*Trop. J. Anim. Sci. 2003 Vol. 6 No. 2: 35-45*

# Serum Biochemical Parameters, Apparent Nutrient Utilisation and Economy of Production of Growing Pigs' Fed Cassava Based Fibrous Diets

**Arowora, K.A[1]. And Tewe, O.O.[2]**

[1]*Nigerian Stored Products Research Institute, P.M.B. 5044, Ibadan*

[2]*Department of Animal Science, University of Ibadan, Ibadan.*

**Target Audience:** This project is targeted towards the farmers, feed millers, nutritionists and Agriculturists.

**Abstract**

*Twenty grower (Large white x Hampshire) pigs weighing 16.5 ± 0.8kg were randomly allotted to five dietary treatments. The diets were isonitrogenous with 20% crude protein and compounded such that maize was replaced by cassava flour and maize offal with supplementation of palm kernel cake and cassava peel with metabolizable energy varying from 2373-2574.0 Kcal/kg. At the end of the experiment, significant differences (P<0.05). were observed among treatments in the levels of serum glucose, cholesterol and triglycerides, while no significant variation (P>0.05) was noted among treatments in protein and hemicellulose utilisation. The best feed cost /kg live weight and projected profit was shown by diet 5 which had 10% each of dried cassava peel and palm kernel cake.*

**Key Words:** Biochemical parameters, nutrient utilisation, growing pigs, fibrous diets, cassava.

**Description of Problem**

The scarcity and escalating cost of conventional feed ingredients have adversely affected the livestock production in Nigeria. In view of this, efforts have been geared towards search for the readily available alternative sources of livestock ingredients. Some of these alternative sources of livestock ingredients are rice bran, corn bran, palm kernel cake and also cassava and its residues, which can be incorporated in the diets of monogastrics and ruminants. It has been found that cassava can replace up to 45% of feeds at the expense of maize, while cassava peels can replace up to 10% brewer's dried grain or rice bran (1). Cassava peel forms the major residue of cassava root after harvest and processing.

A lot of studies have been carried out on the use of cassava in pig feeding. (2) Indicated that maximum level of 40% was incorporated in swine feeding. (3) Reported satisfactory pork carcass when 40% cassava-based diets were fed to pigs of about 18 weeks old. Also, (4,5) have shown the possibility of incorporating up to 40% dried cassava peels into ration for growing finishing pigs.

Several researcher's have reported that deitary components have measurable effects on blood components, hence blood constituents are widely used in nutritional evaluation and survey of human and animals (6,7,8,9). In view of aforementioned, the present study was carried out to evaluate the nutritional effects of cassava-based fibrous diets on blood components and its utilisation in pig production.

## Materials and Method

### Analysis of Experimental Diets:

Experimental diets were analysed for proximate composition by the method of (10), while the dietary fibre in the diets were determined by the method of (11)

### Pig Feeding Trial:

Twenty grower (Hampshire x Large White) pigs weighing 16.5 ± 0.8kg were allotted on the basis of sex and body weight to 1 male and 1 female per replicate in a completely randomised design. Animals were dewormed ad pens disinfected prior to the commencement of the 56-day feeding trial. Five diets with formulations as presented in Table 1 was prepared with diet 1 (control) being a maize-based, while diets 2-5 were cassava-based fibrous diets. Feeds and water were provided *adlibitum.*

**Table 1: The Gross Composition of Experimental Diets (kg)**

| Ingredients | Diet 1 | Diet 2 | Diet 3 | Diet 4 | Diet 5 |
|---|---|---|---|---|---|
| Maize | 40 | - | - | - | - |
| Cassava flour | - | 20.00 | 20.00 | 20.00 | 20.00 |
| Groundnut cake | 17.30 | 21.60 | 25.40 | 21.20 | 25.10 |
| Wheat Offal | 36.70 | 32.40 | 18.60 | 22.80 | 8.90 |
| Maize Offal | - | 20.00 | 20.00 | 20.00 | 20.00 |
| Palm Kernel cake | - | - | - | 10.00 | 10.00 |
| Cassava Peel meal | - | - | 10.00 | - | 10.00 |
| Fish meal | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Bone meal | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Oyster shell | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Premix | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Salt | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Total (kg) | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated crude Protein (%) | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| Metabolisable energy (Kcal/kg) | 2574.0 | 2373.0 | 2454.0 | 2400.5 | 2482.5 |
| Calculated crude Fibre (%) | 7.19 | 9.06 | 8.68 | 8.80 | 8.42 |

