RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 42 Issue 2: 161-167 (June 2023)

Influence of Processed Cassava Peel-leaf Blend as Replacement for Maize on Growth Performance and Serum Parameters of Growing Pigs

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10.18805/ajdfr.DRF-278

ABSTRACT

Background: The use of alternative feedstuff like cassava peel and leaf in pig production is of great concern due to reduced nutrient availability caused by high fibre and antinutritional constituent. The current study investigated the effect of dietary inclusion of differently processed cassava peel-leaf blend (CPLB) on growth and blood parameters of growing pigs.

Methods: CPLB (Cassava peel: Cassava leaf; 5:1) was included in pigs diet in a feeding trial for 16 wks. The CPLB replaced maize at 100%. 24 pigs of mean weight range (20-22 kg) were assigned on a weight equalization basis to four dietary treatments having six replicates with one pig per replicate. A standard corn soya-based diet (control), Unfermented CPLB (UCPLB), water fermented CPLB (WCPLB) and microbial fermented CPLB (MCPLB) using *Aspergillus tamarii* as inoculum was formulated. Growth response was measured and serum analysis was carried out at the end of the 8th and 16th week.

Result: There was no significant ($p>0.05$) effect on growth performance at the end of the 8th and 16th weeks. Dietary inclusion of MCPLB resulted in higher ($p<0.05$) cholesterol (144.30 mmol/L) in pigs than those fed control diet (97.20 mm/L) at the end of 8th week. Pigs fed diet containing UCPLB had reduced ($p<0.05$) serum creatinine (0.58 mg/dl) at the end of 16th week. In conclusion, CPLB based diet irrespective of processing method did not significantly affect growth performance and without negative effect on blood serum parameters.

Key words: Cassava leaf, Cassava peel, Fermentation, Growth performance, Pigs, Serum.

INTRODUCTION

Pig production stands as a means of mitigating animal protein shortage in Africa and this is due to their fast growth, short generation interval, high prolificacy, efficient nutrient conversion into high quality meat and ability to convert agro waste into nutritious meat (Adesehinwa *et al*., 1998). Pigs belongs to the category of monogastric animals which constitute the largest consumer of commercial livestock feeds in Africa (FAO, 2015). Commercial pig production employs the use of concentrate feeding (maize-soybean based) with increasing cost due to poor local production below the demands by man, animals and other channels of usage (Afolayan, 2010). Therefore there is need to find ways of utilizing available agro-industrial wastes in formulating swine diets to produce meat at frugal rate.

One of such available agro industrial by-products and crop residues that could be explored in the nutrition of pigs are cassava peels and leaves. Cassava peels constitute about 10-13% of tuber weight (Oyebimpe *et al*., 2006) with a protein content of approximately 46 to 55 g/kg (Morgan and Choct, 2016). Cassava peel contains crude protein (5.98%), ether extract (0.65%), ash (7.0%), nitrogen-free extract (65.87%) and metabolisable energy of 2044.8 kcal/kg (Salami 2000). Cassava leaf is high in protein (16.6% to 39.9%), a good source of vitamin B, C and carotenes (Dada and Oworu, 2010).

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How to cite this article: Williams, G.A., Akinola, O.S., Adeleye, T.M., Irekhore, O.T., Lala, A.O., Oso, A.O. and Williams, O.K. (2023). Influence of Processed Cassava Peel-leaf Blend as Replacement for Maize on Growth Performance and Serum Parameters of Growing Pigs. Asian Journal of Dairy and Food Research. 42(2): 161-167. doi: 10.18805/ajdfr.DRF-278.

Submitted: 01-04-2022 **Accepted:** 23-02-2023 **Online:** 10-05-2023

The limitation to the use of these by-products in monogastric nutrition is due to the presence of high fibre fractions and its constituent poor amino acid profile (Ngudi *et al*., 2003; Cardoso *et al*., 2005). Thus, to adequately access the rich nutritive potential of these cassava products in swine nutrition, there is a need to engage various processing strategies or methods capable of increasing its utilisation (Motarjemi, 2000). Blood constituents are indicators of the composition of ingested nutrients (Animashahun *et al*., 2006). In addition, the study of blood characteristics can provide useful information for diagnostic and management purpose because blood serves as an important index of physiological, pathological and nutritional status of an animal (Oleforuh-Okoleh *et al*., 2015). Therefore, the current study seeks to investigate the effect of processed cassava peel-leaf blends on growth performance and serum parameters of growing pigs.

