs weighing averagely 8.5±2.5 kg were used for the study. They were allocated into five treatment groups, 5 in each with three replicates in a completely randomized design.

Experimental diet

Five diets were formulated such that diet 1 (control) contained maize as the major energy source. In diets 2, 3, 4 and 5, the dried mixture of cassava peel meal supplemented with dietary sludge were used to replace maize in the proportion of 15, 35, 65 and 85% respectively. The proportions of soybean meal were also adjusted to achieve fairly 15 isoproteinous diets. The compositions of the experimental rations are shown in Tables 1 and 2.

Feeding and collection of data

The pigs were weighed at the beginning of the experiment to obtain their initial live weight and subsequently weighed on weekly basis. The pigs were fed twice daily, in the morning by 8.00 am and in the evening by 5.00 pm. Feed intake was obtained as the difference between quantity offered and quantity left over. Water was offered *ad libitum*. The parameters studied were live weight, weight gain on a weekly basis, feed intake, body length, heart girth and height at withers. The cost of 50 kg bag of each of the feed ingredients at the time of purchase was used to calculate the cost of the experimental diets.

Statistical analysis

Data were subjected to analysis of variance using the procedure outlined by SAS (2002) and significantly different means were separated using the multiple range test by Duncan (1955).

Table1. Composition of experimental diet for weaners pig.

Ingredients	T_1	T_2	T_3	T_4	T_5
Maize	85.00	64.25	45.50	18.75	6.50
Cassava peels/dietary sludge	-	15.00	35.00	65.00	85.00
Ground nut cake	7.60	10.40	8.92	4.06	2.08
Wheat offal	2.10	4.30	3.51	3.69	1.02
Bone meal	1.50	1.50	1.50	1.50	1.50
Limestone	2.00	2.00	2.00	2.00	2.00
Palm oil	1.00	2.00	2.20	2.40	2.60
Weaner premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Ronozyme**	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
Crude protein (%)	19.00	19.00	19.00	19.00	19.00
ME(Keal/Kg)	2878	2857	2835	2813	2791
Fibre (%)	5.35	6.99	8.63	10.26	11.90
Ash (%)	5.94	9.11	12.34	15.57	18.80
Calcium (%)	0.80	0.80	0.80	0.80	0.80
Starch (%)	39.20	36.14	32.99	29.85	26.70
Fat (%)	6.48	7.74	8.99	10.25	11.50

Table 2. Proximate and energy composition of dietary sludge and cassava peel meal (SDCPM).

Ingredients	T_1 (0%)	T_2 (15%)	T_3 (35%)	T_4 (65%)	T_5 (85%)
Dry matter (%)	85.49^b	86.90^b	87.39^c	88.90^b	89.39^c
Crude protein (%)	8.39^d	9.87^c	10.18^a	9.87^c	9.18^a
Crude fibre (%)	9.98^c	10.59^a	10.94^d	10.59^a	8.94^d
Ether Extract (%)	4.72^a	5.12^c	5.33^b	5.12^c	5.33^b
Ash (%)	5.78^d	14.80^b	12.78^c	10.80^b	8.78^c
NFE (%)	44.55^d	43.86^b	52.27^a	54.86^b	56.27^a
Metabolized energy Kcal/100g	2617.00	2290.00	2282.00	2270.00	2263.00

^{a,b,c,d} means on the same row with different superscripts are significantly different ($p<0.05$).

RESULTS AND DISCUSSION

The proximate composition of experimental diets are presented in Tables 1 and 2. The values were closely related to the reports of Ekenem (2007), Akinmutimi and Onen (2008) and Maliki et al (2011) and fall within the nutrient requirements of growing pig as recommended by Akinmutimi (2004). These variations in the proximate and composition maybe due to different source of CPM (Akinmutimi, 2004) and soil as a limiting factor (Obiona et al., 2011). The Nitrogen-Free Extract (NFE) values of 56.27% implies that cassava peel meal supplemented with dietary sludge has a high level of soluble carbohydrate and protein that will enhance palatability and therefore, increase feed intake and digestibility. The MEkcal/kg (2263) of the test ingredient is higher than what was obtained (2604 kcal/kg) by Akanno (1998). The proximate composition of experimental diets reveals that, diets were formulated according to the standard of Bello et al. (2011) and Nsa et al. (2011). The values were closely related to the calculated values and they all fall within the nutrient requirement of pigs especially the CP and energy values. Nsa et al. (2011) reported a 16.90 to 17.91% CP while Emy (2010) reported 17 to 18% CP requirement of monogastric.

