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Effect of Differently Processed Cassava Peel-leaf Blend on Growth Performance, Carcass Yield and Ileal Microflora of Growing Pigs

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ABSTRACT

Background and Objective: The cost of feedstuff like maize and other conventional energy sources have increased due to high competitive demand which necessitated the search into alternative feedstuff like cassava by-products (peel and leaf). However, their nutrient availability is hampered by antinutritional factors and constituent fibre. Therefore this study investigated the effect of dietary inclusion of differently processed Cassava Peel-Leaf Blend (CPLB) on growth performance, carcass yield and ileal microflora of growing pigs. **Materials and Methods:** CPLB (Cassava peel: Cassava leaf, 5:1) was included in pigs diet in a feeding trial for 16 weeks. The CPLB replaced maize at 100%. About 24 pigs of the 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 responses were measured at the end of the 8th and 16th week while microbial count and carcass yield were measured at the 16th week. **Results:** There was no significant ($p>0.05$) effect on performance at the end of the 8th and 16th weeks. Dietary inclusion of WCPLB and SCPLB reduced ($p<0.05$) carcass weight. Reduced ($p<0.05$) *Escherichia coli* count (3.30 and 3.36 Log_{10}) was obtained in the ileum content of pigs fed a diet containing UCPLB and WCPLB, respectively. **Conclusion:** CPLB based diet irrespective of processing method did not affect performance and had comparable dressing percentage for pigs fed a control diet.

KEYWORDS

Pigs, cassava peel, cassava leaf, fermentation, performance, carcass, ileal microflora

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INTRODUCTION

The bulk of feed for commercial poultry and swine production made up of cereal grains most especially maize and soybean keeps increasing due to poor local production which is not meeting the demands by man, animals and other channels of usage[1]. This necessitated the search for cheap alternative sources of energy-yielding ingredients, with less competition and readily available in commercial quantities[2]. 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[3] with a protein content of approximately 46-55 g kg^{-1} [4]. Cassava peel is richer in crude protein (5.98%), ether extract (0.65%), ash (7.0%) and nitrogen-free extract (65.87%) compared to the pulp and metabolisable energy of 2044.8 kcal kg^{-1} [5]. Cassava leaf is high in protein (16.6-39.9%), a good source of vitamin B, C and carotenes[6]. The rich potential of these cassava by-products cannot be fully harnessed in monogastric nutrition due to the presence of high fibre fractions[7] and its constituent poor amino acid profile[8]. Thus, to efficiently harness the nutritive potential of these cassava products in swine nutrition, there is a need to engage various dietary manipulations or processing methods capable of breaking down the constituent fibre and further enriching the final product[9].

Fermentation has been reported to reduce constituent anti-nutritive factors in feedstuffs and produce the desirable flavour that will enhance feed intake[10]. It also improves the nutritional content of the resultant product through vitamin and amino acid biosynthesis and increases fibre digestibility[11]. Solid-State Fermentation (SSF) of fibrous feedstuffs has been used to enhance the nutritive quality of erst while, denigrated feedstuffs using filamentous fungi which produce microbial lipases that break down low-cost agricultural residues to yield high nutritive product[12].

Therefore, the current study seeks to investigate the effect of differently processed cassava peel-leaf blends on growth performance, carcass yield and ileal microflora of growing pigs.

MATERIALS AND METHODS

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 to July, 2018. The site is situated in the derived savanna zone of Southwestern Nigeria on latitude 7°9'39N and longitude 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 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.*[13] 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.*[14]. 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^{-1} 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 the standard method by the Association of Official Analytical Chemists (AOAC) according to Nochera and Ragone[15] and fibre fractions were carried out according to the standard method by McCleary[16], respectively (Table 1). 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[17]. The cyanogenic glycosides of the samples were done using the method described by Vetter[18].

