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ECONOMICS AND EFFECT OF REPLACING WHEAT OFFAL WITH CASSAVA PEEL MEAL ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY OF GROWING PIGS

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ABSTRACT

This study was carried out to determine the feeding value of Cassava Peel Meal (CPM) as replacement for wheat offal in growing pigs' diets. Five treatment diets were formulated by replacing wheat offal with CPM at 0, 25, 50, 75 and 100% for treatments T1, T2, T3, T4 and T5, respectively. A total of 75 growing pigs of large white breed were allotted on weight equalization basis into the five dietary treatments with 15 pigs per treatment and 3 pigs per replicate in a completely randomized design. The pigs were allowed to acclimatize for two weeks before the commencement of the study which lasted for 14 weeks. Results indicated that wheat offal contained 16.25% crude protein (CP), 18.86% crude fibre (CF) and 1.18% ether extract. The values were higher than cassava peel meal's 5.18% CP and 15.18% CF and was lower than 1.99% ether extract. The 25, 50, 75% CPM significantly ($p < 0.05$) increased final live weight, daily weight gain and feed conversion ratio compared to 100% CPM. There was no significant ($p > 0.05$) difference in feed intake. Total feed cost/Kg, feed cost/Kg weight gain and returns on investment significantly ($p < 0.05$) decreased as the levels of cassava peel meal increased in the diets. The bled, scalded, eviscerated and dressed weights decreased as the level of CPM increased in the diets. The heart weight increased with the CPM level, while the liver and the kidney decreased with increase in CPM in the diets. Blood glucose and cholesterol increased with increasing levels of cassava peel meal in the diets while albumin and creatinine decreased as the level of cassava peel meal increased in the diets. The packed cell volume (PCV), haemoglobin (Hb) and red blood cell (RBC) counts decreased ($p < 0.05$) as the level of cassava peel meal increased in the diets. White blood cell (WBC) and lymphocyte values were highest for pigs in T3 (50%) and T4 (75%). The study concluded that cassava peel meal could replace 75% of wheat offal in growing pig diets without deleterious effects on growth performance and economic benefit in terms of total feed cost, cost per kilogram and weight gain.

Key words: Blood serum, cassava peel, carcass, haematology, returns on investment

INTRODUCTION

For sustainable livestock production systems in the tropics, the future scenarios of resource utilization must be predicated on minimizing waste through recycling, which not only reduces the need for raw materials but also helps in protecting the environment [1,2]. The utilization of cassava peel meal, wheat offal, potato peels and rice offal in pig diets is in line with the above premise.

Among the most common by-products is wheat offal, which is the major source of bulkiness needed in livestock rations. This makes it an expensive commodity, coupled with the ongoing war between Russia and Ukraine. As at December 2022, the cost of wheat offal in Nigeria rose to ₦9,800/100 kg (21.28 USD) [6]. This price is extremely high, making pig production an expensive venture. The alternative to using wheat offal may be cassava peels, which are under-utilized and may provide as much nutritional benefit and bulkiness as the wheat offal.

About 15 million tons of cassava by-products comprising peels, stumps, woody and undersized tubers currently disposed off as wastes are generated from processing of cassava (*Manihot esculenta*) every year in Nigeria [3,4,5,6]. Cassava peel is the main by-product from the processing of cassava into various products such as garri for human consumption and others such as cassava starch [7]. Okike [6] estimated that about 250 – 300kg of cassava peel is produced per ton of fresh cassava root in Nigeria.

According to Nnadi [8], cassava peels have the potential to serve as an alternative to wheat offal in livestock feeding because of its relatively high starch content of about 2044.80 kcal/kg and 5.98% crude protein content. Cassava peel is lower in crude protein and higher in energy when compared to wheat offal with 14.81% crude protein and 1602.20 Kcal/kg [9].

However, the use of cassava peels in livestock feeding is limited as a result of high cyanide content, low protein content, poor amino acid profile, comparative high fibre content and quick spoilage, if left unprocessed, particularly during the rainy season [7,10]. The problems of dustiness and milling difficulty will cause reduction in feed intake [11].

Several processing methods have been adopted to improve on the quality of cassava peels. For high cyanide content, parboiling, oven drying and sun drying have been found to drastically reduce or eliminate it [11,12].

The present study was therefore designed to investigate the effect of cassava peel meal as a replacement for wheat offal on the growth performance, blood indices and economics of production of growing pigs.

