ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2024; 24(11): 25005-25022 https://doi.org/10.18697/ajfand.136.24765

Date	Submitted	Accepted	Published
	6th April 2024	18th September 2024	18th November 2024

EVALUATION OF THE CHEMICAL COMPOSITION AND FEEDING VALUE OF SWEET ORANGE PULP AND PINEAPPLE PEEL MEALS AS FIBRE SOURCES IN PIGS' RATIONS

Effiong OO[1]*, Ebegbulem VN[1], Halilu A[1] and TN Kperun[1]

Okokon O. Effiong

*Corresponding author email: okokoneffiong48@gmail.com

[1]Department of Animal Science, Faculty of Agriculture, University of Calabar, Calabar, Nigeria

ABSTRACT

The piggery industry in Nigeria is on the verge of collapsing due to the high cost of conventional feed resources including wheat offal and palm kernel cake that usually form bulk in the diets of pigs. This study was, therefore, designed to compare the chemical composition of orange pulp meal, pineapple peel meal, and wheat offal and evaluate their feeding value in pig rations. The orange pulp and pineapple peels were dried on a concrete floor and analyzed for chemical composition. Three experimental diets were formulated with orange pulp and pineapple peel meals replacing wheat offal as a fibre source. Thirty crossbred (Chester white x Landrace) growing pigs with an average initial weight of 8.20 -- 8.75kg were distributed into three groups, with ten animals per group, and assigned to the three experimental diets. The average daily feed intake and weight gain were monitored throughout the 56-day duration of the experiment. Seven days to the end of the experiment, three pigs randomly selected for the digestibility trial were individually housed in metabolism crates and allowed 5 days of adaptation to the crates and feed before faecal collection commenced. Animals were fed the experimental diets at approximately 4% of their body weight, and the faeces of the animals were collected for 5 days. The determination of the nutrient composition of feed and faecal samples was performed. Data collected were subjected to analysis of variance using a completely randomized design. The result indicated that samples were significantly ($P<0.05$) different in crude protein composition, with the wheat offal having the highest value corresponding to 9.21 ± 0.12%. Orange pulp had the highest content of ash (6.72 ± 0.12%). The gross energy values were 15.23MJ/kg, 15.31MJ/kg and 16.15MJ/kg for pineapple peel, orange pulp and wheat offal, respectively. The highest manganese concentration was observed in wheat offal (5.19± 0.11mg/l), while orange pulp and wheat offal were higher in sodium and phosphorus concentrations. The pigs fed an orange pulp meal diet recorded the highest average daily weight gain (0.31 kg) and a superior feed conversion ratio (4.19) relative to others. Digestibility values were similar across the three treatment groups. It was, therefore, concluded that orange pulp and pineapple peal meal could serve as alternative fibre sources in growing pigs' rations.

Key words: Wheat offal, pineapple peel, orange pulp, growing pigs, digestibility

INTRODUCTION

Concentrates' ingredients such as maize, sorghum, millet, soybeans, and groundnut cake, which are required for the production of feed for monogastric animals such as pigs and poultry, are scarce in Nigeria and, when available, are prohibitively expensive for the average farmer [1]. The astronomic increase in the price of animal feeds has recently reached an alarming proportion. Scarcity and outright non-availability of raw feed materials have hampered the production and expansion of the livestock population. Most farmers have reduced their stock population as a strategy for dealing with rising feed costs, while others have abandoned the business entirely.

Incorporating agro-industrial by-products into pig diets is one way farmers adopt to solve this problem [2]. The agro-industrial by-products commonly used in pig ration production by farmers include wheat offal, brewers' dried grains, palm kernel cake, and maize offal. Between 2005 and now, the prices of these bulk-forming conventional agro-industrial by-products have increased significantly, making the feeding of pigs more difficult for farmers. A ton of wheat offal, a secondary product of the flour mill, sold for sixteen thousand (16,000.00) naira in 2005 and now sells for one hundred and fifty thousand (#150,000.00) naira, while palm kernel cake has sky-rocketed from twelve thousand (#12,000.00) naira in 2005 to one hundred and forty thousand (#140,000.00) naira in 2023, representing about 937.5% and 1,166% increase, respectively.

There is a need, therefore, to urgently search for lesser-known agro-industrial products to replace or complement wheat offal as a dietary fibre source in pigs' rations. The agro-industrial by-products considered in the present study include the orange pulp and the pineapple peel meal. Dried orange pulp meal is considered an energy feed source [3]. The orange pulp, according to Ehsan *et al*. [4], contains protein (7.40%), fat (2.19%), moisture (8.10%), fibre (7.31%), and ash (2.55%). Orange pulp has a digestible energy of about 72.3% [5]. Pineapple peel, on the other hand, is relatively poor in protein (6.12–8.8%DM) according to Aboh *et al.* [6] and [7] and high in crude fibre, ranging from 16.3–42.02% [7, 8]. Further studies revealed that pineapple peal meal is rich in sugar (83.03%), with a high digestible energy of about 73 to 75% [8].