Composition of Vitamin - Mineral premix
Vitamin A (10,000,00 i.u.), Vitamin $D_3$ (2,000,00 i.u.), Vitamin E (8,000 i.u.), Vitamin K(2,000 mg), Vitamin $B_1$ (2,000 mg) Vitmin $B_2$ (5,500 mg), Vitamin B6 (1,200 mg), Vitamin $B_{12}$ (12mg), Biotin (30 mg), Folic Acid (600 mg), Niacin (10,000 mg), Pantothenic acid (7,000 mg), Choline Choride (500,000 mg), Vitamin C (10,000 mg), Iron ( (60,000 mg) Manganese (80,000 mg), Copper (8000 mg), Zinc (50,000 mg), Iodine (2,00 mg), Cobalt (450 mg), Magnesium (100,000 mg), Anti-oxidant (6,000 mg).

**Digestibiliy Study:**

For the digestibility study, two pigs per treatment (1male and 1 female) were housed in specially adapted metabolic cages. They were initially fasted for 24 hours in order to empty their gastrointestinal tract (G.I.T.) content. Feeds and water were provided ad-libitum. The pigs were fed for 5 days and faecal droppings were also collected for 5 days. Each day's collection per animal per treatment was pooled and oven dried. The dried samples were analysed.

**Blood Analysis**

Two males and two female pigs per treatment were bled at the end of the feeding trial. The bleeding was carried out in the morning before feeding and 10ml of blood was obtained from the jugular vein into a sample bottle. The separated serawere decanted into bijoh bottles and stored at -10°C until analysed. The serum metabolites were determined as described (12,13).

The triglyceride determination was carried out by the method of (14), a modification of that of (15). Serum alkaline phosphatase was determined according to the method of (16). Alanine amino transferase (ALT) and aspartic amino transferase (AST) were carried out as described by (17).

**Statistical Analysis:**

All data collected were subjected to analysis of variance using (18). Where significant differences were observed, treatment means were compared using the least significant difference (19)

**Results and Discussion**

Table 2 shows the proximate composition of the experimental diets. The results were observed to be numerically close in dry matter, crude protein, ether extract and crude fibre. There was variation in the ether extraction of the experimental diets with the highest values of 2.45% observed for diets 2 and 3. There was no definite trend in the variation observed in the crude fibre composition. Diet 2 had the highest value of crude fibre content (9.00%), while the lowest crude fibre content (7.20%) was observed in diet 1.

**Table 2: Proximate Composition of Experimental Diets on D.M. Basis.**

| Parammeters (%) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| M.C. (Moisture content) | 13.30 | 18.30 | 18.30 | 16.60 | 18.30 |
| D.M. (Dry matter) | 86.70 | 81.70 | 81.70 | 83.40 | 81.70 |
| Ether extract | 1.73 | 2.45 | 2.45 | 1.80 | 1.72 |
| Ash | 13.84 | 18.97 | 19.58 | 17.98 | 18.35 |
| Crude fibre | 7.20 | 9.00 | 8.50 | 8.67 | 8.34 |
| Crude protein | 20.70 | 20.88 | 20.25 | 20.05 | 20.45 |
| Nitrogen free extract (NFE) | 56.53 | 48.70 | 49.22 | 51.50 | 51.09 |

Table 3: shows the detergent fibre analysis of varying composition of the fibrous components experimental diets, which depicted.

**Table 3: Detergent Fibre Analysis of Experimental Diets on D.M. Basis.**

| Parameters (%) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Neutral Detergent Fibre (N.D.F.) | 58.60 | 45.60 | 46.60 | 48.50 | 44.00 |
| Acid Detergent Fibre (A.D.F.) | 13.70 | 12.40 | 18.40 | 38.10 | 14.50 |
| Acid Detergent Lignin (A.D.L.) | 2.94 | 4.41 | 5.77 | 12.10 | 3.83 |
| Hamicellulose | 44.90 | 33.20 | 28.20 | 10.40 | 29.50 |
| Cellulose | 10.76 | 7.99 | 12.63 | 26.00 | 10.67 |
| Ash | 2.65 | 4.04 | 5.33 | 11.74 | 3.50 |
| Lignin | 0.29 | 0.37 | 0.44 | 0.36 | 0.33 |

The results of apparent digestibility co-efficient of nutrients are shown in Table 4.

