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NUTRIENT DETERMINATION AND APPARENT NUTRIENT DIGESTIBILITY OF GRAVID GILTS FED CASSAVA PLANT MEAL-BASED DIETS

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ABSTRACT

Three CPMs products were developed from cassava variety (*Tropical Manihot Species* (TMS) 30572) harvested at 24 months after planting. The different cassava plant parts (sun-dried unpeeled cassava tuber meal, cassava leaf meal and tender cassava stem meal) were mixed at different ratios of 2:1, 2.5:1 and 3:1 while the ratio of the leaves to tender stems was 5:1 across the three CPMs products. The apparent nutrient digestibility of the developed CPMs products by pre-gestation gilts, and the proximate composition, minerals, amino acids, vitamins, fatty acids and apparent nutrient digestibility of CPM-based diets for gravid gilts were determined using standard laboratory procedures. Results showed that CPM products 2 and 3 had higher crude protein and crude fibre digestibility coefficients and were better digested than CPM product 1. The proximate composition of CPM-based diets differed significantly ($p<0.05$) across dietary groups. The amino acid contents increased with increasing inclusion of unpeeled cassava tuber meal to the CPM-based diets. Also, the Calcium, Phosphorus, Manganese and Chlorine content were influenced ($p<0.05$) by increasing inclusion of unpeeled cassava tuber meal. The apparent nutrient digestibility of the CPM-based diets was significantly ($p <0.05$) higher in 100% CPM-based diets and comparable to the value obtained for the group fed maize-based diet. In conclusion, the CPMs products 2 and 3 had comparable nutrient contents as maize meal and the digestibility coefficient of the nutrients in the experimental diets fed to gravid gilts increased with increasing inclusion of unpeeled cassava tuber meal. Cassava plant meal could give comparable reproductive performance when fed to gravid pigs.

Key words: alternative feedstuff, cassava plant meals, reproductive efficiency, gravid pigs, maize

INTRODUCTION

The use of alternative feedstuffs in the diets of pigs and poultry have gained enormous attention over the years. The undying interest could be due to the extreme competition between man and livestock for available feedstuffs essentially cereal grain such as maize and soybean. Meanwhile, there exist several agro-products and agro-by-products (with limited competition) that could contribute to sustainable livestock production (Ineichen *et al.*, 2023). In Nigeria, such alternatives include cassava and its co-products. Although, cassava meals (tuberous roots, leaves and peels) have long been used as suitable alternatives in diets of pigs, the results of such studies are plagued by inconsistencies and large variations in responses to inclusion levels ranging from 5 to 100 percent (Adeyemi and Akinfala, 2019).

The inclusion levels between 30 and 50 % replacement of maize have given satisfactory performance when sufficiently supplemented (Adesehinwa *et al.*, 2019; Adeyemi, 2023). However, the cost of additional methionine supplementation has further increased the cost of feeds and defeated the competitive advantage over maize (Moseri *et al.*, 2020). An alternative to this scenario is the development and utilization of cassava plant meals (CPMs), that is, sundried unpeeled cassava tuber meal + sundried cassava leaf meal + sundried tender cassava stem meal. The CPMs mixed in varying ratios of 2:1; 2.5:1 and 3:1 were with a view to obtaining a comparable minimum crude protein content of 10 % as maize while also adding bulk to the compounded feed.

In recent time, livestock nutrition has become a nutritional science that requires adequate information on the quality and quantity of the nutrient in feedstuffs (Morgan and Choct, 2016). Since variations exist in the nutrient contents of feedstuffs, consistent efforts are crucial to formulating diets that meet the specific needs at different growth and physiological phases of livestock with minimal waste and environmental pollution. Therefore, the current trend in the use of alternative feedstuffs requires in-depth knowledge of the nutritive value for efficient exploitation as diets for monogastric animals particularly pigs (Adeyemi, 2023).