The study was, therefore, designed to evaluate the chemical composition of the orange pulp meal, pineapple peel meal, and wheat offal and determine their feeding value as fibre sources in pig's ration.

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

MATERIALS AND METHODS

Location of the experiment

The chemical analyses were carried out at the Departments of Pure/Applied Chemistry and Biochemistry Laboratories, University of Calabar, Calabar, Cross River State, while the feeding trial was conducted at the piggery wing of the Animal Science Research Farm of the same Institution. The study was conducted between 1st October, 2020 to 26th November 2020 (56 days). The farm is located within latitudes $4^{o}58.4282^{1}$ and longitude $E8^{o}20.4602$, with an annual precipitation of approximately 1830mm and an average temperature of $24^{o}C$ to $30^{o}C$.

Processing of the experimental materials

The sweet orange pulp and pineapple peels were gathered from the local dealers within the municipality and spread on a concrete floor to dry out under the sun. The dried samples were milled to a fine texture in a local grinder and stored in an airtight plastic container until needed for analysis and feed formulation. The pineapple peels and orange pulp were included at 25% for T2 and T3, respectively. The wheat offal was bought from the Golden Penny flower mill company, Calabar, Nigeria.

Chemical analysis of the test samples

The samples of orange pulp meal, pineapple peel meal, and wheat offal were analyzed for their proximate composition using methods stated by AOAC [9]. The gross energy content of the test materials was determined with a Gallen Pump Oxygen Adiabatic Bomb Calorimeter. Calcium, manganese, iron, and phosphorus were determined using an atomic absorption spectrophotometer (Unicam, 939), while a flame photometer was used to determine the potassium and sodium contents of the samples. The method described by AOAC [10] was used in the estimation of vitamin A, while B-carotene estimation was carried out using the method of AOAC [11]**.** The Vitamin C (ascorbic acid) was estimated by extracting 1g of each sample with 10ml of triglyceride acetyl solution (TCA), filtered and pipette into test tubes of 1ml of DICS reagent which were caped, mixed and incubated in a water bath at $37^{o}C$ for 3 hours. The test tubes were then removed from the water bath and chilled for 10 minutes in an ice bath while mixing slowly. Two (2 mL) of H_2SO_4 was added to all the tubes. The spectrophotometer was adjusted with the blank to read zero absorbance at 520nm and then the absorbency of the standard was taken. The results were extrapolated and calculated as:

$$(SA \times SC) \div (AoS \times VoS)$$

Where:

SA = Sample absorbance
SC = Standard concentration
AoS = Absorbance of a standard
VoS = volume of sample

https://doi.org/10.18697/ajfand.136.24765

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Experimental diets

Three diets were formulated for the experiment, with diet 1, containing wheat offal as a fibre source, formulated to supply 15% crude protein and a metabolizable energy of 2,650 kcal/kg. Diets 2 and 3 were formulated with the wheat offal being substituted with orange pulp and pineapple peel meal, respectively.

Experimental animals and design

A total of thirty (30) crossbred (Chester White x landrace) growing pigs of about twelve (12) weeks old with an initial weight of 8.20 -- 8.75kg were obtained from the departmental research farm and shared into three (3) groups, with ten (10) animals per group. Animals were dewormed before the commencement of the experiment with piperazine administered in drinking water. Groups were assigned to the three experimental diets described earlier. Each animal was given free access to the experimental feed and water in a concrete trough daily.

The average feed intake and weight gain were monitored weekly throughout the 56-day duration of the trial. The feed consumption efficiency was computed based on the feed intake and the weight gain also weekly. Seven days before the end of the feeding phase, three pigs were selected randomly for the digestibility trial. They were housed individually in metabolism crates and allowed 5 days of adaptation to the crates and feed before faecal collection commenced. Each animal was fed the experimental diets at approximately 4% of their body weight followed by faecal collection for five (5) days. At the end of the period of collection, the faeces were pooled together, according to treatment, dried in an oven at 60 °C, and used for nutrient digestibility determination. The composition of dry matter, crude protein, crude fibre, ether extract, and ash contents of feed and faecal samples was performed based on [12]. The digestibility of the individual nutrients was calculated by subtracting the quantity of nutrients in the feed from the quantity of nutrients in the faeces and then multiplying by a hundred.

Statistical analysis

The collected data were subjected to analysis of variance procedures. All statistical analyses were carried out using the SAS computer software package [13].