MATERIALS AND METHODS

Study Location

The study was carried out at the Piggery Unit of the Teaching and Research Farm, University of Calabar, Calabar, Nigeria. Calabar is geographically located within the tropical rain forest zone of Nigeria, with a land mass of 233.2 square mile (604km²) and lies between latitude 4° 50' N to 4° 39' N and longitude 8° 17' E to 10° 43' E of the equator. The relative humidity is 55 – 99 % with an elevation above sea level of 99 meters. The annual temperature and rainfall ranges between 25° and 30°C and 1260 to 3500 mm, respectively [13].

Experimental pigs and management

A total of ninety (90), cross bred (Large White × Land Race) growing pigs of mixed sexes with a body weight range of 15.93 – 16.09 kg were used in this study. The pigs were purchased from a reputable commercial farm in Akpabuyo, Cross River State, Nigeria. The pens and equipment were cleaned and prepared before the arrival of the pigs. The pigs were all dewormed with Piperazine and injected with antibiotics before being balanced for the initial weight and randomly allotted to 5 experimental dietary treatments of 18 pigs per treatment. There were 3 replicates of 6 pigs each. The pigs were allowed to acclimatize to the feed and the pen house for two weeks before commencement of the study. The pigs were raised under intensive system of management on a concrete floor pen, with clean water and feed given ad-libitum.

Experimental diets

Fresh cassava peels of Tropical Manihot Series (TMS) 3055 variety were obtained from cassava processing mills at Akpabuyo Local Government Area of Cross River State and were spread on a clean concrete slab to sun dry to a constant weight according to the intensity of the sun. The dried cassava peels were then milled with hammer mill, and incorporated in the experimental diets to replace wheat offal at 0, 25, 50, 75, and 100% to form dietary treatments T1, T2, T3, T4 and T5, respectively (Table 1).

Proximate composition

Ten (10) Samples each of the feed, feedstuffs and faecal droppings were analyzed chemically according to the official methods of analysis described by the

Association of Official Analytical Chemists [14] at the Biochemistry laboratory, University of Calabar, Calabar, Nigeria.

Growth performance

The initial weight values of the animals were taken at the commencement of the experiment and subsequently on a weekly basis. Feed intake was measured daily by weighing the left over and deducted from the total weight of the feed offered. Weight gain, feed conversion ratio and protein efficiency ratio were obtained by calculations.

Blood sample collection

At the end of the feeding trial, blood samples (approximately 10 ml) were collected from each pig from each of the replicates through jugular vein puncture using hypodermic syringe. Five milliliters were drawn into a heparinized tube to prevent coagulation while the remaining 5 ml were introduced into another set of bottles without anticoagulants and all the samples were stored at -4°C for subsequent analysis.

The packed cell volume (PCV) were analyzed by centrifugation of the blood in the heparinized capillary tube (with one end sealed) using haematocrit centrifuge. Haemoglobin concentration was determined using Sahl's method [15]. Red blood cell (RBC) counts were analyzed with the aid of Neubauer counting chamber (haemocytometer). Blood smears were used for total thrombocyte and total white blood cell (WBC) counts [16] and WBC differential counts were classified as lymphocytes, neutrophils, eosinophils, basophils and monocytes. Plasma glucose was measured using the enzymatic glucose oxidase method [17]. Mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated from packed cell volume (PCV), haemoglobin (Hb) and red blood cell (RBC) values [18]. Total serum protein was measured using the biuret method.

Digestibility trial

Two pigs per replicate were transferred to metabolic cages during the last 14 days of the experimental period for the collection of faeces and urine. The urine samples were collected daily in a container containing 1.0ml each of 25% H₂SO₄, the urine samples were measured and stored in a refrigerator at -5°C until they were required for chemical analysis. Faecal samples were collected daily, oven dried and taken to the laboratory for proximate analysis to determine the nutrient composition in the feed according to Association of Official Analytical Chemists

(AOAC) [14] methods. Nutrient retention was determined for crude protein, ether extract, crude fiber, ash and nitrogen free extract using the following formula:

$$\frac{\text{Nutrient in Feed} - \text{Nutrient in Faeces} \times 100}{\text{Nutrient in Feed}}$$

Carcass characteristics and organ weights

At the end of the feeding trial, three (3) pigs were selected from each treatment, fasted overnight for eight hours to reduce gastro-intestinal content [19], for carcass and organ weight determinations. Slaughtering was done by manual *exsanguination* by severing the jugular vein, carotid arteries and trachea with a knife after stunning [20]. The slaughtered pigs were scalded and eviscerated, the internal organs were carefully separated, and all weighed to determine their absolute weights.