Some studies (Akinfala *et al.*, 2013; Akinfala *et al.*, 2019; Adeyemi and Akinfala, 2019) have evaluated the responses of growing pigs to diets containing graded levels of cassava plant meals and found satisfactory performance on growth, lean carcass and economy of production when labour cost was considered. To the best of our knowledge, information on the nutritive value of cassava plant meal to match the requirements of gravid pigs is yet to be elucidated. Meanwhile, cassava-based diets fed to gestating pigs gave inferior reproductive

efficiency compared to those fed control (maize-based) diet (Gomez, 1977). The inferior performance could be attributed to the variation in nutrient profile of cassava meals and the inadequacy of the available nutrients to support the requirements of the animals. This study therefore assessed the nutrient profile of cassava plant meal diets and the apparent nutrient digestibility of gravid gilts with the possibility of optimising nutrient use efficiency to enhance their reproductive performance.

MATERIALS AND METHODS

Experimental location

The nutrient analyses in the different cassava plant meal products were carried out at the Department of Animal Science, University of Ibadan, Ibadan, while the apparent nutrient digestibility trial was carried out at the Swine Unit of the Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State.

Collection and preparation of cassava plant meal products

The cassava tuber variety TMS 30572 of 2 years old was purchased in farms around Supare-Akoko, Ondo State. The stems were gently lifted, soil was shaken off the roots, plucked, washed and chopped into small pieces. The cassava leaves were harvested from the stems while the tender cassava stems usually 6 – 7 nodes from the top of the plant were harvested, with all the different cassava components spread separately on concrete floor for sun-drying. Depending on the intensity of the sun-light, the unpeeled chopped cassava tuber, cassava leaves and tender cassava stems took an average of 4 – 5 days to dry. The different components were individually milled using a 2 mm sieve diameter milling machine and stored in polythene sacks for future use. Three cassava plant meal (CPM) products delineated as CPMs 1, 2 and 3 were mixed in different ratios of 2:1; 2.5:1 and 3:1 respectively, following the procedure outlined by Akinfala *et al.* (2002). The different mixing ratios were done with a view to obtain a minimum crude protein content of 10% as maize.

Experimental diets

Five experimental diets denoted as T1, T2, T3, T4 and T5 were formulated using NRC (2012) as guide to meet the nutrient requirements of gravid pigs. Diet T1 is the control (maize-based diet) while diets T2 and T3 as well as T4 and T5 contained 50% and 100% CPM products 2 and 3 respectively in replacement of maize.

Table 1: Composition of experimental diets for gravid gilts

	Experimental diets				
Ingredients (%)	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	26.0	13.0	-	13.0	-
Cassava p1ant mea1	-	13.0	26.0	13.0	26.0
Palm Kernel Cake	24.0	22.0	22.0	22.0	22.0
Wheat offal	24.0	25.0	25.0	25.0	25.0
Ground nut cake	10.0	10.0	10.0	10.0	10.0
Soybean	8.0	8.0	8.0	8.0	8.0
Fish meal	2.0	2.0	2.0	2.0	2.0
Bone meal	2.5	1.5	1.5	1.5	1.5
Oyster shell	3.0	3.0	3.0	3.0	3.0
Vit-min Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Calculated Ana1ysis					
ME (kcal/Kg)	2498.10	2461.35	2384.18	2447.05	2376.93
Crude protein (%)	12.26	12.98	13.43	13.12	13.35
Crude fibre (%)	9.02	9.89	10.57	9.16	10.94

Prior to practical diet formulation, the three cassava plant meal products 1, 2 and 3 as well as maize meal were balanced with other ingredients (bone meal, salt, vitamin and mineral premix) and fed to four pre-gestation gilts to ascertain the best two of the three CPM products having comparable apparent nutrient digestibility as maize (Table 2).

Table 2: Composition of test ingredients (Cassava plant meal products and maize)

	Cassava plant meal (CPM) products			
Ingredients (%)	**CPM 1**	**CPM 2**	**CPM 3**	**Maize**
SUCTM	64.67	69.29	72.75	-
SCLM	26.95	23.08	20.21	-
SCTSM	5.38	4.63	4.04	-
Maize	-	-	-	97.0
Bone meal	2.5	2.5	2.5	2.5
Vitamin-mineral premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	**100.0**	**100.0**	**100.0**	**100.0**

SUCTM: Sundried Unpeeled Cassava Tuber Meal; SCLM: Sundried Cassava Leaf Meal; SCTSM: Sundried Cassava Tender Stem Meal