RESULTS AND DISCUSSION

Proximate and gross energy compositions of orange pulp, pineapple peel and wheat offal

The proximate composition and gross energy (GE) content of the test samples are presented in Table 1. Variation in the dry matter (DM) content between the test samples was significantly ($P<0.01$) different with wheat offal having the highest value (90.15±0.00), followed by orange pulp, with the value corresponding to 89.22±0.12.

https://doi.org/10.18697/ajfand.136.24765

Crude protein (CP) composition equally differed significantly (P<0.01) with the wheat offal having the highest value corresponding to 9.21±0.12%, while the orange pulp had the lowest CP composition of 6.40±0.12%. The crude fibre (CF) composition ranged from 11.79±0.11% in pineapple peel to 13.42±0.04% in wheat offal, while orange pulp had 12.32±0.18%. Variation in the CF composition was significant (P<0.01) among the samples. The composition of the ether extract was statistically (P > 0.05) similar across the three sample groups with the wheat offal having the highest value. Orange pulp meal had the highest content of ash (P<0.05) corresponding to 6.72±0.06%, followed by pineapple peel (5.24±0.02%), and wheat offal (4.41±0.06%). The gross energy values were 15.23MJ/kg, 15.31MJ/kg and 16.15MJ/kg for pineapple peel, orange pulp and wheat offal, respectively. Gross energy composition was similar among the three samples.

The dry matter (DM) content of wheat offal obtained in this experiment was similar to the 90.97% reported by Mayaki *et al*. [14] but slightly lower than the 93.4% recorded by Aderimi and Alabi [15], while the value for the orange pulp (89.25%) was within the average range of 86.50%-92.60% reported by Marondes *et al*. [16]. The dry matter content of pineapple peel (87.80%) in this study also fell in line with the average range of 87.60-90.60% reported by CIRAD [17], but lower than 80.18% reported by Ibrahim *et al*. [18]. The dry matter content of feed stuffs reveals the actual amount of various nutrients available to the livestock consuming the feed. Although significantly lower, the pineapple peel meal and the orange pulp meal contained an appreciable amount of dry matter that could support the growth of animals relative to the conventional wheat offal.

The percentage crude protein in wheat offal (13.42±0.04) was lower than the average values of 13–16% and 16.60% reported by Alawa [19] and Umuna [15], respectively. The changes may be associated with the variety of wheat and the method by which the wheat offal was extracted. The CP value of orange pulp in this study compared favourably with the range (5.9% -9.3%) reported by Marondes *et al*. [16], Ehsan *et al*.[4], and Damila *et al*. [7], while the CP value for the pineapple peel (7.68±0.03%) was higher than the value of 3.58% reported by CIRAD [17], 5.78±0.10 % by Taiwo *et al*. [20], 5.04% by Ibrahim *et al*. [18] but close to 6.12% observed by Aboh *et al*. [6] and 5-9% by Kodagoda *et al*. [21] and Morais *et al*. [22].These changes may be attributed to the variety of samples used and the extent to which the samples were extracted. The crude fibre composition of wheat offal was comparatively higher than the 10% reported by Olomu [23] and 8.5% observed by Aderimi and Alabi [15]. The value obtained from the orange pulp compared favourably with the average value of 10.9-16.1% reported by Noblet and Goff [24] and Marondes *et al*. [16], while that of the pineapple peel was lower than the average values of 16.1-21.1% reported by CIRAD [17] and 4.10±0.06% by Taiwo *et al*. [20].

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

The effect of fibre on the availability of nutrients in feeds seems to be related more closely to its negative implications on the apparent digestibility of the feed nutrients than to the quantity of energy from the fibre itself [25]. The high NFE in orange pulp and pineapple peel is an indication that they contain a higher energy level. Variation in the nutritive value of dried citrus pulp depends on many factors, including the relative proportion of skin and seeds, which varies according to the citrus species and the process of harvesting and season. Changes were also known to occur in the proximate and nutritive compositions with time due to changes in the variety of crops used in producing them and methods of industrial processing.

The gross energy content of orange pulp and pineapple peel was lower than the average range (17.1-18.2MJ/kg) reported by AFZ [26] for wheat offal. Similarities in the gross energy content between wheat offal, orange pulp, and pineapple peel are an indication that the test samples have the potential to supply energy to animals when used in feed formulation.