Experimental animal, design and dietary treatments: Twenty four crossbred (large white×landrace) male pigs (15 weeks old) with average weight (20-22 kg) were randomly assigned on a weight equalization basis to four dietary treatments. Pigs were housed individually in 24 pens (0.5×0.25×0.3 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.*[19]. Three additional experimental diets were formulated such that UCPLB (Diet 2), WCPLB (Diet 3) and SCPLB (Diet 4) replaced maize (weight for weight) in the control diet (Table 2). Pigs in each treatment group were

Table 1: 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^{-1})	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^{-1})	3575.70	3011.01	3980.80	3918.95	3825.34
Digestible energy (Kcal g^{-1})[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 and [a]Calculated using the method of Adeola[18]

Table 2: 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^{-1}) [a]	3156.10	3068.60	3156.40	3150.49
Metabolizable energy (Kcal kg^{-1})	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

UCPLB: Unfermented cassava peel-leaf blends, WCPLB: Water fermented cassava peel-leaf blends, MCPLB: Microbial fermented cassava peel-leaf blends and [a]Calculated using the method of Adeola[18]

fed with their respective experimental diets. Feed was offered to the animals during the trial which lasted for 16 weeks based on the NRC[19] recommended intake partitioned for each body weight range. Experimental diets were fed twice daily (8:00 and 18:00 hrs) while, clean water was supplied *ad-libitum*.

Growth performance: The body weight of the pigs 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 was also calculated.

Carcass and organ weight measurements: At the end of the 16th week, four pigs per treatment whose weights were representative of the average weight of the pigs contained in each treatment were selected. The animals were starved of feed overnight but had access to drinking water. Animals were weighed the next day and taken to the slaughter slab and stunned, properly bled, scalded, de-haired and eviscerated before dissecting into separate parts for carcass and organ measurements. Measurement was carried out on the cut parts which were the head, trotters, back, belly, hams, loins and shoulder. The internal organs such as heart, liver, spleen, kidney, lungs and the large/small intestine were measured with the aid of a digital sensitive scale.

Gut microflora: Following carcass measurement, the gastrointestinal tract of slaughtered pigs was excised. The ileum was separated from the gastrointestinal tract and the respective ileal content were collected aseptically in sterile bottles under ice conditions. Fresh digesta samples of about 1g were placed in sterile bottles which were used for bacterial analysis. The digesta samples were plated on selective culture media. The plates were incubated anaerobically (MACS MC Anaerobic chamber) at 37°C for 48 hrs. The following selective culture media were used: MRS (de Man, Rogosa, Sharpe) agar (Oxoid CM 361) for *Lactobacillus* sp. and KFS (Kenner Formula for Streptococcus) agar (Oxoid CM 701) for *Streptococcus* sp. by spread plate technique[20]. The counting of total bacteria was carried out using a colony counter (Stuart Scientific) and weighed in terms of Colony-Forming Unit (CFU) per gram digesta.

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 the Tukey test of SAS as described by Ramatsoma *et al.*[21] while, significant differences were considered at $p<0.05$.

RESULTS

Chemical composition of test ingredients: Table 1 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 dietary treatment on all performance indices measured at both ends of 8 and 16 weeks.

Carcass yield: Carcass characteristics of growing pigs are shown in Table 4. The result showed a significant ($p<0.05$) effect of dietary treatment on carcass weight, dressing percentage, belly, forelimb, hind limb and lungs. Pigs fed a diet containing WCPLB and those fed diet containing MCPLB had reduced ($p<0.05$) carcass weight when compared to the control group. Pigs fed the control diet and those fed diet containing UCPLB had higher ($p<0.05$) dressing percentage compared to those fed diet containing WCPLB. Pigs fed with cassava-based diets notwithstanding the processing method had reduced forelimb and belly weights than the control group.