Experimental animals, management and design

Digestibility of test ingredients and maize meal

Four crossbred (Large White x Hampshire) gilts with an average weight of 49.52±.38 Kg were used in a 4x4 Latin square design experiment. Each of the four experimental gilts received four different diets (Cassava plant meals products 1, 2, 3 or maize meal) in four periods with each period lasting 10 days (comprising of 7 days for the experimental trial and 3 days of resting in between periods). Each experimental pig was fed based on 4% of its body weight while water was supplied *ad libitum*. Faecal collection was carried out on the last three days of the trial, pooled among treatment groups, oven dried and homogenised, while representative samples were used for proximate analysis following the procedure of AOAC (2006). The best two cassava plant meal products were used as basal diets for gravid gilts.

Digestibility of experimental diets fed to gravid gilts

Fifteen crossbred (Large White x Hampshire) gravid gilts were used for the apparent nutrient digestibility experiment. Three gravid gilts each serving as a replicate were randomly allotted to five dietary treatment groups in a completely randomised design. Each replicate was housed in a metabolic cage made of metal with facilities for feeding and watering. The first four days of the trial was for acclimatisation while faeces were collected in the last three days. All faecal collections were pooled for each treatment group, oven dried at 70 °C overnight and thereafter homogenised while representative samples were taken for proximate analysis following the procedure outlined by AOAC (2006). Nutrient digestibility was calculated as follow:

$$Nutrient\ digestibility = \frac{Nutrient\ intake - Nutrient\ in\ faeces}{Nutrient\ intake} X\ 100\%$$

Chemical analysis

The proximate composition, amino acid, minerals, vitamins and fatty acid contents of the experimental diets were determined using standard laboratory analytical methods.

Statistical analysis

Data were subjected to One-way Analysis of Variance using the General Linear Model procedure of SAS (2009). Means were separated using Duncan Multiple Range test at 5% level of significance.

RESULTS AND DISCUSSION

The results of apparent nutrient digestibility of cassava plant meal products and maize by pre-gestation gilts are presented in Table 3. There was significant ($p<0.05$) influence of treatment groups on crude protein, crude fibre and ether extract digestibility of the experimental gilts. Also, the digestibility values obtained for the crude protein and crude fibre contents of the CPM products followed an increasing trend with inclusion of more tuberous root meal to the different CPM mix. This could indicate that, the digestibility of the different CPM products depends on the quantity of sundried unpeeled cassava tuber meal present in the total CPM product. This results agrees with those of previous studies (Akinfala *et al.*, 2019; Adeyemi and Akinfala, 2019) that, the level of unpeeled cassava tuber meal in the CPM product influences its digestibility. For the ether extract, all the values obtained were numerically similar though followed a decreasing trend with increased inclusion of the unpeeled cassava tuber meal. This could be indicative of the quantity of total crude fat present in the different CPM products. Meanwhile, there exists no influence of experimental gilts or the different periods on any of the proximate parameters.

Table 3: Apparent nutrient digestibility of maize and cassava plant meal products fed to experimental gilts

		CPM products						
Proximate composition	**Maize**	**1**	**2**	**3**	**SEM**	**TRT**	**WK**	**PIG**
Dry matter (%)	84.32	85.35	85.64	85.85	0.50	0.25	0.32	0.44
Crude protein (%)	79.72^{b}	71.33^{c}	79.51^{b}	83.86^{a}	1.84	0.01	0.16	0.25
Crude fibre (%)	81.02^{a}	62.93^{d}	74.13^{c}	79.71^{b}	0.72	<0.001	0.27	0.10
Ether extract (%)	76.40^{b}	83.16^{a}	82.05^{a}	80.79^{a}	1.14	0.03	0.54	0.09
Ash (%)	63.42	62.28	61.22	60.67	0.33	0.20	0.41	0.16
NFE (%)	87.34	79.30	81.89	82.97	1.96	0.09	0.30	0.52
Digestible energy (kcal/g)	3.03	2.91	2.97	3.00	2.06	0.53	0.18	0.10

Means in the same row with different superscripts differ at p <0.05; SEM: Standard Error of Means; TRT: Treatment; WK: Week or period; CPM: Cassava Plant Meal