Economic benefit analysis

The prevailing market prices of the ingredients at the time of the study were used to calculate cost per kilogram (kg) feed based on the formulae given by Ndelekwute *et al.* [21].

$$\text{Cost per kg feed} = \frac{\text{price per kg of feed ingredient} \times 100}{\text{their proportion in the feed}}$$

Feed cost per pig = cost per kg feed × quantity of feed consumed by the pig

Feed cost per weight gain = cost per kg feed × feed conversion ratio (FCR)

Revenue per pig = Price per kg live weight × final live weight

Gross margin = Revenue per pig – feed cost per pig.

Profit = Revenue – Cost

Statistical analysis

Data generated from the study were analyzed using analysis of variance and where statistically significant difference was observed, the means were separated using Duncan Multiple Range Test according to Statistical Analytical Software (SAS) [22].

RESULTS AND DISCUSSION

The proximate composition of the cassava peel and the wheat offal as shown in Table 2 indicated that cassava peel contained 36.41, 5.18, 1.99 and 15.18% dry matter, crude protein, ether extract and crude fibre, respectively, while wheat offal

contained 9.10, 16.25, 11.18 and 18.88% dry matter, crude protein, ether extract and crude fibre, respectively. The low moisture content of cassava peel implied that it can be preserved for a long period after sun-drying. This will perhaps increase the relative concentration of the nutrients and improve the shelf life [23]. The crude protein level of 5.18% in cassava peel meal is low when compared with wheat offal of 16.25%. This implies that when using cassava peel meal in large amounts for feeding pigs, supplementation with a protein source is necessary. The 15.18% fibre content of cassava peel recorded in this study is comparable with that of 18.88% in wheat offal. Fibre in a bulky pig diet is important for proper digestion in pigs. In addition, high fibre feeds are also known to support bowel regularity, maintain normal cholesterol and blood sugar levels, reduce constipation and are important for the prevention of heart diseases [24]. The ash content of 5.02% and 4.82% for cassava peel and wheat offal, respectively, were relatively high when compared to other roughages like rice offal, Brewer's dried grains of 2.66% and 3.11%, respectively [25]. The level of ash in feedstuff is an indication of its mineral content [26], therefore, it is an indication that both feedstuffs are potential sources of minerals, though the level of minerals might be due to soil or sand contamination in the sample.

Table 3 shows the performance characteristics of growing pigs fed diets with cassava peels as a replacement for wheat offal. The 25, 50, 75% CPM significantly ($p < 0.05$) increased final live weight, daily weight gain and feed conversion ratio compared to 100% CPM. The observed depressed performance parameters of the pigs at 100% replacement of wheat offal with cassava peel could be attributed to the low crude protein content of the diet as contributed by the cassava peel. Cassava peel had a lower crude protein content (Table 2) when compared to wheat offal, this implied that the higher the cassava peel in the diet at the expense of wheat offal, the lower the crude protein of the diet. The role of protein in growth performance of any animal cannot be overemphasized. It functions in the replacement of worn-out cells, effective digestion of other nutrients and blood formation [27]. Also, cassava peel is known to contain some anti-nutrients, notable are the hydrogen cyanide and tannins both of which are recorded to be growth depressants. The more the peels, though sundried, the more the anti-nutrients. Sun-drying alone may not eliminate the anti-nutrients completely from the peels [28]. There were no significant ($p > 0.05$) differences in feed intake across the treatment groups. This means that the test ingredient (cassava peel) did not inhibit the consumption of any of the diets. Each ingredient in all the diets was included at the same level and received the same treatment apart from wheat offal that was replaced gradually with cassava peel. Therefore, any differences in the utilization of the diets could be attributed to the variation level of wheat offal and cassava

peel. The diet containing 100% cassava peel was the only diet that significantly ($p < 0.05$) depressed final body weight (40.88kg), weight gain (24.90kg) and encouraged the poorest feed conversion ratio (4.15). The other diets (including the control diet) had similar ($p > 0.05$) results in all these parameters. The feed conversion ratio showed a similar trend with the weight gain and utilization was significantly ($p < 0.05$) poor at 100% replacement level.