**Table 4: Apparent Digestibility Co-efficient of Nutrients by Growing Pigs Fed Cassava-based Fibrous Diets.**

Parameters(%)

| | DIETS | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Daily dry Matter Intake/kg | 1.10 ± 0.02 | 0.94 ± 0.04 | 1.14 ± 0.01 | 0.98 ± 0.01 | 1.02 ± 0.04 |
| Apparent digestibility of dry matter kg | 69.35 ± 2.28$^{b}$ | 60.80 ± 0.23$^{c}$ | 72.55 ± 2.05$^{b}$ | 71.70 ± 0.70$^{b}$ | 82.00 ± 0.87$^{a}$ |
| Crude protein | 80.24 ± 0.39 | 67.32 ± 0.29 | 76.94 ± 0.96 | 76.85 ± 0.44 | 83.25 ± 0.53 |
| Crude fibre | 70.31 ± 0.23$^{b}$ | 57.41 ± 1.41$^{c}$ | 73.40 ± 0.08$^{a}$ | 74.85 ± 0.78$^{a}$ | 79.05 ± 0.08$^{a}$ |
| Ether extract | 81.02 ± 1.16$^{c}$ | 65.30 ± 0.33$^{d}$ | 85.72 ± 0.91$^{b}$ | 83.80 ± 0.64$^{b}$ | 88.45 ± 0.84$^{a}$ |
| Ash | 84.38 ± 1.57$^{a}$ | 71.74 ± 1.90$^{b}$ | 89.60 ± 0.82$^{a}$ | 87.80 ± 0.70$^{a}$ | 88.50 ± 2.06$^{a}$ |
| Nitrogen free extract | 56.38 ± 1.49$^{b}$ | 47.24 ± 0.05$^{bc}$ | 53.10 ± 1.80$^{b}$ | 59.93 ± 0.79$^{b}$ | 72.15 ± 1.24$^{a}$ |

a,b,c,d -means with different superscripts on the same row differ significantly ($P<0.05$)

No significant differences were observed in the crude protein digestibility among treatments, this could be due to the isonitrogenous nature of the dietary treatments.

However, the numerically highest level of crude protein digestibility was observed in diet 5 (83.25 ± 0.53%), while the lowest was recorded for diet 2 (67.32 ± 0.29%). This observation could be due to the variation in the levels of digestible protein in the dietary treatments, as high levels of digestible protein could have resulted to high digestibility of protein. The result of this study is in conformity with the report of (20) who found that the apparent digestibility of crude protein varied with the concentration of protein in the diet. Significant difference (P<0.05) was observed in crude fibre digestibility. Diet 5 had the best crude fibre utilisation, while the lowest was showed by diet 2. Apparent crude fibre digestibility tended to vary with the proportion of the dietary fibre sources, addition of cassava peel meal (CPM) and palm kernel meal (PKM) in diet tend to improve crude fibre digestibility. The probable reason for this could be variation in the proportion of the various macromolecular components of dietary fibre in the diets as described by (21). Significant differences (P<0.05) were observed in the apparent digestibilities of ether extract, N.F.E. and ash. The highest value of N.F.E. digestibility was noted in diet 5, while the lowest was indicated by diet 2. This observation could be as a result of varying composition of soluble carbohydrates in the dietary components, which resulted in varying digestibilities, more so when the fibre composition of the diets would have had influence on the overall digestibilities of the nutrients.

On Table 5 were shown the results of apparent digestibility co-efficient of fibrous components.

**Table 5: Apparent Digestibility Co-efficient of Fibre Components by Growing Pigs Fed Cassava based Fibrous Diets**

| Parameters(%) | DIETS | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| NDF | 74.42 ± 0.050[a] | 67.23 ± 1.06[c] | 72.50 ± 2.24[b] | 69.98 ± 0.34c | 77.93 ± 0.81[a] |
| ADF | 51.20 ± 5.45[b] | 45.15 ± 1.80[b] | 55.39 ± 1.36[b] | 70.09 ± 1.12[a] | 53.60 ± 5.36[b] |
| ADL | 26.27 ± 0.74[b] | 45.56 ± 6.62[b] | 46.33 ± 6.22[a] | 63.70 ± 0.75[a] | 30.41 ± 6.20[b] |
| Cellulose | 58.91 ± 6.28[b] | 43.18 ± 4.26[b] | 58.75 ± 1.58[b] | 73.06 ± 1.29[a] | 61.94 ± 2.87[b] |
| Hemicellulose | 82.60 ± 2.34 | 77.22 ± 0.23 | 84.13 ± 1.79 | 69.60 ± 2.52 | 86.59 ± 1.93 |
| Lignin | 40.18 ± 1.63[b] | 56.05 ± 7.29[a] | 46.14 ± 2.05[a] | 35.67 ± 3.02[b] | 35.99 ± 4.38[b] |

a,b,c - means with different superscripts on the same row differ significantly (P<0.05).