MATERIALS AND METHODS

The experiment was executed in accordance with the approved guidelines for Animal Research by Nigeria Institute of Animal Science in Nigeria (NIAS).

Experimental site

The experiment was carried out at the piggery unit of the Directorate of University Farms, (DUFARMS) Federal University of Agriculture, Abeokuta, Alabata, Ogun State, Nigeria from March 2019 to July 2019. The site is situated in the derived savanna zone of Southwestern Nigeria on Latitude 7°9′39N and 3°20′54E and 76 m above sea level. The mean annual rainfall is 1040 mm and occurs from March to October, the temperature average is 34°C throughout the year.

Processing of test ingredients

Cassava peel meal (CPM) and cassava leaf meal (CLM)

Dried cassava peels were obtained from the cassava processing plant in Igbo-ora, Oyo state, Nigeria. The dried peels were subsequently hammer milled (2 mm sieve) to yield cassava peel meal (CPM) and stored in bags. Fresh cassava leaves without petioles were manually plucked from an established cassava farm (Odeda, Ogun State, Nigeria). The leaves were evenly spread on the concrete floor and sun-dried for 2-3 days until the dried leaves became crispy while still retaining the greenish colouration. The dried crispy leaves were milled (2 mm sieve) to yield cassava leaf meal (CLM) which was stored in plastic bags under room temperature.

Unfermented cassava peel-leaf blend (UCPLB)

A blend of cassava peel meal (CPM) and cassava leaf meal (CLM) was prepared using the Pearson Square method according to Adeyemi *et al*. (2014) by mixing at a ratio of 5: 1 (5 parts CPM: 1 part CLM) to form an unfermented cassava peel-leaf blend (UCPLB) with a protein content of 8.83%. Crude protein contribution from individual components in the mix is 81.26% and 18.74% from CPM and CLM respectively.

Water fermented cassava peel-leaf blend (WCPLB)

Prepared by mixing dried CPLB (5:1) with water (in ratio 1:1, kg: Lt) in plastic drums. The blend was mixed thoroughly to ensure all portions of the blend come in contact with water. After mixing, the wet blend was placed in black polythene bags and tied properly to create an anaerobic environment within the bags. The bags were left for 7 days to ensure proper fermentation of the contents. On the seventh day, the bags were opened and the ingredients were sundried and stored before diet formulation.

Microbial (*Aspergillus tamarii*) fermented cassava peel-leaf blend (MCPLB)

Pure strains of *Aspergillus tamarii* obtained from the Culture Collection Unit of the Department of Microbiology, Federal University of Agriculture, Abeokuta was used as inoculums in this processing method. Spores of *Aspergillus tamarii* used for fermentation of the CPLB was prepared by following standard protocols described by Murray *et al*. (2003). Spore suspension (inoculum) of *Aspergillus tamarii* was prepared by washing spores from Petri dishes into clean water at an inoculum size of 10.5×10^{8} spores/g of CPLB. The wet blend was mixed properly and placed into black polythene bags which were tied properly to create an anaerobic environment within the bags. The bags were stored and left for 7 days to ensure proper fermentation of the contents. On the seventh day, the bags were opened and the ingredients were sundried and stored before diet formulation.

Chemical composition of test ingredients

Proximate composition of samples from CPM, CLM, UCPLB, *WCPLB* and *MCPLB* was determined using standard method by Association of Official Analytical Chemists (AOAC) according to Nochera and Ragone (2016) and fibre fractions were carried out according to the standard method by McCleary (2007) respectively. All analysis done was on a dry matter basis. NDF (assayed without a heat-stable amylase and expressed inclusive of residual ash), ADF (expressed inclusive of residual ash) and Lignin (determined by solubilisation of cellulose with sulphuric acid) and crude protein (total nitrogen × 6.25). Gross energy was estimated using the adiabatic bomb calorimeter (Model 1261; Parr Instrument Co., Moline, IL, USA) while digestible energy was calculated according to Adeola (2001). The cyanogenic glycosides of the samples were done using the method described by Vetter (2000).