The cost of feeding pigs with cassava peel meal as a replacement for wheat offal is shown in Table 3. Treatment 1(Control) had the highest cost of feed per kilogram (N29,640 (USD 64.37)) and tended to decrease as the level of cassava peel increased in the diets. This was so because of the very high cost of wheat offal. The total cost of feed intake per pig tended to be lower in Treatment 5, followed by Treatments 4 and 3. Treatments 1 and 2 were seen to have the highest ($p < 0.05$) and similar ($p > 0.05$) total feed cost per kilogram when compared to other treatments.

Feed cost/kg weight gain showed significant ($p < 0.05$) differences and decreased as the level of cassava peel increased in the diets, this could be as a result of a carryover effect of the performance trend of the pigs. The gross margin was most favorable with pigs on Treatment 5 followed by pigs on Treatments 2 and 3. This observation shows an indication of favorable cost analysis which could be translated to mean a positive response of pigs to cassava peel-based diets. Reports by Akinfala and Tewe [29], Akinfala [30] and Adeyemi and Akinfala [31] have shown the cost-effective advantage of adding the under-utilized fractions (leaves and tender stems) of cassava to the diets of pigs.

Table 4 shows the nutrient digestibility values of growing pigs fed cassava peel-based diets as a replacement for wheat offal. No significant differences were observed among the treatment means for the digestibility. However, lowest numerical digestibility values were obtained from pigs in T5, having digestible crude protein (64.90%), crude fibre (70.03%) and ash. The crude protein digestibility values decreased as the cassava peels increased in the diets, likewise the crude fibre and the ash digestibility. This observation could be due to the relative low nutrient content of cassava peels. Wheat offal contains higher values of crude protein and crude fibre. The high dry matter digestibility recorded for all the pigs across the treatment groups is an indication that the diets were palatable and digestible [32], and there is positive relationship between apparent digestibility of feed and protein intake.

Crude protein digestibility ranged between 64.90 (diet T5)-74.61(diet T2%). These values were higher than the average value (61.50%) reported by Bawa *et al.* [33] when young pigs were fed mechanically extracted neem seed cake. The nitrogen free extract apparent digestibility was least in pigs fed the control diet; this could be due to the fibrous nature of the feed being contributed to the high inclusion level of wheat offal. High fibre level in monogastric diets is known to reduce energy digestibility of such diets [9].

Table 5 shows the carcass and organs weight of pigs fed graded levels of cassava peels in place of wheat offal. The percentage bled weight, scald weight, eviscerated weight and dressing percentage were significantly ($P<0.05$) affected by the dietary treatments. The highest bled weight (86.44%) was obtained in pigs fed 0% CPM-based diets compared with 84.70, 83.61, 82.66 and 81.00%, respectively for animals fed 25, 50, 75 and 100% CPM. The corresponding values for the scald were 89.95, 87.60, 87.04, 84.92 and 81.74% while the eviscerated weight percentage were 67.70, 66.50, 66.00, 64.58 and 63.49, respectively for the pigs fed 0, 25, 50, 75 and 100% CPM based diets. The highest value of 57.06 % as dressing percentage obtained for the animals fed 0.00% CPM significantly ($p<0.05$) reduced to 56.65, 56.09, 56.00 and 53.09% in animal fed 25, 50, 75 and 100% CPM respectively. In the same vein the eviscerated weight was highest (57.06%) for pigs fed 0%CPM based diet, followed by pigs fed 25%, 50%, 75% and 100% CPM based diets in that order. The general drop in the carcass indices recorded across the dietary treatments with increasing levels of CPM in the diets did not correspond with the live weight of the animals, especially, animals in 25% CPM, which seem to have the highest live weight. The higher dressing percentage for pigs in the control diet is a plus to the diet, however, the higher bled weight obtained for animals in the control diet is not all that good, in the sense that blood retention in meat can lead to poor keeping quality of the carcass [20]. Among the internal organs measured, only the heart, liver and kidney showed significant ($p<0.05$) effect. The heart tended to enlarge as the level of CPM increased in the diets, while the liver and kidney seemed to degenerate as the level of CLM increased in the diets. The increase in the heart is in agreement with the report of Carew [34], who linked such enlargement to the presence of anti-nutritional factors in the mucuna, the authors said that the enlargement of the heart muscle was as a result of the extra workload imposed by stress or disease. The lower values of the liver and the kidney of the pigs fed CLM based diets than the control diet could mean that the residual anti-nutritional factors present in CPM affected the organs. Onyeyili [35] identified these organs as the primary organs of biotransformation and linked the changes in these organs to their roles in elimination of metabolic waste and toxins from the animal's body [20].