Initial live body weight of weaner pigs ranged from 8.88 to 9.32 kg. The average final body weight gain of the weaner pigs obtained as shown in Table 3 revealed that, experimental animals were significantly ($p<0.05$) affected by the experimental diets. Animal fed 15% inclusion of cassava peels supplemented with dietary sludge gave the highest final body weight (25.67 kg), followed by control (23.84 kg), and while values obtained for 35, 65 and 85% experimental diets decreased with increasing replacement levels of cassava peels supplemented with dietary sludge.

Table 3. Performance characteristics of weaner pigs fed experimental diet.

Parameters	Levels of inclusion					SEM (±)
	T_1 (0%)	T_2 (15%)	T_3 (35%)	T_4 (65%)	T_5 (85%)	
Ave. initial weight(kg)	9.32	8.88	9.00	9.00	9.00	
Ave. final weight(kg)	23.84^{b}	25.67 ^{a}	22.00 ^{c}	21.50^{d}	20.84^{d}	0.46
Ave. total weight gain(kg)	14.52^{b}	16.79 ^{a}	13.00 ^{d}	12.50^{cd}	11.84^{d}	0.44
Ave. weekly weight gain(kg)	2.07^{b}	2.40 ^{a}	1.86 ^{c}	1.78^{cd}	1.69^{d}	0.64
Feed intake(kg)	35.00	35.00	35.00	35.00	35.00	0.01
Feed conversion ratio	2.41^{c}	2.06 ^{d}	2.69^{b}	2.80^{b}	2.96^{a}	0.68
Protein efficiency ratio	2.18^{b}	2.52^{a}	1.95^{c}	1.88^{cd}	1.78^{d}	0.08
Mortality (%)	-	-	-	-	-	-

^{a,b,c,d,e} means along the same row with different superscripts are significantly ($p< 0.05$) different from each ot her, Ave: Average, SEM: Standard error of mean.

Also, similar significant ($p<0.05$) differences were recorded in average total weight gain and weekly weight gain of weaner pigs fed experimental diets that ranged from 15 (2.40) to 85% (1.69 kg) respectively. Feed intake values were not significantly ($p>0.05$) affected at weaner phase; results were the same across the groups.

Feed conversion ratio differed significantly ($p<0.05$) in the experimental animals, while animals on 15% (2.06) diet gave the best compared to other diets with corresponding values of 0 (2.41), 35 (2.69), 65 (2.80) and 85% (2.96) respectively. Protein efficiency ratio of weaner pigs was significantly ($p<0.05$) influenced by the experimental diets, highest value was recorded in 15% (2.52) diet, followed by control (2.18), 35 (1.95), 65 (1.88) and 85% (1.78) in that order. There was no mortality throughout this phase of feeding trial.

The effect of feeding cassava peels supplemented with dietary sludge meal on the performance characteristics such as average final weight, average total weight gain, average weekly weight gain, feed conversion ratio and protein efficiency experienced a gradual fall in values as the levels of cassava peels supplemented dietary sludge meal increased and this fall was critical at complete replacement of maize with cassava peel and dietary sludge meal at 85% inclusion. However, the study is in agreement with Igene (2006) who observed that the uses of cassava in feeding pigs at level higher than 50% usually resulted to decrease in both live weight and feed conversion efficiency. Also, Amaefule et al. (2006) and Ekenem (2007) posited that inclusion of cassava peels above 60% will also has a deleterious effect on the performance of weaner pigs. The decreased in average weekly body weight gain with increased levels of cassava peels dietary sludge meal in the diets is attributed to the tendency of cassava peels dietary sludge meal in pig diets to decrease the level of fat lay down in the tissues. The poor results noticed with high processed cassava peels supplemented dietary sludge meal in the diet is also ascribed to the techniques of processing cassava peels and dietary sludge meal, which is in accordance with Ubalua (2007) who reported that digestive disturbance have been frequently noticed when large amount of cassava peels is fed to certain animals due to the presence of cyanogenic potential and high variable fiber contents in cassava peels which increased the osmosis pressure in the gastro-intestinal trait and subsequently cause digestion disturbance. This situation could cause the decreased in feed intake with the increased levels of processed cassava peels supplemented with dietary sludge meal in the diets, as a result of high dehydration and increase salivation in the weaners, resulting in a decreased body weight. Also, the dustiness of processed cassava peels with dietary sludge meal ration has contributed to the decrease in feed intake as a result of nasal disorder caused by high levels of cassava peels in the diet. Higher inclusion of the by-product in monogastric feeding or formulation of diets with processed cassava peels, as sole energy source is therefore limited because of its fibrous nature. Feed efficiency was found to increase with increased levels of cassava peels supplemented dietary sludge meal in the diet indicating a lower efficiency of utilization of cassava peels supplemented dietary sludge meal diet by the weaner pigs in this study. This is in accordance with work of Bimrew (2014) who showed that early weaned pigs have limited amylase, protease, lipase activity and enhancement of the extent of digestion of nutrients would improve performance and reduce the incidence of the diarrhea that results from undigested nutrients reaching the gut fermented by bacteria.