Experimental animal, design and dietary treatments

Twenty four (24) crossbred (Large white × Landrace) male pigs (15 wks old) with average weight (20-22 kg) purchased from reputable pig farm at Iperu Remo, Ogun State were randomly assigned on a weight equalization basis to four dietary treatments. Pigs were housed individually in 24 pens (0.5 m × 0.25 × 0.3 m). Six pens were assigned to each treatment. A standard soybean-maize based diet (control; Diet 1) was formulated following the National Research Council (NRC) requirement for growing pigs according to

Nyachoti *et al*. (2005). Three additional experimental diets were formulated such that UCPLB (Diet 2), WCPLB (Diet 3) and MCPLB (Diet 4) replaced maize (weight for weight) in the control diet (Table 1). Pigs in each treatment group were fed with their respective experimental diets. Feed was offered to the animals during the trial which lasted for 16 weeks based on the NRC recommended intake partitioned for each body weight range. Experimental diets were fed twice daily (8:00 and 18:00 hr) while clean water was supplied *ad-libitum*.

Growth performance

The initial body weight of the pigs were taken and subsequent weight per pen was measured weekly, while the gain in weight was calculated. Daily feed intake was also measured as the difference between the feed offered and leftovers, while feed conversion ratio (FCR) was also calculated as Feed consumed/Weight gain.

Blood collection

Blood samples were collected from 3 randomly selected pigs per treatment at the end of 8^{th} and 16^{th} week of the study. This was done through the culinary vein using disposable syringes with 20×100 mm metallic needles. 2.5 ml blood was collected from each pig; it was collected in plain bottles (without EDTA) for serum parameters. Blood samples were centrifuged (1200 rpm for 15 min) for separation of plasma. Aliquots of plasma was taken and frozen at -20°C until further analysis.

Serum parameters

The total serum protein, albumin and globulin were determined using bromocresol purple method (Varley *et al*., 1980), serum creatinine according to Bonsness and Taussky (1945). Serum enzymes (alanine aminotransferase (ALT), alkaline phosphatase (ALP) and aspartate aminotransferase (AST))

Table 1: Gross composition of experimental diet.

	Control	UCPLB	WCPLB	MCPLB
Ingredients				
Maize	40.00	0.00	0.00	0.00
UCPLB	0.00	40.00	0.00	0.00
WCPLB	0.00	0.00	40.00	0.00
MCPLB	0.00	0.00	0.00	40.00
Soyabean meal	17.00	18.00	19.00	18.00
Groundnut cake	8.00	10.00	11.00	10.00
Palm kernel cake	11.00	10.00	10.00	13.00
Wheat offal	18.00	12.50	11.50	9.00
Palm kernel oil	1.00	4.50	3.50	5.00
Limestone	1.00	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
*Vitamin/mineral premix	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Nutrients composition				
Digestible energy (kcal/kg)[a]	3156.10	3068.60	3156.40	3150.49
Metabolisable energy (kcal/kg)	2588.00	2516.25	2588.25	2505.50
Protein (%)	19.16	19.68	19.29	19.66
Ether extract (%)	3.88	2.97	3.83	4.24
Carbohydrate	57.96	53.7	58.24	54.23
Fibre (%)	4.90	9.26	7.68	7.33

*Vitamin/mineral premix: Vit. A. 5,500,000 (iu), Vit D3. 1500,000 (iu), Vit E. 10,000 (mg), Vit.k3 1,500 (mg), Vit. B1, 1,600 (mg), Vit. B2 24,000 (mg), niacin 20,000mg, pantothenic acid 5,000 mg vit B6 1,500 mg, Vit. B12 10 mg, folic acid 500 mg, Biotin H2 750 mg, chlorine chloride 175,500 mg, cobalt 200 mg, copper 300 mg, iodine 1,000 mg, iron 20,000 mg, manganese 40,000 (mg), selenium 200 mg, zinc 30,000 mg, anti- oxidant 1,250 mg.

UCPLB: Unfermented cassava peel-leaf blends; WCPLB: Water fermented cassava peel-leaf blends; MCPLB: Microbial fermented cassava peel-leaf blends.

[a]: Calculated using the method of Adeola (2001).

were analysed using the commercial kits (Qualigens India. Pvt. Ltd., Catalogue number 72201-04). The serum cholesterol was estimated using the enzymatic colorimetric methods (according to the manufacturer's manual) using Randox ® diagnostic cholesterol kit.