Table 6 shows the serum biochemical parameters of pigs fed cassava peel meal as a replacement for wheat offal. The serum biochemical analysis helps in providing information about state of tissues, organs and metabolic state of the body [36]. Glucose level increased significantly ($p < 0.05$) as the level of cassava peels increased in the diets with pigs on 100% cassava peels having the highest level (91.32 mg/dl). Albumin and creatinine also followed similar trend with the highest and lowest values recorded for pigs on diet 5. The total protein and albumin did not show any significant ($p > 0.05$) differences.

The values obtained for the blood urea concentration suggested that there was no kidney damage due to hydrogen cyanide (HCN) from cassava peels. Urea is the main nitrogenous end product arising from the catabolism of amino acids that are not used for biosynthesis in mammals [35, 36]. The high glucose level associated with cassava peels indicates that cassava peels breakdown to more sugar in their body after consumption than wheat offal. Cassava peels also seemed to encourage cholesterol, however, did not exceed the 300 mg recommended by United States for healthy individuals, which is equivalent to one and a half egg [37]. All the values for the serum chemical parameters were within the normal range for healthy growing pigs [38].

Table 7 shows the haematological parameters of pigs fed cassava peel as replacement for wheat offal. The result showed that the haematological indices were significantly ($p < 0.05$) influenced by the replacement of wheat offal with cassava peel meal except on monocytes %, neutrophils %, eosinophils % and platelets. Cassava peels had reduction ($p < 0.05$) effect on PCV, Hb and RBC, which is confirmation that hydrogen cyanide is one of the most incriminated anti-nutritional components. Nsa *et al.* [26], associated reduction in the values of Hb, PCV and RBC with the direct involvement of Hydrogen cyanide when they included protein fractions prepared from sand box seed in broiler bird diets. The levels of RBC and WBC obtained in this research showed no pathological effect, which is an indication that the health of the animals was not sacrificed. Also, the protein content of the diets was adequate since the values were within the normal range for healthy pigs [39]. Haemoglobin concentration range in the study falls under the normal range for healthy pigs, thus cassava peel meal is capable of supporting high oxygen carrying capacity of the blood. The lymphocytes and the neutrophils values of the experimental pigs fall within the range reported by Bawa *et al.* [32] for healthy pigs, which is an indication of a well-developed immune system in growing pigs with such number of immune cells to proffer good health [40].

Considering all the parameters, an appreciable savings could be achieved by replacing wheat offal with cassava peels at 75% without deleterious effect on growth performance, nutrient digestibility, carcass and blood characteristic of pigs with an improved revenue per kilogram of final body weight. Feeding pigs with diets without cassava peels proved to be more expensive compared to feeding with cassava peel meal based – diets without any associated increase in body weight. Replacement levels of cassava peel meal for wheat offal beyond 75% would not be economically viable for pig production in terms of returns on investment.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The study concluded that an appreciable amount of savings could be achieved through the use of cassava peels as a replacement for wheat offal up to 75% without any deleterious effect on growth parameters and health status of growing pigs and economic benefit in terms of total feed cost, revenue per kilogram weight gain and gross margin.

Table 1: Gross composition of experimental diets (%)

Ingredient	T ₁ 0%CPM	T ₂ 25%CPM	T ₃ 50%CPM	T ₄ 75%CPM	T ₅ 100%CPM
Maize	56.50	56.50	56.50	56.50	56.50
SBM	12.00	12.00	12.00	12.00	12.00
GNC	10.00	10.00	10.00	10.00	10.00
Wheat offal	16.00	12.00	8.00	4.00	0.00
CPM	0.00	4.00	8.00	12.00	16.00
Fish meal	2.00	2.00	2.00	2.00	2.00
DCP	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
CP (%)	20.53	20.31	20.07	19.87	19.65
CF (%)	8.66	8.63	8.60	8.56	8.52
ME (Kcal/Kg)	3031.60	3038.50	3044.90	3051.92	3057.63
Determined analysis:					
CP (%)	20.29	20.21	20.14	20.05	19.88
CF (%)	8.43	8.33	8.21	8.09	8.01
ME(Kcal/Kg)	3029.90	3037.10	3042.66	3049.24	3055.71