The mineral and vitamin composition of the orange pulp, pineapple peel, and wheat offal

The vitamin and mineral composition of the test samples are presented in Table 2. The result indicated that wheat offal had the highest ($P<0.01$) concentration of calcium (3.37±0.10), potassium (0.75±0.02), Manganese (5.19±0.11), sodium (1.38±0.0.06) and Phosphorus (3.00±0.0.01) compared with the pineapple peel with the least concentration. The concentration of iron in orange pulp was the same as observed in wheat offal. There was no trace of manganese in the pineapple peel meal. Wheat offal had the highest concentration of Vitamin A with a value corresponding to 2.72±0.05mg/l, followed by the orange pulp meal (2.05±0.01mg/l), while pineapple peel had the lowest concentration, corresponding to 1.71±0.01mg/l. The result revealed a difference ($P<0.01$) in the treatment samples for vitamin A. Vitamin B concentrations were 3.82±0.01mg/l, 3.23±0.06 mg/l and 2.79±0.06 mg/l for pineapple peel, orange pulp and wheat offal, respectively, whereas the vitamin C (ascorbic acid) concentrations were 4.18mg/l, 9.03mg/l and 12.53mg/l for the wheat offal, pineapple peel and orange pulp meal, respectively.

The iron concentration in orange pulp was below the 46 mg/kg reported by AFZ [26] for wheat offal. Dietary availability of iron reduces the interference with calcium, phosphorus, and magnesium metabolism on recovery from nutritional ferropenic anaemia. The calcium concentration in orange pulp and pineapple peel was in line with the range (2.1-9.8 mg/l) reported by Crawshaw [27]. About 99% of the body's calcium is in the skeleton, while the balance is extracellular and useful in nerve conduction, contraction of the muscle, clotting of blood, and activation of the immune system. Drawing of calcium from the bone reserve will occur if animals are exposed

Since 2001
ajfand
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

to low dietary calcium leading to calcium being taken from the bone reserve, resulting in tetany, rickets, and abnormal growth in the animal.

The phosphorus concentrations observed in the study were higher than the 0.1% reported by Arthington *et al*. [3] for the orange pulp and 0.2 mg reported by CIRAD [17] for the pineapple peel. Eighty (80) % of the dietary phosphorus is in the bones and teeth, while the remaining 20% is used in energy utilization and transfer, acid-base, and osmotic balance. Phosphorus needs depend on the class of animal, body size, and level of production, including feed types and the environmental condition of the animals. Sodium plays a major role in maintaining body fluid volume, blood pH, and proper osmotic relationships. Dietary sodium deficiencies reduce the utilization of dietary protein and energy and influence reproductive performance negatively. The high level of sodium in the orange pulp relative to wheal offal is an indication that the sample can support the physiological process in animals. The vitamin A and C concentrations in pineapple peel fell within the average range of 1.56-3.84mg/100g reported by Achinewhu and Hart [28]. The ascorbic acid content of pineapple fruit varies with ripening. The result showed lower values when compared to those obtained for orange pulp and wheat offal in the study. The Vitamin B concentration was higher in pineapple peel as compared to values obtained from wheat offal and orange pulp meal.

Performance of growing pigs fed diets containing orange pulp, pineapple peel, and wheat offal fibre as sources

The growth characteristics of pigs fed diets with three sources of fibre are shown in Table 3.

The mean daily feed consumption did not vary significantly (P > 0.05) among the treatment groups. The values were 1.20kg, 1.23kg, and 1.22kg for pigs fed diets containing wheat offal, orange pulp meal, and pineapple peel meal, respectively. The highest average daily weight gain, with a value corresponding to 0.31kg, was observed among pigs fed orange pulp meal diet, followed by 0.27kg recorded for pineapple peel meal diets while pigs fed wheat offal diet had the lowest average weekly weight gain of 0.24kg. Variation between treatment means was significant (P<0.05). Pigs on orange pulp meal diets recorded a superior feed conversion ratio (4.19) compared to those fed wheat offal (5.26) and pineapple peel meal diets (4.50).

The non-significant relationship among the treatment groups in the average weekly feed intake implies that the treatment diets were not different in their energy content. It is known that monogastric animals eat to satisfy their energy requirements. In other studies, it was also reported that high dietary fibre affects the voluntary feed intake and nutrient digestibility of young pigs as a consequence of gut fill, compromising the energy intake of pigs. The average daily feed intake (1.20-1.23kg) observed in

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

this work was close to 1.09-1.38g, and 1.26-1.33kg reported by [29] and, [30] for growing pigs fed diets based on by-products of maize and wheat processing and those on cassava peel meal diets supplemented with allzyme. In another study, [31], [32], and [33] recorded an average daily feed intake of 1.42-1.47kg, 1.34-1.51kg, and 1.68-2.00kg, respectively for pigs fed cereal offals diets, diets supplemented with different multi-enzymes complexes, and hatchery waste meal which were higher than values obtained from this study. The average feed intake range (1.20 - 1.23kg) obtained in this study is lower than 1.258.80 – 2.253.29kg reported by Bollido [36] in an experiment evaluating the growth performance, piglets' size and profitability of native pigs fed with kitchen leftover, madre de aqua (*Trichantergigantean*) in contrast with commercial feeds.