The apparent digestibilities showed significant variation (P<0.05) among treatments in NDF, ADF, ADL, Cellulose and Lignin. The reason behind significant variation in NDF digestibility may be due to varying ability of the growing pigs to digest and retain cell wall constituents. It was also shown that diet 5 which had the highest NDF digestibility had the lowest NDF composition (44.00%), which tended to aid its digestibility, while diet 2 with the lowest NDF digestibility had the highest crude fibre composition of 9.06%. This is in accord with the findings of (22,23) who showed that high fibre content would hinder the efficient absorption and subsequent utilisation of nutrients.

The probable reason for variation in the ADF utilisation among treatments could be varying concentration of the proportion of various macromolecular components of dietary fibre as described by (21). Apparent digestibility co-efficient of ADL by the experimental pigs were significantly found to be the best in treatment 4 while it was poorest in treatment 1. Although treatment 4 recorded the second lowest dry matter intake, its lignin and ash constituents were better utilized as reflected in the highest percent of ADL digestibility.

There was a definite trend in the digestibility of cellulose among treatments. A direct relationship was observed in the composition of cellulose in the diets and its digestibilities. This was reflected as shown by diet 2 with lowest composition and lowest digestibility (43.18±4.26%), while diet 4 that had highest composition of cellulose, also had highest diegestibility (73.06 ± 1.29%). This observation can be explained by the fact that fibre utilisation is influenced by the physical and chemical composition of the total diet and also on the level of feeding (24,25). No definite trend was observed in the hemicellulose digestibility. This was reflected, as diet 1 with highest hemicellulose concentration did not show highest digestibility (82.60 ± 2.34%). Although, diet 4 with lowest concentration of hemicellulose also had lowest digestibility (69.60±2.52%). This observation could be due to the composition of the experimental diets coupled with the level of feeding, age and weight of the animals (24,25,26).

A haphazard trend was depicted in lignin digestibility. Statistical trend revealed significant variation (P<0.05) among treatments with the highest being demonstrated in treatment 2 that had the second highest lignin composition of 0.37%, while the lowest digestibility was recorded in diet 4 to be (35.67±3.02%). This observation could be due to the varying ability of experimental pigs in handling lignin. It can also be due to the influence of age and weight of the experimental pigs on fibre utilization (26).

Table 6 shows the serum metabolites of grower pigs fed cassava-based fibrous diets at the end of 8th week.

**Table 6: Serum Metabolites of Grower Pigs Fed Cassava-based Fibrous Diets at the end of 8th week.**

| Parameters(%) | DIETS | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Total protein(g/dl) | 6.10 ± 0.06 | 6.30 ± 0.07 | 6.25 ± 0.03 | 6.10 ± 0.08 | 5.95 ± 0.03 |
| Albumin (g/dl) | 3.00 ± 0.07 | 3.20 ± 0.08 | 3.05 ± 0.03 | 3.20 ± 0.09 | 3.15 ± 0.03 |
| Globulin (g/dl) | 3.10 ± 0.06 | 3.20 ± 0.10 | 3.20 ± 0.08 | 3.10 ± 0.07 | 3.15 ± 0.12 |
| Urea (mg/dl) | 22.50 ± 0.29 | 22.50 ± 0.96 | 18.50 ± 0.30 | 18.00 ± 0.58 | 17.50 ± 0.54 |
| Cholesterol (mg/dl) | 129.50 ± 0.87$^c$ | 143.00 ± 1.23$^b$ | 121.00 ± 1.45$^c$ | 155.00 ± 2.04$^a$ | 143.50 ± 1.73$^b$ |
| Triglyceride (mg/dl) | 98.50 ± 0.90$^c$ | 120.00 ± 2.04$^a$ | 87.50 ± 1.44$^d$ | 78.00 ± 2.05$^e$ | 122.50 ± 1.73$^b$ |
| Glucose (mg/dl) | 139.00 ± 0.58$^a$ | 120.00 ± 2.05$^b$ | 142.50 ± 4.33$^a$ | 122.00 ± 1.29$^b$ | 101.50 ± 0.87$^c$ |
| SALP (Serum alkaline Phosphatase) (i.u/1) | 122.50 ± 1.45 | 133.00 ± 1.23 | 125.50 ± 0.29 | 126.00 ± 1.25 | 101.50 ± 0.87 |
| AST (Aspartate amino Transferase)(i.u/1) | 34.00 ± 1.15 | 38.00±0.82 | 33.00 ± 0.60 | 33.00 ± 1.23 | 37.00 ± 0.58 |
| ALT (Alanine amino Transferase) (i.u/1) | 34.00 ± 0.60 | 36.00 ± 1.23 | 39.00 ± 0.58 | 35.00 ± 0.82 | 32.00 ± 1.15 |
| Creatinine (mg/dl) | 1.30 ± 0.06 | 1.18 ± 0.05 | 1.00 ± 0.06 | 0.78 ± 0.05 | 1.15 ± 0.03 |

a,b.c.d. e – means with different superscripts on the same row differ significantly (P<0.05).