The proximate composition of the experimental diets fed to gravid gilts are shown in Table 4. The values obtained for the crude protein, crude fibre, ash and ether extract varied significantly across treatment groups with the control diet having significantly lower values for the CP, CF and ash contents whereas the ether extract value was highest in the control diet and least in 100% CPM 3. The increasing trend observed in the CP, CF and ash contents of the CPM-based diets could be due to the increasing inclusion of tuber meal in the diets. Cassava meal has been found to be rich in minerals and fibre and to a lesser extent in crude protein (Adeyemi, 2023; Ogundeji and Akinfala, 2020). The values obtained for the nitrogen free extract were similar across treatment groups with the observed variations due to the variations in other proximate parameters.

Table 4: Proximate composition of experimental diets fed to gravid gilts

	EXPERIMENTAL DIETS						
Parameters (%)	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**p**
Dry matter (DM)	86.85	86.53	86.50	86.62	86.51	0.17	0.50
Crude protein (CP)	12.17^{b}	12.30^{b}	12.65^{a}	12.54^{ab}	12.86^{a}	0.20	0.03
Crude fibre (CF)	8.14^{b}	8.40^{b}	8.77^{a}	8.92^{a}	9.25^{a}	0.24	0.01
Ash	5.75^{b}	5.96^{b}	6.29^{a}	6.45^{a}	6.72^{a}	0.22	0.04
Ether extract (EE)	4.67^{a}	4.49^{a}	4.33^{a}	4.01^{b}	3.86^{b}	0.17	0.01
Nitrogen free extract (NFE)	69.27	68.85	67.96	68.08	67.31	0.42	0.12

Diet 1: Control (Maize-based); Diets 2 and 3: 50% and 100% replacement of maize with CPM 2; Diets 4 and 5: 50% and 100% replacement of maize with CPM 3

The amino acid composition of experimental diets fed to gravid pigs are presented in Table 5. The lysine, methionine threonine and leucine contents of the test diets decreased with increasing inclusion of unpeeled cassava tuber meal to the CPM 2 and 3 based diets. This could imply that, the unpeeled cassava tuber meal contained lower quantity of these amino acids. Coincidentally, lysine, methionine and threonine are critically essential amino acids for all categories of swine especially the gravid pigs. On the contrary, the arginine, phenylalanine, histidine and cysteine contents increased significantly ($p<0.05$) with increasing inclusion of unpeeled cassava tuber meal from 50% to 100% in both CPM 2 and 3 diets. Similarly, the isoleucine and tryptophan contents of the test diets followed an increasing trend, though the values obtained for these amino acids were numerically similar. This trend may mean that, cassava tuber meal contained abundant quantity of these amino acids, hence the improvement in the contents. Similar trend but lower values were reported by Ogundeji and Akinfala (2020). The incorporation of these CPM products at either 50% or 100% inclusion level could improve feed intake, protein synthesis and enhance the immune functions of the gravid gilts.

Table 5: Amino acid composition of experimental diets

	EXPERIMENTAL DIETS						
Amino acids (g/100g)	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**P**
Lysine	4.61		4.35	4.08	4.14	0.17	0.10
Methionine	1.28		1.20	0.96	1.23	0.04	0.07
Arginine	6.19^{a}		5.16^{c}	5.35^{bc}	5.50^{b}	0.14	0.01
Threonine	3.77		3.55	3.22	2.94	0.27	0.52
Leucine	8.23^{a}		7.59^{ab}	7.18^{b}	6.59^{c}	0.22	0.03
Isoleucine	3.80		3.46	3.62	3.74	0.10	0.07
Phenylalanine	4.97^{a}		3.90^{c}	4.43^{b}	4.61^{b}	0.12	0.01
Tryptophan	0.89		0.73	0.89	1.00	0.04	0.12
Histidine	2.88^{a}		1.98^{b}	2.49^{ab}	2.68^{a}	0.15	0.01
Cysteine	1.45^{a}		0.97^{b}	1.33^{a}	1.39^{a}	0.17	0.01