The significantly higher (P<0.05) daily weight gain observed from pigs fed diets containing orange pulp and pineapple peel meals relative to those on wheat offal diet shows that the test samples were rich in nutrients, particularly energy, minerals and vitamins, thus improving the growth potential of the animals. Amaefule *et al*. [34] stated that lower energy and higher crude fibre content in the diet could result in a significant reduction in the daily weight gain of pigs. The average weight gain obtained in the experiment (0.24-0.31kg) was similar to 0.23-0.31 reported by Robert *et al*. [29] for growing pigs fed diets based on by-products of maize and wheat processing, and 0.31 -0.34 by Sorunke *et al.* [32] for pigs fed diets supplemented with different multi-enzymes complexes. The average daily weight gain (0.48-0.58kg) observed by Peter *et al*. [33] for pigs on hatchery waste meal diet was higher than the value obtained from this study

The lower feed conversion ratio (4.19, and 4.50) observed among pigs fed the treatment diets compared to those on control diet (5.26) suggests that treatment diets were better digested and utilized than the control (wheat offal) diet. Generally, the FCR values observed in this experiment were higher than those reported by Thomas *et al*. [35] but similar to the range (4.13-4.36) reported by Sorunke *et al.* [32] for pigs fed diets supplemented with different multi-enzymes complexes and (4.5-5.4) reported by Irekhore *et al*. [29] for growing pigs fed diets based on by-products of maize and wheat processing. The FCR values of 3.24-4.32, and 3.31-4.12 for pigs fed different multi-enzymes complexes and hatchery waste meal diets which reported by Wafar *et al*. [31] and [33] were higher than values obtained from this study.

The economics of feeding diets containing three fibre sources to growing pigs
The economics of feeding diets with three different fibre sources to growing pigs are presented in Table 4.

Replacing wheat offal with orange pulp meal and pineapple peel meal reduced the cost/kg of feed production from N13,796. 16 to N10, 993.25 and N10, 903.82, respectively. Utilization of pineapple peel meal and orange pulp meal equally reduced the cost of feed consumed by the pigs significantly (P<0.05). The cost of feed consumed from the various treatments was N 205.30 for the wheat offal diet, N 159.60 for the orange pulp meal diet, and N 159.60 for the pineapple peal meal. The cost of feed/gain was reduced from N843.80 to 636.94, and N712.67 by replacing wheat offal with orange pulp and pineapple peel meals.

The reduction in the total cost of feeds containing orange pulp and pineapple peel meal may be attributed to the low cost of processing the orange pulp and pineapple peel meal relative to the wheat offal. The cost of procuring the wheat offal was higher compared to the amount spent on processing the other two agro-products. Reductions in the cost of producing orange pulp and pineapple peel meal diets together with lower feed consumption resulted in a reduced cost per kg of gain. The higher financial benefit as a result of feeding orange pulp and pineapple peel meal diets to pigs would be beneficial to farmers whose overall interest is in a higher profit.

Nutrient digestibility of pigs on diets containing orange pulp, pineapple peel, and wheat offal fibre as sources

Data for nutrient digestibility of pigs fed diets with varying fibre sources is shown in Table 5. Pigs fed diets containing the three dietary fibre sources recorded similar (P > 0.05) dry matter digestibility. The values were 90.10, 89.35, and 87.80% for pigs on the Pineapple peel meal, orange pulp meal, and wheat offal diets, respectively. Digestibility values for the protein, fibre, and ash were also similar across the three treatment groups. Pigs on wheat offal diet recorded the highest (50.0%) ether extract digestibility, while the least (33.33%) ether extract digestibility was recorded among pigs fed orange pulp meal diet. Nitrogen-free extract (NFE) digestibility varied (P<0.05) significantly among the pigs with those on the orange pulp diet having the highest value of 88.11%. Pigs fed pineapple peel meal diet had the lowest NFE of 74.39%.

Improved dry matter, protein, fibre, ether extract, ash, and nitrogen-free extract digestibility as observed in this present study is an indication that the orange pulp and pineapple peel did not contain higher concentrations of indigestible components (Lignin, cellulose and hemicellulose) which cannot be digested by the animals' enzyme during the digestion process.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

From the above findings, it was, therefore, concluded that orange pulp meal could serve as a better alternative to wheat offal as a fibre source in monogastric diets, particularly pigs against pineapple peel meal.

ACKNOWLEDGEMENTS

We are grateful to the Department of Animal Science, University of Calabar, Nigeria for providing us with the animals used for this experiment. We also express our heart appreciation to the technical staff of the Teaching and Research Farm for their professional services throughout the duration of this research.