It was observed that the total serum protein, albumin and globulin were not significantly different (P<0.05) among treatments. The similarities observed in the values of albumin among treatments could be due to the isonitrogenous nature of the diets. (27) had reported that the albumin level tends to remain constant throughout life after reaching a maximum at about three weeks of age. The observed values were within the normal ranges of 4.80-10g/dl and 1.80-5.60g/dl reported by (28) for serum total protein and albumin respectively. The serum globulin contents of pig across the groups were not influenced by the varying levels of fibrous ingredients included (crude fibre contents). This was in agreement with the findings of (29) who reported that total globulin showed little or no change even when changes were observed with the total proteins.

The mean serum creatinine contents varied non-significantly (P>0.05) among the treatments with the lowest being reflected in treatment 4. (30) reported an average creatinine of 95.0 ± 11.7 umole/litre for growing pigs with a mean weight of 35.4kg. The pigs fed ad-libitum had significantly lower (P<0.01) level of creatinine compared to pigs with restricted diet, this is similar to the result obtained in this study as the pigs in treatment 1 consuming lowest diet had highest creatinine while pigs that had highter dry matter intake in treatments 3 and 4 had low levels of creatinine.

The result of this work showed a non significant variation (P>0.05) in serum urea concentration among treatment groups. This could be as a result of varying quality of protein fed to the pigs on different treatments, despite the fact that they were isonitrogenous. This is in agreement with the finding of (31) who found that the level of blood urea in monogastrics does not remain constant and it is influenced by the quantity and quality and the proximity of the processing meal. However (30) reported increases in serum urea with increasing age. The dietary treatments had significant effect (P<0.05) on the serum cholesterol levels of pigs across the groups. The observed values were in agreement with the normal range of 76-174mg/dl reported by (28). This could probably be as a result of the fact that 10-15% dietary crude fibre limit in swine diets (32) was not exceeded. Although no definite pattern was observed in the levels of ether extract, diet 4 with highest cholesterol levels (155.0 ± 2.04mg/dl) had 1.80% ether extract which was second highest, also diet 3 with highest level of ether extract had lowest level of cholesterol (121.0 ± 1.45mg/dl). This observation could probably be due to the levels of unsaturated fatty acids in ether extract of the diets among treatment groups. This observation is in line with the findings of (33) who found that saturated animal fats in the diet of pigs produced higher serum cholesterol levels than unsaturated fat.

The serum glucose levels recorded in this investigation had no definite pattern. These results showed that diet 2 with highest level of fibre had the second lowest serum glucose content, while diet 1 with lowest fibre content had the 2nd highest serum glucose concentration. This observation is partly in line with the findings of (34) who reported reduction in blood glucose with high fibre diets. The similarity of the values obtained across the group could be adduced to the fact that the fibre in the diets were not higher than the recommended limit of 10-15% dietary crude fibre in diets for pigs reported by (32,35).

It was shown in Table 6 that the dietary treatments had significant effects (P<0.05) on the serum triglyceride (TG) among treatments. Variation in the TG levels could have resulted from the differences in the composition of the plant and animal fats in the diets as reflected in the composition of ether extract, as diet 2 which could probably be due to the similarity in the experimental diets which had no significant effect on the enzyme activities. The highest activity of AST was indicated by diet 4 with 33.00 ± 1.33 i.u/l, while the lowest activities were shown by deits 2 and 3 (38.00 ± 0.82 i.u/l and 38.00 ± 0.06 i.u/l respectively). Also, the highest activity of ALT was observed in diet 5 (32.00 ± 1.15 i.u./1) while the lowest activity of 39.00 ± 0.58 i.u./l was indicated by diet 3. These low levels of AST and ALT observed in this investigation would be indicative of healthy experimental pigs as high levels of the two enzymes could suggest malfunction in the liver and other tissues, thus elevating serum enzymes levels which could have resulted mainly from toxicity (39).

Table 7 shows the performance characteristics of grower pigs fed cassava-based fibrous diets.