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

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

UCPLB: Unfermented cassava peel-leaf blends, WCPLB: Water fermented cassava peel-leaf blends, MCPLB: Microbial fermented cassava peel-leaf blends and [a]Calculated using the method of Adeola[18] SEM: Pooled standard error of means

Table 4: Carcass characteristics of finishing pigs fed a diet containing differently processed cassava peel-leaf blend

Parameters (kg)	Control	CPLB	WCPLB	SCPLB	SEM	p-value
Carcass weight	45.00^{a}	39.67^{ab}	37.00^{b}	37.00^{b}	1.36	0.037
Dressing percentage	66.83^{a}	65.39^{a}	60.99^{b}	62.36^{ab}	0.74	<0.001
Head	5.57	5.43	5.13	5.67	0.22	0.881
Belly	4.80^{a}	3.93^{b}	3.70^{b}	3.83^{b}	0.18	0.047
Back	7.93	6.83	6.60	6.60	0.26	0.199
Forelimb	15.27^{a}	12.87^{b}	11.73^{b}	11.80^{b}	0.47	0.001
Hind limb	15.63^{a}	13.33^{ab}	12.97^{ab}	12.33^{b}	0.55	0.044
Trotter	1.83	1.69	1.63	1.63	0.05	0.593
Internal organs						
Total internal organ	9.37	8.47	9.07	8.33	0.34	0.738
Full stomach	1.23	1.17	1.18	1.37	0.15	0.973
Kidney	0.17	0.12	0.08	0.15	0.01	0.168
Liver	1.02	0.93	0.90	0.92	0.03	0.500
Lungs	0.60^{a}	0.48^{b}	0.43^{b}	0.52^{b}	0.02	0.009
Spleen	0.10	0.10	0.10	0.13	0.01	0.441
Heart	0.23	0.20	0.17	0.18	0.02	0.736
GIT weight	6.33	5.73	6.85	5.93	0.37	0.782

UCPLB: Unfermented cassava peel-leaf blends, WCPLB: Water fermented cassava peel-leaf blends, MCPLB: Microbial fermented cassava peel-leaf blends and [a]Calculated using the method of Adeola[18, abc]Means on the same row having different superscripts are significantly different ($p<0.05$) and SEM: Pooled standard error of means

Table 5: Ileum microflora (log_{10} organism) of growing pigs fed a diet containing differently processed cassava peel-leaf blend

Microbes	Control	UCPLB	WCPLB	MCPLB	SEM	p-value
Streptococcus faecalis	3.40	3.58	3.59	3.39	0.05	0.429
Escherichia coli	3.78[a]	3.30[b]	3.36[b]	3.43[ab]	0.07	0.046
Pseudomonas	2.20	3.00	1.00	2.16	0.44	0.529
Proteus spp.	2.10	1.00	1.00	2.00	0.46	0.784
Staphylococcus aureus	0.00	1.00	2.20	1.10	0.46	0.463
Total bacteria count	4.03	3.90	3.98	3.90	0.03	0.484

[ab]Means on the same row having different superscripts are significantly different (p<0.05) and SEM: Pooled standard error of means

Ileum microflora: The effect of dietary inclusion of differently treated CPLB on the microbial count of ileum content is shown in Table 5. The result showed a significant effect (p<0.05) only on *Escherichia coli* count. Pigs fed the control diet had a higher (p<0.05) *Escherichia coli* count than those fed diet containing UCPLB and WCPLB.

DISCUSSION

The performance of growing pigs at the end of 8 weeks indicated that CPLB inclusion irrespective of treatment in the diet of pigs had no significant effect on all growth parameters measured. This is in concordance with the report of Irekhore *et al.*[22], who obtained no significant effect of cassava peel replacement for maize on performance indices of growing pigs. Ly *et al.*[23], also reported no significant effect of dried and ensiled cassava leaf in the diet of crossbred pigs on final body weight, average daily gain, dry matter intake and Feed Conversion Ratio (FCR). Adesehinwa *et al.*[1], also reported comparable final weight of growing pigs fed cassava peel based diets with those fed maize-based diets. However, feed intake was numerically higher for pigs fed a diet containing UCPLB and MCPLB. This contradicts the findings of Fatufe *et al.*[24], who reported depressed feed intake when cassava root peel was used in the diets of pigs. Hong *et al.*[25], also observed significantly reduced feed intake with the inclusion of fermented cassava tuber wastes in the diet of crossbred pigs. These discrepancies can be linked to the difference in age and size of the animal used. It has been known that there is a connection between feed intake with body size[26].