Conflict of Interest

The Authors declared that there were no conflicts of interest.

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 1: Gross composition of experimental diets

Ingredients	Wheat offal	Orange pulp diet	Pineapple peel diet
Maize	50.00	50.00	50.00
Soybean meal	10.00	10.00	10.00
PKC	10.00	10.00	10.00
Wheat offal	25.00	-	-
Orange pulp meal	-	25.00	-
Pineapple peel meal (PPM)	-	-	25.00
Fish meal	2.00	2.00	2.00
Bone meal	1.50	1.50	1.50
Vitamin/mineral premix	0.50	0.50	0.50
Lysine	0.30	0.30	0.30
Methionine	0.20	0.20	0.20
Salt	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**
Analysis			
Crude protein %	15.00	14.09	14.06
Crude fibre%	9.32	9.24	8.40
Metabolizable energy (kcal/kg)	2,650.00	2,595.00	2,591.00

Table 2: Proximate mean composition and gross energy of orange pulp, pineapple peel and wheat offal

Composition	Pineapple peel	Orange pulp	(Wheat offal)	P-value
Dry matter (%)	87.73±0.17^{c}	89.22±0.12^{b}	90.15±0.00^{a}	0.000
Crude protein (%)	7.68±0.03^{b}	6.40±0.12^{c}	9.21±0.12^{a}	0.000
Crude fibre (%)	11.79±0.11^{c}	12.32±0.18^{b}	13.42±0.04^{a}	0.000
Ether extract (%)	2.15±0.03^{b}	2.07±0.01^{b}	2.70±0.06^{a}	0.000
Ash (%)	5.24±0.02^{b}	6.72±0.06^{a}	4.41±0.06^{c}	0.000
NFE (%)	60.93±0.02^{ab}	61.81±0.57^{a}	60.43±0.25^{b}	0.087
Gross energy (KJ/kg)	15.23±0.06	15.31±0.02	16.15±0.07	0.110

^{abc}Means in the same row with different superscripts differ significantly (P≤0.01)
*Values are Means ± SD (n=3)

ajfand Since 2001 AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 3: Mean mineral and vitamin composition of the orange pulp, pineapple peel and wheat offal (mg/l)

Composition	Pineapple peel meal	Orange pulp meal	Wheat offal	P-value
Minerals				
Iron	0.01 ±0.00[b]	0.02 ±0.00[a]	0.02 ±0.00[a]	0.000
Calcium	2.61 ±0.02[b]	2.27 ±0.06[c]	3.37 ±0.10[a]	0.000
Potassium	0.61 ±0.01[c]	0.67 ±0.02[b]	0.75 ±0.02[a]	0.002
Manganese	0.00 ±0.00[c]	1.36 ±0.34[b]	5.19 ±0.11[a]	0.000
Sodium	0.14±0.01[c]	1.38 ±0.06[a]	1.20 ±0.06[b]	0.000
Phosphorus	1.31 ±0.06[c]	2.63 ±0.06[b]	3.00 ±0.01[a]	0.000
Vitamins				
Vitamin A	1.71 ±0.01[c]	2.05 ±0.01[b]	2.72 ±0.05[a]	0.000
Vitamin B	3.82±0.01[a]	3.23 ±0.06[b]	2.79 ±0.06[c]	0.000
Vitamin C	9.03±0.02[b]	12.53±0.06[a]	4.18 ±0.01[c]	0.000

[abc]Means in the same row with different superscripts differ significantly (P≤0.01)
*Values are Means ± SD (n=3)

Table 4: Performance of growing pigs fed diets containing orange pulp, pineapple peel, and wheat offal fibre as sources

Parameter	Wheat offal	Orange pulp meal	Pineapple peel meal	± SEM
Initial weight (kg)	8.75	8.38	8.20	0.15
Av. final weight (kg)	21.38	25.53	24.55	0.44
Total weight gain (kg)	12.63[c]	17.15[a]	16.35[b]	0.43
Average daily weight gain (kg)	0.23[c]	0.31[a]	0.29[b]	0.02
Average daily feed intake (kg)	1.20	1.23	1.22	0.11
Feed conversion ratio	5.22[a]	3.97[c]	4.21[b]	0.22

[abcd] - Means with different superscripts on the same row are significantly different (p<0.05)
SEM: Standard error of mean

Table 5: Economics of feeding diets with three fibre sources to growing pigs

Parameter	Wheat offal	Orange pulp	Pineapple peel	± SEM
Cost of feed (₦)	205.30[a]	159.60[b]	159.60[b]	0.86
Av. Cost of feed consumed (₦)	13,796.16[a]	10,993.25[b]	10,903.82[c]	3.68
Av. Cost of feed per gain (₦)	843.80[a]	636.94[b]	712.67[b]	0169

abcd - Means with different superscripts on the same row are significantly different ($P<0.05$)
SEM: Standard error of mean, T 1: wheat offal, T 2: orange pulp meal, T 3: Pineapple peel meal