Table 7: Performance Characteristics of Grower Pigs Fed Cassava-based Fibrous Diets.

| Parameters | Diet 1 | Diet 2 | Diet 3 | Diet 4 | Diet 5 |
|---|---|---|---|---|---|
| Average initial Live weight(kg) | 16.25 ± 2.70 | 16.00 ± 3.82 | 17.13 ± 2.38 | 17.13 ± 2.25 | 16.12 ± 4.53 |
| Average final liveweight(kg) | 32.50 ± 2.70 | 30.38 ± 6.15 | 33.00 ± 2.79 | 32.13 ± 1.18 | 32.00 ± 6.63 |
| Average total liveweight gain (kg) | 16.25 ± 0.23 | 14.38 ± 2.56 | 15.87 ± 3.10 | 15.00 ± 0.41 | 15.88 ± 2.77 |
| Weekly dry Matter intake (kg) | 22.00 ± 0.99 | 25.63 ± 1.24 | 25.75 ± 1.94 | 24.95 ± 1.76 | 25.30 ± 1.70 |
| Weekly body weight gain(kg) | 8.00 ± 0.55 | 6.92 ± 0.90 | 7.75 ± 1.29 | 7.50 ± 1.14 | 7.92 ± 0.80 |
| Feed conversion ratio | 2.77 ± 0.11 | 3.55 ± 0.24 | 3.35 ± 0.76 | 3.33 ± 0.68 | 3.20 ± 0.80 |
| Daily dry matter Intake (DDM1) (kg) | 3.14 ± 0.17 | 3.52 ± 0.16 | 3.68 ± 0.27 | 3.56 ± 0.25 | 3.62 ± 0.17 |
| Daily weight Gain (DWG)(kg) | 1.14 ± 0.07 | 099 ± 0.05 | 1.10 ± 0.05 | 1.07 ± 0.16 | 1.13 ± 0.12 |
| Daily protein intake (DPI)(kg) | 0.63 ± 0.03 | 0.71 ± 0.05 | 0.74 ± 0.06 | 0.71 ± 0.03 | 0.72 ± 0.05 |
| Protein efficiency ratio | 1.80 ± 0.06 | 1.37 ± 0.10 | 1.42 ± 0.19 | 1.45 ± 0.13 | 1.53 ± 0.09 |

No significant differences were obtained among (P>0.05)

The average daily weight gain per treatment was found to be highest and lowest in treatments 1 and 2 with 1.14 ± 0.07 and 0.99 ± 0.05kg respectively. Feed conversion also followed the same trend with the lowest value being obtained in diet 1 (control and maize-based), next to it was diet 5, which had the best performance among the test diets (cassava based fibrous diets). The superior performance of growing pigs on this diet can be explained on the attributes of the diets which contained cassava peel and palm kernel cake at 10% levels of inclusion for these ingredients. Use of cassava flour in pig diets had been reported to increase the dustiness of such feeds (40). However, addition of additives such as molasses or palm oil reduces such dustiness. Palm kernel cake contains varying amounts of oil. Indeed in an earlier survey, (41) showed that the ether extract level of palm kernel cake obtained from different processing sites in Ibadan ranged from 5.20-8.10%.

On Table 8 are shown the economies of production of grower pigs fed cassava-based fibrous diets. The cost of feed consumed per day varied among treatments, but this variation was not significantly different among treatments. The highest cost of feed consumed per day was observed in diet 1, the maize-based diet to be ₦43.95 ± 2.71, while the lowest cost of feed consumed per day was recorded in diet 5 with ₦37.31 ± 3.24. This could be attributed to the replacement of more expensive maize (₦22.00/kg) with the relatively cheap cassava flour and maize offal costing ₦5.00/kg and ₦8.00/kg respectively. Maize offal was reported to be a cheaper energy source (42,43,44). Although differences were observed in projected revenue, total cost of feed consumed and projected profit among treatments, these differences were not statistically significant. This could probably be due to the fact that the experimental treatments are not sensitive enough to reveal significant differences among treatments.

The highest projected profit in Naira was recorded for diet 5 while the lowest was observed in treatment 2.

**Table 8: Economies of Production of Grower Pigs Fed Cassava-based Fibrous Diets.**

| Parameters(%) | Diets | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Feed cost/kg Diet (₦) | 13.92 | 10.34 | 10.17 | 10.02 | 9.87 |
| Cost of feed Consumed/day (₦) | 43.95±271 | 38.49±3.35 | 39.45±3.75 | 38.01±3.45 | 37.31±3.24 |
| Cost of feed/kg live Weight gain (₦) | 38.28±2.08 | 36.70±3.01 | 33.69±5.27 | 33.36±2.69 | 31.51±2.73 |
| Projected revenue at N70.00/kg (₦) | 4480.00±261.92 | 3875.15±552.50 | 4340.00±272.61 | 4200.00±318.22 | 426.80±229.80 |
| Total cost of feed Consumes (₦) | 2449.92±149.23 | 2037.15±201.05 | 2095.02±209.50 | 2000.04210.26 | 994.94±193.50 |
| Projected profit(₦) | 2030.08±11269 | 1838.00±351.45 | 2244.98±63.11 | 2199.96±107.96 | 2431.86±35.98 |

**Conclusions and Applications**

(1) From the results of this study, similar growth patterns were observed among treatments and despite significant differences observed in some parameters measured under nutrient utilization and serum biochemistry, it can therefore be concluded that cassava-based fibrous diets can economically replace maize-based diet in the production of grower pigs.