At 16 weeks, performance parameters were not significantly affected with the inclusion of differently treated CPLB in the diet of pigs. The comparable effect of dietary treatments on performance suggests the suitability of the blend in the diet of pigs. The findings of Adeyemi *et al.*[13] 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. A slight increase in final weight and weight gain was observed with pigs fed a diet containing MCPLB however, not significant could be associated with the fermentation process which enhanced weight gain. Fermentation enhanced the nutrient content of foods through the biosynthesis of vitamins, essential amino acids and proteins by improving protein quality and fibre digestibility[27]. Overall the similar weight gain of pigs fed a diet containing CPLB compared with the control diet indicates that CPLB based diets were able to support as much growth as the maize-based diet.

Pigs fed the control diet had improved dressing percentage which is possibly due to the constituents of the diet. Pigs on a high level of nutrition particularly with accessible energy and protein content result in rapid protein synthesis and increased tissue accretion[28]. Pigs on a higher nutritional plane obtain an adequate intake of nutrients required to sustain rapid growth and development[29]. However, pigs fed a diet containing WCPLB had a similar dressing percentage with those fed a control diet. This suggests adequate energy and protein available to the pigs. This is also associated with the influence of fermentation of CPLB which had aided the availability of locked up nutrients in the feed material. The primal cut parts which include the belly and hind limb weight is higher in pigs fed the control diet. This corroborates the report of Njoku *et al.*[28], who reported that pigs with larger body weights had higher head, ham, feet and shoulder weights. Lo-Fiego *et al.*[30] and Latorre *et al.*[31], also observed that the weights of ham, shoulder and loin increased with an increase in weight at slaughter.

The result of the present study showed no significant effect of CPLB in the diet of pigs on total internal organs, kidneys, liver, heart and GIT weight. The lack of effect on kidney and liver by the dietary treatments suggested the safety of the test ingredients. This is following the report of Agunbiade *et al.*[32] and Ojebiyi *et al.*[33], who observed non-detrimental effects on internal organs when cassava peel meal and cassava peel and leaf meal mix were fed as a replacement for maize in diets of growing rabbits. The stomach and gastrointestinal tract weight were not affected by feeding CPLB based diet to pigs which suggest no pressure on the organs. An increase in the weight of the stomach is known to result from increased pressure on the organ to digest fibrous feed[28].

The occurrence of *Streptococcus faecalis* and *Streptococcus aureus* in the ileum digesta samples of the pigs confirms the existence of a normal microbiota environment as these organisms exist under the normal microbiota of the vertebrate gastrointestinal tract[34]. There was no difference in total bacteria count across treatments. This is contrary to the report of Aro *et al.*[35], who observed an increase in the faecal bacterial count of pigs fed a cassava-based diet. The non-significant difference in total bacterial count obtained in this study implies that differently treated CPLB based diets influenced the microflora in a similar pattern just as the maize-based diet due to the availability of readily utilizable nutrients. The reduction in *Escherichia coli* observed with the inclusion of CPLB in the diet of pigs is associated with the acidic environment created as a result of short-chain fatty acid produced by dietary fibre fermentation in the gut capable of inhibiting the growth of some intestinal pathogens such as *Escherichia coli*, *Salmonella* spp. and *Clostridium* spp.[36]. This study reveals the utilize ability of cassava peel and leaf by growing pigs and this confirms the suitability of replacing CPLB either fermented or not for maize in the diet of pigs without compromise on performance and no negative effect on real microbiota. In addition, the non-negative impact on ileal microflora implies efficient nutrient assimilation from CPLB for adequate tissue accretion.

CONCLUSION

The inclusion of cassava peel-leaf blends as a replacement for maize in the diet of pigs irrespective of the subjected processing methods did not adversely affect performance. The inclusion of CPLB in the diet of pigs reduced the *Escherichia coli* count in the ileum of pigs.

SIGNIFICANCE STATEMENT

This present study discovers that properly processed cassava peel-leaf blends can replace maize in the diet of growing pigs without negatively affecting performance. In addition, this study revealed an adequate ratio combination of cassava peel and cassava leaf to obtain crude protein close to maize. This study will help the researcher on the right combination of the by-product for further nutritional investigation and also encourage the farmer on utilization of the by-product in pig feeding.

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