Mean in the same raw with different superscripts differ at p <0.05; SEM: Standard Error of Mean; Diet 1: Control (Maize-based); Diets 2 and 3: 50% and 100% replacement of maize with CPM 2; Diets 4 and 5: 50% and 100% replacement of maize with CPM 3

The vitamin contents of the experimental diets are presented in Table 6. There were significant variations ($p<0.05$) in the vitamin contents obtained in all dietary groups. All the values obtained for cholecalciferol, riboflavin and cobalamin contents of the experimental CPM-based diets were statistically higher than those of the control diet although only the 100% CPMs 2 and 3 diets had significantly higher contents of tocopherol and folate compared to other dietary groups. Previous studies (Alejandro and Caban, 2014; Weber *et al.*, 2014; Marantidis *et al.*, 2016; Santos *et al.*, 2020) have found positive effects of retinol, tocopherol, riboflavin, cholecalciferol, and folic acid in the reproductive physiology of pregnant sows by improving total litter weight and piglet birth weight.

Table 6: Vitamin composition of experimental diets

	EXPERIMENTAL DIETS						
Vitamins	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**p-value**
A (µg/g)	15.17^{a}	14.87^{a}	14.40^{b}	13.28^{b}	11.40^{c}	0.53	<0.001
D (µg/g)	0.17^{b}	0.21^{a}	0.29^{a}	0.22^{a}	0.26^{a}	0.02	<0.001
E (µg/g)	0.13^{b}	0.15^{ab}	0.19^{a}	0.14^{ab}	0.17^{a}	0.01	<0.001
B_2 (mg/100g)	0.077^{d}	0.080^{c}	0.088^{b}	0.082^{c}	0.097^{a}	0.03	0.01
B_9 (mg/100g)	0.104^{b}	0.106^{b}	0.119^{a}	0.108^{b}	0.125^{a}	0.002	0.04
B_{12} (mg/100g)	0.012^{d}	0.015^{c}	0.022^{b}	0.017^{c}	0.027^{a}	0.002	0.003

B_1 Thiamin; B_2 Riboflavin; B_3 Niacin; B_6 Pyridoxine; B_9 Fo1acin; B_{12} Coba1amin; Mean in the same raw with different superscripts differ at p <0.05; SEM: Standard Error of Mean; Diet 1: Control (Maize-based); Diets 2 and 3: 50% and 100% replacement of maize with CPM 2; Diets 4 and 5: 50% and 100% replacement of maize with CPM 3

The mineral contents of the experimental diets are shown in Table 7. The Phosphorus, Chlorine, Calcium, Manganese and Zinc contents of the CPM-based diets increased with increasing inclusion of cassava tuber meal from 50% to 100% in the CPMs 2 and 3 diets. The extremely lower contents of Phosphorus in CPM-based diets compared to maize-based diet could be due to abundance of inherently bond phytic Phosphorus present in cereal grains with a higher proportion of the phytic-P in unavailable form. Similar observation was reported by Ogundeji and Akinfala (2020). There was no difference ($p<0.05$) in the values obtained for the Calcium, Sodium and Manganese of all the CPM-based diets. Lower values were reported for all the minerals investigated in this study by Ogundeji and Akinfala (2020). For gravid pigs, Ca and P have been implicated in development of skeletal growth in addition to metabolic function while Zn, Na and Cl play central roles in immunity and reproduction (Sampath *et al.*, 2023).

Table 7: Mineral composition of experimental diets

	EXPERIMENTAL DIETS						
Minerals	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**p-value**
Phosphorus (%)	0.376[a]	0.114[c]	0.120[c]	0.141[b]	0.144[b]	0.052	0.046
Chlorine (%)	5.494[b]	2.284[c]	3.600[b]	2.318[c]	7.765[a]	1.636	0.009
Calcium (%)	0.030[b]	0.539[a]	0.584[a]	0.556[a]	0.596[a]	0.080	0.042
Sodium (g/Kg)	0.408[b]	0.598[a]	0.571[a]	0.608[a]	0.594[a]	0.032	0.035
Manganese (g/Kg)	0.017[b]	0.083[a]	0.092[a]	0.086[a]	0.091[a]	0.014	0.007
Zinc (g/Kg)	0.096	0.080	0.091	0.088	0.093	0.003	1.238