**References**

1. Tewe, O.O. (1997). Sustainability and development: Paradigms from Nigerian's livestock industry. University Inaugural lectures delivered on 9th October 1997 on behalf of the Faculty of Agriculture and Forestry, University of Ibadan.

2. Maner, J.H. (1972). Implications of Cyanide toxicity in rations. Pp 113-120. In: Chronic cassava toxicity, Proceedings of an interdisciplinary workshop, London, England, 29th - 30th Jan. 1973.

3. Thompson, F.W. (1946). The use of cassava in the feeding of pigs on Achimota College Farm, and Forest, (2): 84.

4. Tewe, O.O. and B. Pessu (1982). Performance and nutrients utilisation in growing pigs fed on cassava peel rations containing different cyanide levels. Nutr. Reports International, 20(1): 50-58.

5. Tewe, O.O. and O.L. Oke (1983). Performance, carcass characteristics and economy of production of growing pigs on varying cassava peel levels. Nutr. Reports International, 29(2): 235-243.

6. Church, J.P., J.T. Judd, E.W. Young, J.L. Kebay and W.W. Kin (1984). Relationship among dietary constituents and specific serum clinic components of subjects eating self selected diets. Amer. J. Clin. Nutr. 40, 1338-1344.

7. Kerr, G.R., E.S. Lee, M.K.M. Lan, R.J. Lorimar and E. Raudal (1982). Relationship between dietary and biochemical measures of nutritional status. Amer. J. Clin Nutr., 35:294-308.

8. Babatunde, G.M., W.O. Pond, L. Krook, L. Dvanvleek, E.F. Walker and P. Chapman (1987). Effect of dietary safflower oil or hydrogenated coconut oil on growth rate and on blood and tissue components of pigs fed on fat free diets. Journal of Nutrition, 92193 - 201.

9. Olorede, B.R., O.P. Ajagbonna and G,M. Babatunde, (1997). Comparison of air-dried and oven-dried poultry dropping in broiler and oven-dried poultry dropping in broiler rations. Effects on performance and heamatological parameters. Int. J. Anim. Sci., 10:289 - 293.

10. Association of Official Analytical Chemistry (1990). Official Methods of Analysis 15th Edition Washington.

11. Vansoest, P.J. and R.H. Wine (1967). Use of detergents in the analysis of fibrous feeds. IV. The determination of plant cell wall constituents, J. Assn. Official anal chem., 51: 780.

12. Toro, G. and G.P. Ackerman (19750. Practical clinical cemistry, Little Brown and Company, Boston, Massachusetts.

13. Kaneko, J.J. (1989). Clinical biochemistry of domestic animal. 4th edition, Academic Press Inc. N.York.

14. Gottfried, P. and B. Roseberg (1973). Improved manual spectrophotometric procedure for determination of serum protein. Clin. Chem., 19:1077 - 1078.

15. Levy, A.L. (1972). Triglyceride by Nonane Extraction and colorimetric manual. Amer. Clin. Lab. Sci., 6:472 - 482.

16. King, E.J. and A.R. Armstrong (1934). A convenient method of determining serum and bile phosphatase activity. Can. Med. Assoc. J., 31:376 - 381.

17. Reitman, S. and S. Frankel, (19570). A colorimetric method for determination of SGOT and SGPT. Amer. J. Clin. Path., 28: 56 - 62.

18. SPSS (1988) Statistical package for social scientists, SPSS Inc. Chicago, Il.

19. Steel, R.G.D. and J.H. Torrie (1980). Principles and procedures of statistics. A biochemical approach. 2nd ed. MC. Graw - Hall Book Company.

20. Sewar, G. and A. Paquet (1989). Availability of amino acid in some petide and derivatives present in dietary proteins. In: Absorption and utilisation of amino acids, Friedman, M. Ed. C.R.C. Boca Raton, F.L. 1989 Vol. 11, Pp. 147 - 154.

21. Eastwood, M.A. and R. Passmore (1983). Dietary fibre. Lancet, 23 (2), 202 - 206.

22. Potter, L.M., L.D. Matterson, A.W. Arnold, W.J. Pudekwioicz and E.P. Singson (1960). Studies in evaluating energy content of feds for chicks. Poult. Sci., 51: 960 -967.