Statistical analysis

All data obtained were subjected to a One-way analysis of Variance using Statistical Analysis System Software (SAS) and mean separation was done using Tukey test of SAS as described by Ramatsoma *et al*. (2015) while significant differences were considered at $p<0.05$.

RESULTS AND DISCUSSION

Chemical composition of test ingredients

Table 2 shows the nutrient composition, fibre fraction, gross energy and cyanide content of test ingredients.

Growth performance

The performance of growing pigs is shown in (Table 3). There is no significant ($p>0.05$) effect of processed CPLB inclusion on all performance indices measured at the end of 8th and 16th weeks. This is in concordance with the report of Irekhore *et al*. (2015) who observed no significant effect of dietary inclusion of cassava peel as replacement for maize on performance indices of growing pigs. Ly *et al*. (2010) also reported no significant effect of dried and ensiled cassava leaf in the diet of crossbred pigs on final body weight, average daily gain and FCR. However, on the contrary, Hong *et al*. (2016) observed significantly reduced feed intake with the inclusion of fermented cassava tuber wastes in the diet of crossbred pigs. Fatufe *et al*. (2007) also reported depressed feed intake when cassava root peel was used in the diets of pigs. These discrepancies can be linked to the differences in the processing of the cassava by-product, age and size of the animal used. The findings of Adeyemi *et al*. (2014) with no difference in the performance of rabbits fed 50% fermented cassava peel and leaf meal as a replacement for maize corroborates the result of the present study. In all, the similar weight gain of pigs fed diet containing CPLB compared with the control diet as obtained in this study indicates that CPLB based diets were able to support as much growth as the maize-based diet.

Serum parameters

Serum parameters of growing pigs is shown in (Table 4). At the end of 8 weeks, the result shows significant ($p<0.05$) effect of cassava peel-leaf blend inclusion on serum cholesterol of pigs. Growing pigs fed diet containing MCPLB had higher ($p<0.05$) cholesterol content compared to those fed control diet but similar to those fed diet containing UCPLB and WCPLB. Increased serum cholesterol obtained for growing pigs fed cassava based diet could be as a result of the dietary oil constituent. Other serum parameters were not significantly ($p>0.05$) affected. This agrees with the report of Unigwe *et al*. (2016) who reported no significant effect of fermented cassava peel inclusion in diets of growing pigs in respect of total protein, globulin, albumin and creatinine.

At the end of 16th week, there was significant ($p<0.05$) difference in serum creatinine of pigs fed diet containing cassava peel-leaf blends. This is similar to the report of Midau *et al*. (2011) who reported significant difference on serum creatinine of broiler chicken fed graded levels of enzyme (maxigrain) supplemented cassava peel meal (CPM) based diets. Pigs fed diet containing UCPLB had reduced ($p<0.05$) serum creatinine content compared to those fed diet containing MCPLB but similar to those fed control diet and diet containing WCPLB. However, the serum creatinine values across treatment fell below the normal range which indicates no muscular wastage which might

Table 2: Chemical composition of test ingredients.

Nutrient composition (%)	CPM	CLM	UCPLB	WCPLB	SCPLB
Crude protein	4.46	27.78	8.97	8.11	11.68
Ether extract	1.81	4.93	0.76	1.66	0.61
Crude fibre	14.23	17.70	13.00	12.24	12.87
Ash	5.51	8.08	7.73	9.06	7.56
Nitrogen free extract	84.25	44.57	57.39	56.03	60.79
Total cyanide (mg/kg)	4.03	1.82	1.37	1.32	1.28
ADF	25.04	26.14	37.48	23.55	26.96
ADL	13.67	14.10	21.59	20.23	20.23
NDF	24.26	21.32	37.84	35.62	26.19
Gross energy (kcal/g)	3575.70	3011.01	3980.80	3918.95	3825.34
Digestible energy (kcal/g)[a]	2860.56	2408.81	3184.64	3135.16	3060.27

UCPLB: Unfermented cassava peel-leaf blend; WCPLB: Water fermented cassava peel-leaf blends; MCPLB: Microbial fermented cassava peel-leaf blends; ADF= Acid detergent fibre; ADL= Acid detergent lignin; NDF= Neutral detergent fibre.