*Contained Vitamin A(10,000,000.00 IU), D3 (2,000,000.00IU): E (20,000.00mg): K3 (2000.00mg): B1 (3000.00mg): B2 (5000.00mg): Niacin (45,000.00mg): Calcium pantothenate (10,000.00mg): B12 (20,000.00mg): Choline Chloride (300,00mg), Folic Acid (1000.00mg): Biotin (50,00.00mg): Manganese (300,000.00mg): Iron (120,000.00mg): Zinc (80,000.00mg): Copper (8,500.00mg): Iodine (1500.00mg): Cobalt (300.00mg): Selenium (120.00mg): Antioxidant (120,000.00mg) per 2.5Kg.

ME=Metabolisable energy, GNC= Groundnut cake, CP=Crude Protein, CF=Crude Fibre, Kcal/Kg=Kilocalorie per Kilogram, SBM =Soya bean meal, DCP= Dicalcium Phosphate and CPM =Cassava peel meal

Table 2: Proximate composition of cassava peel and wheat offal

Parameter (%)	Cassava peels	Wheat offal	LOS at 0.05
Dry matter	85.41	89.10	NS
Crude protein	5.18	16.25	S
Crude fibre	15.18	18.86	S
Ether extract	1.99	1.18	S
Ash	5.02	4.82	NS

LOS= level of significance, NS=Not significant, S=Significant

Table 3: Effect of replacing wheat offal with graded levels of cassava peel on the growth response and economics of growing pigs' production

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Initial body weight (kg)	15.95	15.93	15.97	15.93	15.98	-
Final body weight (kg)	50.66 ^a	52.89 ^a	53.01 ^a	49.21 ^a	40.88 ^b	2.33
Total weight gain (kg)	34.65 ^a	36.97 ^a	36.92 ^a	33.28 ^a	24.90 ^b	2.00
Daily weight gain (g)	495.00 ^a	528.14 ^a	527.43 ^a	475.43 ^a	355.71 ^b	1.88
Daily feed intake (g)	1628.55 ^a	1705.89 ^a	1714.15 ^a	1568.92 ^a	1476.65 ^b	4.01
Total feed intake (kg)	114.00	119.42	120.00	109.82	103.37	8.56
Daily Protein Intake(kg/d)	0.38	0.36	0.34	0.33	0.31	0.01
Protein Efficiency Ratio	0.77	0.68	0.65	0.70	0.87	0.01
Feed conversion ratio	3.29 ^a	3.23 ^a	3.25 ^a	3.20 ^a	4.15 ^b	0.11
Daily feed cost (g/₦)	260.00 ^a	246.40 ^b	238.20 ^c	230.00 ^c	221.80 ^d	5.92
Total feed cost (kg/₦)	29,640 ^a	29,440 ^a	28,584 ^b	25,259 ^b	22,928 ^c	6.40
Feed cost/kg weight gain (₦)	598.79 ^a	557.58 ^b	541.90 ^c	531.17 ^d	327.38 ^d	11.47
Revenue (₦) at ₦1500/kg	742.50 ^b	792.21 ^a	791.15 ^a	713.15 ^c	613.20 ^d	6.59
Gross margin (₦)	19.35 ^d	29.62 ^b	31.50 ^b	25.43 ^c	46.61 ^a	2.10

T₁= Treatment one, T₂= Treatment two, T₃= Treatment three, T₄= Treatment four, T₅= Treatment five, Kg=Kilogram, g=grams, ₦=naira

Table 4: Apparent Digestibility (%) of Nutrients in pigs fed cassava peel meal as replacement for wheat offal

Parameter (%)	T1 0% CPM	T2 25% CPM	T3 50% CPM	T4 75% CPM	T5 100% CPM	SEM
Dry matter	86.45	84.82	84.35	83.96	83.41	1.31
Crude protein	74.22	74.61	73.54	73.09	64.90	2.20
Ether extract	78.10	78.29	78.41	78.90	79.26	2.05
Crude fibre	67.31	68.03	68.49	68.71	70.03	8.02
NFE	59.43	61.00	63.52	63.61	61.70	2.99