23. Sosulki, F.M. and A.M. Cadden, (1982). Composition and physiological properties of several sources of dietary fibre. J. Fd. Sci., 47: 1472 -1476.

24. Cunnigham, H.M., D.W. Friend and J.W.G. Nicholson (1962). The effect of age, body weight, feed intake and adaptability of pigs

on the digestibility and nutritive value of cellulose. Can. J. Amin. Sci., 42: 167 - 175.

25. Myer, R.O., P.R. Cheeke and W.H. Kennick, (1975). Utilisation of alfalfa protein concentrate by swine, J. Amin. Sci., 40:885.

26. Zivkovic, S. and J. P. Bowland (1970). Influence of substituting higher fibre ingredients for corn on the digestibility of diets and performance of sows and litters. Can. J. Anim. Sci., 50: 177 - 184.

27. Miller, E.C., D.E. Ullrey. I. Pikerman, D.A. Schmidt, J.a. Hoefer and R. W. Luecke, (1961). Swine haematology from birth to maturity. Serum proteins. J. Anim. Sci., 20: 31 - 35.

28. Mitruka, B.M. and H.M. Rawnsley (1977). Clinical biochemical and haematological reference values in normal experimental animals. Massom, N.Y.

29. Allison, J.B. (1955). Biological evaluation of proteins. Physical. Rev., 35: 664 - 669.

30. Doornenbal, H.A., K.W. Tong and A.P. Sather (1983). Studies on the performance, development and carcass composition of growing pigs, effects of sex, feeding regime and age on blood serum parameters. Can. J. Anim. Sci., 63: 977 - 984.

31. Wilson, G.D.A., D.G. Harvery and C.R. Snook (1972). A review of factors affecting blood biochemistry in the pig. Br. Vet. J., 128: 596 - 609.

32. Braude, R. (1967). The effect of changes in feeding patterns on the performance of pigs Proc. Nutr. Soc., 26:163.

33. Barnes, R. H. E. Kwong,. W. Pond, R. Lowry and J.K. Loosli (1959b). Dietary fat and protein and serum chelesterol. II Young Swine, J. of Nutrition, 69: 269.

34. Dodson, P.M., J Stocks, J. Holdsworth and D.J. Galton (1981). The growth promoting action of cellulose in purified diets for chicks. J. Nutr., 34: 295 - 300.

35. National Research Council (1988). Nutrient requirements of swine. 9th reviewed National Acad. Press, Washington, D.C.

36. Lowenstein, F.W. (1964). Epidemiological investigations in relation to diet in-groups who show little arteriosclerosis and almost free of coronary ischaemic heart disease. Amer..J. Clin. Nutr., 15: 175.

37. Foot, M., T.F. Cruzi, and M.T. Clandiwin (1982). Influence of dietary fat on the lipid composition of rat brain synaptosomal and microsomal membranes. Biochem. J., 208 (3):631 - 640.

38. Baetz, A.L. (1971). Blood constituents change in fasted swine. Am. J. Vet. Res., 32: 1491 - 1500.

39. Adeleye, A.A. (1992). Physiological responses of pigs fed. Graded levels of cassava (*Mahihot esculenta crantz*) peel in maize-based diet. Ph.D. Thesis. Department of Animal Science, University of Ibadan, Ibadan.

40. Tewe, O.O. (1992). Detoxification of Cassava products and effect of residual toxins on consuming animals. In: Roots, Tubers, plantains and Bananas in livestock feed. Proceedings of the FAO Expert consultation held in CIAT. Cali, Colombia, South America, 21 - 25 January, 1991: Pp 81 - 98.

41. Tewe, O.O., K.A. Arowora, T.O. Fasesin and R.O. Lamina (1999). Carbohydrate constituents of cassava peel clones and their utilisation in pig grower rations. Trop. Anim. Prod. Inves., 2: 29 - 34.

42. Ter-Meulen, U. and E.A. El-Harith (1985). Feeding farm animals on unused resources in the tropics and subtropics. Anim. Res. Dev., 22: 166 - 127.

43. Longe, O.G. and Faghenro - Byron, J.O. (1990). Composition, physical characteristics of some fibrous wastes and by-products for pigs feeds in Nigeria, Bietr. Trop. Landwirtsch, Vet. Med., 28 (2): 199 - 205.

44. Ande, K.O. (1992). Density and water holding capacity of diets containing graded levels of palm kernel meal and corn offal and dressing characteristics and gut dimensions of broilers fed these diets. M.Sc. Thesis, Department of Animal Science, University of Ibadan, Ibadan.