Mean in the same raw with different superscripts differ at p <0.05; SEM: Standard Error of Mean; Diet 1: Control (Maize-based); Diets 2 and 3: 50% and 100% replacement of maize with CPM 2; Diets 4 and 5: 50% and 100% replacement of maize with CPM 3

The fatty acid composition of experimental diets is shown in Table 8. The values obtained for the fatty acid contents of the CPM-based diets increased with increasing inclusion from 50% to 100% of the CPM products 2 and 3 respectively. This study supports the reports of previous studies (USDA, 2016; Adeyemi, 2023) that cassava tuber meal contained abundant quantity of linoleic and linolenic acids which functions primarily in optimising fetal development in pregnant sows and enhancing the quality and acceptability of meat (Nong *et al.*, 2020; Komprda *et al.*, 2020).

Table 8: Fatty acid composition of experimental diets

	EXPERIMENTAL DIETS						
Fatty acid (%)	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**P**
Lino1eic acid	1.35[c]	4.86[b]	5.09[b]	7.14[a]	7.29[a]	0.80	0.006
Lino1enic acid	0.094[c]	0.253[b]	0.270 [b]	0.351[a]	0. 378[a]	0.05	0.004
Arachidonic acid	1.93[d]	5.18[c]	5.52[c]	7.43[b]	7.71[a]	0.59	0.003

Mean in the same raw with different superscripts differ at p <0.05; SEM: Standard Error of Mean; Diet 1: Control (Maize-based); Diets 2 and 3: 50% and 100% replacement of maize with CPM 2; Diets 4 and 5: 50% and 100% replacement of maize with CPM 3

The apparent nutrient digestibility of experimental diets fed to gravid gilts is shown in Table 9. The crude fibre digestibility increased with increasing inclusion of unpeeled cassava tuber meal to the CPM-based diets. The increased digestibility values could be due to the highly digestible amylose content of cassava tuber meal than maize. This results are in agreement with those of previous studies by Adeyemi, (2023); Akinfala *et al.* (2013 and 2019). The crude protein, ether extract and ash digestibility coefficients varied with increased inclusion of unpeeled cassava tuber meal from 50 to 100% of the different CPM products. Again, this could be due to the rich abundance of the nutrients in unpeeled cassava tuber meal. The variations observed in the values obtained for the nitrogen free extract of the experimental diets could be due to the variations in other proximate parameters. The digestible energy content of the experimental diets varied between 2.67 and 2.79 Kcal/g. The apparent nutrient digestibility values showed that, the gravid gilts could adequately utilize the nutrients in the experimental diets to support fetal growth and enhance their reproductive performance.

Table 9: Apparent nutrient digestibility of experimental diets by gravid gilts

	EXPERIMENTAL DIETS						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**	**p**
Dry matter (%)	90.19	89.02	88.42	88.60	88.40	2.44	0.52
Crude protein (%)	91.02	89.00	92.23	90.96	92.00	2.11	0.15
Crude fibre (%)	80.27[a]	76.82[b]	81.24[a]	78.90[b]	83.26[a]	1.29	0.001
Ether extract (%)	88.14	85.22	88.69	86.08	89.13	0.22	0.18
Ash (%)	62.99	58.34	60.12	60.27	61.85	1.02	0.26
NFE (%)	69.58	66.64	65.72	67.79	66.74	2.32	0.09
Digestible energy (kcal/g)	2.79	2.69	2.67	2.74	2.70	0.05	0.42

Mean in the same raw with different superscripts differ at p <0.05; SEM: Standard Error of Mean; Diet 1: Control (Maize-based); Diets 2 and 3: 50% and 100% replacement of maize with CPM 2; Diets 4 and 5: 50% and 100% replacement of maize with CPM 3

CONCLUSION AND RECOMMENDATION

Based on the findings of this study, it can be concluded that, the CPMs products 2 and 3 had comparable nutrient contents as maize meal and the digestibility coefficient of the nutrient in the experimental diets fed to gravid gilts increased with increasing inclusion of unpeeled cassava tuber meal. It is recommended that cassava plant meal could be included in the diets to enhance the reproductive performance of breeding pigs.

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