Economics and efficiency of experimental diets are shown in Table 4. Feed cost (N/kg) was higher in diet containing maize, followed by diet 2, 3, 4 and 5 with corresponding values of N99.91, N 90.90, N79.86, N66.40 and N56.50 respectively. Total cost of feed per weight gain per pig were N3496.75, N3181.50, N2795.40, N2325.40 and N1977.50 for diet 1, 2, 3, 4 and 5. Figures show that maize based diet (control) was the highest, followed by diet 2, 3, 4, and 5 in that order. This could be traceable to high cost of maize as a major source of energy in the diet. Revenue/total live weight gain/pig (N) ranged from N5372.80 in diet 2 to N3788.80 in diet 5. Highest revenue was obtained in diet 2 with 25% inclusion of experimental

Table 4. Economics and efficiency of weaner pigs fed experimental diets.

Parameters	Levels of inclusion				
	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)
Ave. initial wght/pig (kg)	9.32	8.88	9.00	9.00	9.00
Ave. final wght/pig (kg)	23.84	25.67	22.00	21.50	20.84
Ave. total wght gain/pig (kg)	14.52	16.79	13.00	12.50	11.84
Feed cost (₦ /kg)	99.91	90.90	79.86	66.44	56.50
Total feed consumed/pig (kg)	35.00	35.00	35.00	35.00	35.00
Total cost of feed/pig (₦) live weight gain	3496.75	3181.50	2795.40	2325.40	1977.50
Revenue/total live wght gain/pig (₦)	4646.40	5372.80	4160.00	4000.00	3788.80
Gross profit/pig (₦)	1149.55	2191.30	1364.60	1674.90	1811.30

Ave: Average.

diet as the alternative energy source, also on the gross profit/pig (N), pigs in diet 2 yielded highest and profit were N2191.30, N1811.30, N1674.90, N1364.60 and N1149.55 for diet 2, 5, 4, 3 and 1 respectively.

Economics and efficiency of weaner pigs fed experimental diets assessed by feed cost (N/kg), total cost of feed consumed (N/kg), and cost of feed per pig (kg) decreased as the levels of inclusion of cassava peels supplemented dietary sludge meal in the diets increased. Profit/pig (N) revealed that 15% diet was the most cost effective for producing weaner pigs. Feed cost/kg was least in 85% (N56.50) and highest (N99.91) in control diet. Similarly, total cost of feed consumed per pig was least (N1977.50) in 100% cassava peels supplemented dietary sludge meal diet and highest in maize (N3496.75) based diet, is credited to the high cost of maize during the experimental trial. This is in agreement with earlier reports by Irekhore et al. (2006) and Adesehinwa et al. (2011) that cassava peels introduced up to 30% in piglet diets had no effect on growth rate and in pigs above 35 kg weight, that feeding up to 57% inclusion was adequate for replacement for maize in young pig diets and has showed to be cost effective. Low cost of feed/kg live weight gain in pigs observed in 15% diet translated to more revenue and profit. Thus, 15% diet was the most efficient and cost effective. This profit derived from 15% diet was almost twice the one of maize. Also of interest is the fact that other substitutes at 35, 65 and 85% were more profitable than maize based diet.

Oboh et al. (2016) reported that replacement of cassava peel for maize up to 50% level in a weaner pigs diet resulted to higher revenue and profit. However, Oboh et al. (2014) also reported that replacement of whole maize with maize offal's with brewers dried yeast mixture up to 50% level resulted to higher profit. Damisa et al. (2009) further stressed that the inclusion of cassava peels meal up to 38% with 4 to 5% palm oil, gave a better economic performance than other combination of peels and palm oil. This study confirmed that cassava peels meal at 25% as energy source is the most cost effective ingredients for ration formulation in pigs. The result of the study is in conformity with reports of earlier authors (Manilal et al., 1985) and has justified the need for continuous search for alternative feed ingredients.

Conclusion

The findings of this study revealed that there were significant differences on all the growth performance parameters measured as well as the economic evaluation of the feed. It is therefore concluded that dietary sludge mixed with processed cassava peel meal has positive effects on the growth performance of pigs. It is recommended that pig's farmers should use processed cassava peel meal supplemented with dietary sludge feeds on pigs at 85% as it produces higher effects on the daily feed intake of pigs.

CONFLICT OF INTERESTS

Author declares not conflict of interest.

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