Table 6: Nutrient digestibility of pigs on diets containing orange pulp, pineapple peel, and wheat offal fibre as sources

Parameter	Pineapple peel meal	orange pulp meal	wheat offal	± SEM
Dry matter	90.10	89.35	87.80	0.15
Crude protein	83.33	86.29	86.65	0.70
Crude fibre	86.2	83.5	85.0	0.80
Ether extract	46.67[b]	33.33[c]	50.00[a]	1.55
Ash	81.80[a]	66.00[b]	83.30[a]	1.61
Nitrogen Free Extract	74.39[c]	88.11[a]	78.69[b]	0.46

abc -Means with different superscripts on the same row are significantly different ($P<0.05$)
SEM: Standard error of mean

https://doi.org/10.18697/ajfand.136.24765

REFERENCES

1. **Agunbiade JA, Bello RA and OA Adeyenu** Performance characteristic of weaner rabbits on cassava fed-based balanced diet. *Nig. J. of Anim. Prod.* 2009; **2:** 171-175.

2. **Adesehinwa AOK** Energy and protein requirements of pigs and the utilization of fibrous feedstuffs in Nigeria. *Afri J. of Pig Farming*. 2016; **4(6)**: 1- 9. ISSN 2375-0731.

3. **Arthington JD, Kunkle WE and AM Martin** Citrus pulp for cattle. *Vet. Clin. North Am Food Anim. Prac.* 2002; **18:** 317–326.

4. **Ehsan H, Muhammad SH, Muhammad N, Arshad M, Muhammad I, Zafar I and J Saqib** Physicochemical and rheological study of orange pulp fortified cookies. *Sci. Letters*. 2015; **3(2)**: 64-67.

5. **Despeters EJ, Fadel JG, Arana MJ, Ohanesin N, Etohebarn MA, Hamilton CA, Hinders RG, Maloney MD, Old CA, Riordan TJ, Perez Monti H and JW Pareas** Variability in the chemical composition of seventeen selected by-product feedstuffs used by the California industry. *The Prof. Anim. Scientist.* 2000; **16(2)**: 69-99.

6. **Aboh AB, Zoffoun GA, Djenontin AJP, Babatounde S and GA Mensah** Effect of graded levels of dry pineapple peel on digestibility and growth performance of rabbit. *Journal of Appl. Biosciences.* 2013; **67**: 5271 – 5276. ISSN 1997–5902.

7. **Damila R, MoraisEliza M, RottaSheisa C, SargiElton G, BonafeRúbia M, Suzuki N, Makoto ES and Visentainer** Proximate composition, mineral contents and fatty acid composition of the different parts and dried peels of tropical fruits cultivated in Brazil. *Journal of Brazil Chem. Soc.* 2017; **28 (2)**: 301-318.

8. **Gethmini K** Analysis of proximate composition and physico-chemical properties of pineapple wastes. Sri Lanka Association for the Advancement of Science, Proceedings of the 73rd Annual Sessions. December, 2017.

9. **AOAC Official methods of analysis**. Revised edition. Association of Official Analytical Chemists, Washington DC. 2000.

10. **AOAC Official Methods of Analysis.** Association of Official Analytical Chemists. 14th Edition, AOAC, Arlington. 1984.

11. **AOAC Official Methods of Analysis**. Horowitz (ed.) 1980; 734-740.

12. **AOAC Official Methods of Analysis**. Revised edition. Association of Official Analytical Chemists, Washington DC. 2001.

13. **SAS (Statistical Analysis System)**. SAS User's Guide: Statistics. SAS Institute, Cary, NC. 2009.

14. **Mayaki OM, Ozumba AU, Aderele AA and AO Daramola** Effect of Sources of Fibre on Performance of Growing Snail. *Nigerian Food Journal.* 2013; **31(1)**: 28-32.

15. **Aderimi F and O Alabi** Effects of graded levels of cassava peels fortified with moringa as a replacement to wheat bran on performance, digestibility and blood profile of broilers. *J. of Agric. Sci. and Technol*. 2013; **3**: 210-215. ISSN 1939 -1250.

16. **Marondes MI, Valadares SD, Detmann E, Valadares RFD, Silva LFCE and MA Fonseca** Rumen degradation and intestinal digestibility of crude protein in feeds for cattle. *Rev. Bras. Zootec.* 2009; **38(11)**: 2247-2257.

17. **CIRAD.** *Laboratory Data* 1991; 1963-1991.