[a:] Calculated using the method of Adeola (2001).

Table 3: Performance of growing pigs fed a diet containing differently processed cassava peel-leaf blend.

Parameters (kg)	Control	UCPLB	WCPLB	MCPLB	SEM	p-value
At 8 weeks						
Initial weight	20.17	20.83	20.58	22.00	1.07	0.948
Final weight	44.00	45.00	40.67	43.50	1.81	0.869
Weight gain	23.83	24.17	20.08	21.50	0.92	0.356
Weight gain/wk.	3.97	4.03	3.35	3.57	0.15	0.356
Total feed intake	56.88	59.16	51.03	59.08	2.39	0.619
FCR (kg:kg)	2.40	2.45	2.49	2.84	0.09	0.290
At 16 weeks						
Initial weight	44.00	45.00	40.67	43.50	1.81	0.869
Final weight	65.83	66.83	64.00	67.17	1.89	0.944
Weight gain	21.83	21.83	23.33	23.67	0.56	0.549
Weight gain/wk.	3.64	3.64	3.89	3.94	0.09	0.549
Total feed intake	91.55	92.50	86.98	89.76	2.40	0.875
FCR (kg:kg)	4.25	4.28	3.77	3.79	0.13	0.363

UCPLB= Unfermented cassava peel-leaf blend, WCPLB= Water fermented cassava peel-leaf blends, MCPLB= Microbial fermented cassava peel-leaf blends, SEM= Pooled standard error of means, FCR= Feed conversion ratio.

Table 4: Serum parameters of growing pigs fed diet containing differently processed cassava peel-leaf blend.

Parameters	Control	UCPLB	WCPLB	SCPLB	SEM	p-value	Normal range
At 8 weeks							
Total protein (g/dl)	6.57	6.37	6.47	7.03	0.25	0.841	¶6.6-8.9
Albumin (g/dl)	3.67	4.30	4.07	4.63	0.17	0.348	¶3.6-5.0
Globulin (g/dl)	2.90	2.17	2.33	2.37	0.20	0.667	Б 2.8-4.1
Cholesterol (mmol/L)	97.20^{b}	108.30^{ab}	110.80^{ab}	144.30^{a}	7.58	0.029	*81.4-134.1
Creatinine (mg/dl)	2.00	2.27	2.07	2.07	0.07	0.596	¶1.0-2.3
Thiocyanate (µg/ml)	1.09	1.41	1.42	1.36	0.09	0.649	ǂ2.5 (Lethal level)
At 16 weeks							
Total protein (g/dl)	7.42	7.54	7.67	7.87	0.32	0.973	¶6.6-8.9
Albumin (g/dl)	3.86	4.88	4.19	4.48	0.44	0.904	¶3.6-5.0
Globulin (g/dl)	3.56	2.66	3.49	3.41	0.31	0.775	Б 2.8-4.1
Cholesterol	76.06	84.46	128.03	110.18	9.08	0.148	*81.4-134.1
Creatinine (mg/dl)	0.65^{ab}	0.58^{b}	0.61^{ab}	0.75^{a}	0.03	0.032	¶1.0-2.3
Thiocyanate (µg/ml)	1.59	1.91	1.99	1.64	0.09	0.393	ǂ2.5 (Lethal level)

^{ab} Means on the same row having different superscripts are significantly different (P<0.05).

UCPLB= Unfermented cassava peel-leaf blend, WCPLB= Water fermented cassava peel-leaf blends, MCPLB= Microbial fermented cassava peel-leaf blends, SEM= Pooled standard error of means.

¶= Brockus *et al.* (2005), Б = (Klem *et al.* (2010), *= Merck's Manual (1998), ǂ = Kampe *et al.* (2000).

have been possibly caused by inadequacy of protein in pigs because creatinine is an indirect measure of protein utilization (Rafiu *et al*., 2013). The other serum parameters determined were not significantly (p>0.05) affected.

CONCLUSION

The inclusion of cassava peel-leaf blends as replacement for maize in the diet of pigs irrespective of the subjected processing methods did not adversely affect performance and serum parameters of pigs. Therefore in spite of the high fiber content of the cassava peel-leaf based diets, the processed cassava peel-leaf blends can adequately replace maize in the diet of pigs.

Conflict of interest

The authors declared no conflict of interest.

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