Table 5: Carcass and organ weights of pigs fed cassava peel meal in place of wheat offal

Parameter	T1 0% CPM	T2 25% CPM	T3 50% CPM	T4 75% CPM	T5 100% CPM	SEM
Live Wt. (Kg)	48.60	48.57	48.62	48.64	48.58	2.29
Bled Wt. (% LW)	86.44 ^a	84.70 ^b	83.61 ^c	82.66 ^d	81.00 ^e	5.93
Scald Wt. (% LW)	89.95	87.60	87.04	84.92	81.74	9.70
Eviscerated Wt. (% LW)	67.70	66.50	66.00	64.58	63.49	7.04
Dressing (%)	57.06	56.65	56.09	56.00	53.09	5.04
Internal organs Weight (% LW)						
Heart	0.40 ^c	0.45 ^{bc}	0.49 ^b	0.56 ^a	0.58 ^a	0.08
Lung	1.18	1.11	1.09	1.05	1.01	0.01
Liver	2.88 ^a	2.74 ^b	2.43 ^c	2.16 ^d	2.12 ^d	0.50
Kidney	0.38 ^a	0.37 ^a	0.34 ^b	0.30 ^{bc}	0.27 ^c	0.04
Spleen	0.15	0.18	0.22	0.26	0.29	0.02
Empty Intestine	9.00	9.56	9.90	10.15	10.19	1.18
Empty Stomach	3.18	2.97	3.02	3.00	2.61	0.10

^{abcd} Means within the same row with different superscripts differ significantly ($p < 0.05$)

Table 6: Effect of replacing wheat offal with cassava peel meal on the Serum biochemical parameters of growing pigs

Parameters	T1 0% CPM	T2 25% CPM	T3 50% CPM	T4 75% CPM	T5 100% CPM	SEM
Glucose (mg/dl)	80.08 ^c	83.00 ^c	87.66 ^b	88.07 ^b	91.32 ^a	3.03
ALT(IU/L)	11.32	10.41	10.08	10.99	11.20	0.18
AIP(IU/L)	32.32 ^a	23.00 ^b	19.21 ^c	18.43 ^c	18.02 ^c	0.09
Cholesterol (mg/dl)	124.70 ^e	200.76 ^d	229.55 ^c	259.60 ^b	298.11 ^a	7.41
Urea(mg/dl)	10.55	10.81	9.33	9.01	8.76	0.59
Albumin (g/dl)	3.98 ^d	4.05 ^d	4.95 ^c	5.60 ^b	5.85 ^a	0.18
Creatinine (mg/dl)	1.34 ^d	2.05 ^c	2.05 ^c	2.49 ^b	2.87 ^a	1.11

^{abcd} Means on the same row with different superscripts are significantly different (p<0.05)

ALP= alkaline phosphate, ALT= alkaline aminotransferase

Table 7: Effect of replacement of wheat offal with cassava peel meal on the haematological parameters of growing pigs

Parameter	T1 0% CPM	T2 25% CPM	T3 50% CPM	T4 75% CPM	T5 100% CPM	SEM
Packed cell volume (%)	35.98 ^a	34.90 ^b	33.65 ^c	32.45 ^d	32.00 ^e	1.11
Haemoglobin (%)	12.22 ^a	11.86 ^b	11.31 ^c	11.06 ^d	10.99 ^d	1.21
Red blood cells ($\times 10^6$ /ul)	12.06 ^a	12.01 ^a	11.45 ^b	11.22 ^c	11.05 ^d	0.42
White blood cells ($\times 10^3$ /ul)	8.86 ^b	8.90 ^b	9.31 ^a	9.35 ^a	8.870 ^b	0.36
Lymphocytes (%)	69.99 ^b	69.76 ^b	81.90 ^a	80.92 ^a	70.84 ^b	1.90
Neutrophils (%)	28.76	26.91	26.62	26.50	30.54	1.41
Monocytes (%)	4.01	3.41	3.64	3.92	3.99	0.14
Eosinophils (%)	2.07	2.12	2.40	2.94	2.97	0.05
Platelets ($\times 10^3$ /ul)	62.20	60.65	60.43	60.12	58.93	2.09

^{abc} Means on the same row with different superscripts are significantly different (p<0.05)

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