18. **Ibrahim H, Alemede CI and QV Saidu** Dietary levels of pineapple peels on growth performance, reproductive performance, nutrient digestibility and carcass characteristics of weaner rabbits. *J. of Agripreneurship and Sus. Dev.* 2023; **6(1)**: 171-182.ISSN: 2651-636.

19. **Alawa JP and NN Umuna** Alternative food formation in developing countries: prospects of utilization of agro-industrial by-products. *J. of Anim. Res.* 1993; **13**: 63-98.

20. **Taiwo FO, Akinlabu DK, Ajayi OO, Adeniran SA, Jacob OP and OA Olayinka** Phytochemical constituents and proximate analysis of dry pineapple peels. *Earth and Env. Sci.* 2022; **993(1)**: 012027.

21. **Kodagoda K and R Marapana** Development of non-alcoholic wines from the wastes of Mauritius pineapple variety and its physicochemical properties. *J. Phermacog. Phytochem*. 2017; **6**: 492-497.

22. **Morais DR, Rotta EM, Sargi SC, Bonafe EG, Suzuki RM, Souza NE, Matsushita M and JV Visentainer** Proximate composition, mineral contents and fatty acid composition of the different parts and dried peels of tropical fruits cultivated in Brazil. *J. Brazil. Chem.Soc*. 2017; **28**: 308-318. https://doi.org/10.5935/0103-5053.20160178

23. **Olomu JM** Monogastric Animal Nutrition: Principles and Practice. Jachem Publ., Benin, Nigeria. 1995.

24. **Noblet J and L Goff** Effect of dietary fibre on the energy value of feeds for pigs*. Animal Feed Technology*. 2002; **90**:35-52.

25. **Owens FN, Sapienza DA and AT Hassen** Impact of nutrient composition of feeds on digestibility of organic matter by cattle: A review. *J. of Anim. Sc*. 2010; **88(13):** E151-E169. https://doi.org/10.2527/jas.2009-2559

26. **AFZ** Lo-La Banque de Donnes de l'Alimentation evaluation of sweet database association. Francaise de Zootechnie 2011.

27. **Crawshaw R** By-product feeds: animals feed from the food and drink industries. Lam University Press. 2004.

28. **Achinewhu SC and AD Hart** Effect of processing and storage on the ascorbic acid (vitamin C) content of some pineapple varieties grown in the Rivers State of Nigeria. *Plant Foods for Human Nutr*. 1995; **46(4)**: 335-337 https://doi.org/10.1007/BF01088433

29. **Robert M, David M and RK Danald** Performance of growing pigs fed diets based on by-products of maize and wheat processing. *Trop. Anim. Health Prod*. 2009; **41(3)**: 3-20.

30. **Irekhore OT, Adeyemi OM, Idowu OMO, Akinola OS and KO Bello** Growth Performance indices and cost benefits of growing pigs fed cassava peel meal diets supplemented with allzyme. *Int. J. of Applied Agric. Sc. and Apicultural Res*. 2015; **(1&2)**: 51-59.

31. **Wafar RJ, Tarimbuka LI, Sini T, Adi ZA, Lamalang EE and ML Bako** Growth performance and nutrient digestibility of weaner pigs fed cereals offals in diets. *Nig. J. Anim. Prod*. 2020; **47(6)**: 129-134.

32. **Sorunke AO, Adesehinwa AOK, Boladuro BA, Ogunyemi DJ, Abiola JO, Onarinde OE and AO Adesehinwa** Performance and economic analysis of growing pigs fed diets supplemented with different multi-enzymes complexes *Nig. J. Anim. Prod.* 2021; **48(5)**: 285-292.

33. **Peter A, Ebenezer G, Bumbie GZ, Osei DY and AFN Odoi** Growth performance of pigs fed hatchery waste meal. *Livestock Res. for Rural Dev*. 2023; **35(5)**: 1-6.

34. **Amaefule PE, Shurson GC and HH Sten** Digestibility of dietary fibre in distiller's by-product feed ingredients fed to Yorkshire Pigs. *J. Anim. Sci*. 2007; 2208-2216.

35. **Thomas J, Buldgon A, Delacollette M, Wavroille J, Agnecssens R, Destain JP and P Leterme** Influence of source and concentration of dietary fibre on *in-vivo* nitrogen excretion pathways in pigs and on hindgut fermentation of dietary fibre in corn-soybean meal diet for growing pigs. *J. of Anim. Sci.* 2010; **82**: 57-63.

36. **Bollido ME** Growth performance, piglets size and profitability of native pigs fed with kitchen leftover, madre de aqua (*Trichanter gigantean*) in contrast with commercial feeds. *African Journal of Food, Agriculture, Nutrition and Development.* 2024; **24(4):** 26024-26037. https://doi.org/10.18697/ajfand.129.24385