Nutritional Assessment of Graded Levels of Fermented Mixtures of Cassava Peels and Palm Kernel Cake on Growth Weight, Haemoglobin Content, Serum Biochemistry, Economic and the Carcass Evaluation of Pigs

R. P. Obongekpe
Department of Animal Science, University of Uyo, Uyo, NIGERIA

Corresponding Author: obongekperichard2@gmail.com

ABSTRACT
The effect of feeding graded amounts of fermented mixtures of cassava peels and palm kernel cake on pig output was explored in this research. The experiment was performed at the Teaching and Research Farm Swine Unit, Uyo University, Uyo, Akwa Ibom County. Cassava root pulp and palm kernel cake were combined in a 3:1 ratio and allowed to ferment for six days in an air-tight environment, after which they were sundried. The commodity is known as the FCP blend. A total of 40 big white breeder pigs were used for the research. Based on average initial weights (20-25 kg), the pigs were divided into 5 groups and each group of rising pigs was assigned to each of the five treatment diets using a fully randomised system (CRD). 2 replicates of 4 pigs (2 male and 2 female) were found in each treatment group. These pigs were fed twice a day and adlibitum was provided in water. The treatment diets were based on the following formulations of cassava peels / PKC at 0, 25, 50, 75 and 100% maize substitution in the control diet. The 50:50 ratio of cassava peels and palm kernel cake was extracted from a manual scale equivalent weight (kg) of the two test ingredients percentage in the diet, both diets were formulated as iso-nitrogenic and iso-caloric. At all stages, weekly feed intake, weight changes, serum / haematology reaction and economic assessment were reported during the feeding trial, while weight gain, feed conversion ratio and protein efficiency ratio were measured to determine the weaner pig’s results. Two pigs were slaughtered at the end of the trial to measure the internal organs such as core, abdominal fat, spleen etc and analyse the performance of the carcass. The findings of the study indicate substantial (p<0.05) variations in the performance characteristics of weaner pigs, while animals on a 25% diet offered the highest in final weight gain, feed conversion ratio and protein production efficiency relative to other diets ratio (25.67kg, 2.06 and 2.52) respectively. The dietary inclusion of cassava peels / PKC diets in weaner pigs as an alternate source of energy or protein rich foods, increasing attention has been centered on home-grown under-exploited crops whose product and by-products contain comparatively high amounts of energy or macromolecule that may be accustomed improve the diets of overwhelming majority of world. Africa is currently riddled with food crisis, owing to partly unprecedented increase in human population and startling decline in per capital food production in the last decades. Our inability to produce more food to feed ourselves and reduce the rising food prices on the market has aggravated. The degree of poverty among Nigerians, reflected in the decline in the quality and quantity of their animal protein intake. Nigeria has a wide range of sources of animal protein; 19 million animals, 72.5 million goats, 41.3 million cattle, 7.1 million pigs, 145 million chickens, 11.6 million ducks, 2.1 million turkeys, donkeys, etc. (FMARD, 2011, Oboh, 2016). According to Egbunike (1997 as quoted in Oboh, Moseri & Okosun, 2018), Nigeria remains the least source of animal protein relative to North America, Western and Eastern Europe with 66, 53 and 39 grammes of animal protein consumption per day. In addition, Acholonu (1996 as cited in Oboh, Moseri & Okosun, 2018) recorded consumption of meat per caput of poultry in the USA, Malaysia, Brazil, South Africa, Indonesia, China and Nigeria as 38, 22, 19, 18, 4.8, 4.8 and 2.2g respectively. The FAO (2004) recorded a higher pigmeat production of 63.9 million metric tonnes per year than the total meat production from beef, horses, sheep and goats of 58.9 million metric tonnes per year. Nigeria was not able to fulfill the demand for animal protein in adequate amounts for its population (Ibe, 2004). Tewe (1997 as cited in Oboh, Moseri & Okosun, 2018) indicated that the average daily intake of animal
protein in Nigeria is 4.82 g per head compared to 35 g recommended for proper development, fertility, lactation, health and survival, while Ibe (2004) added that many Nigerians eat less than 10 g of animal protein daily compared to the minimum of 28 g / caput / day considered compatible with a healthy diet. Moreso, FAO (2004) reported that about 89.5 g of protein is necessary for the proper functioning of the body on a daily basis, of which 34 g is derived from animals. It is worth remembering that the intake of meat is also an indicator of a nation or individual's economic position (Ososanya, 2004).

However, insufficient supplies of feed at reasonable rates are the key factor hindering the rapid expansion of piggery production in Nigeria (Ugwu, Onyimonyi & Ozonoh, 2008). Feed is the most costly input in the output of piggery since it accounts for around 70-80 percent of the variable production expense in reared stocks (Omeje, Marere & Isikwenu, 1999, Ijaiya & Davis, 2005). In the feed sector, the expense of grains has contributed to the quest for renewable energy feed sources (Onyimonyi & Onukwufor, 2003). Unfortunately, many of these non-conventional feed services tend to be lacking or have substituted only minimal amounts of maize and other grains (Udedibie, Anyaegbu, Onwuchekwa & Egbuokporo2004, Esonu, Emenalom, Udedibie, Anyanwu, Madu & Inyang, 2005). In the feed sector, the expense of grains has contributed to the quest for renewable energy feed sources (Onyimonyi & Onukwufor, 2003). Unfortunately, many of these non-conventional feed services tend to be lacking or have substituted only minimal amounts of maize and other grains (Udedibie, Anyaegbu, Onwuchekwa & Egbuokporo2004, Esonu, Emenalom, Udedibie, Anyanwu, Madu & Inyang, 2005).

Swine production is a growing industry in Nigeria, but because of the high cost and unreliable supply of traditional energy and protein supplies, the high cost of feeding has been the main constraint. This may be supply of traditional energy and protein supplies, the high cost and unreliable supply of traditional energy and protein supplies, the high cost of feeding has been the main constraint. This may be due to competition for some food and feed ingredients used for livestock feeding in ration formulations (Zahari et al., 2006). PKC can be commonly enriched with a lack of protein and essential fatty acids that distinguish cassava from other grains. PKC can be commonly enriched with a lack of protein and essential fatty acids that distinguish cassava from other grains.

Cassava (Manihot esculenta) is a wet tropical all-season crop and ranks among the world's top ten food crops (Oyebeim, Fanimo, Oduguwu & Biobaku, 2006). Among staple crops, it is the main provider of carbohydrates (FAO, 1995). Nigeria's total annual production in 2002 was 34 million tonnes (FAO, 2002). There is 30 to 40 percent dry matter in cassava stems, greater than other roots and tubers. This depends on variables such as variety, form of soil, moisture, climatic conditions, and harvest root age. Starch and sugar are the primary dry matter elements, about 90% of which is starch (FAO, 2002). Cassava is a high yielding tropical root crop, thrives well under comparatively low fertility in the soil, and persists in large climatic variations. Waste / root meal cassava flour is another agro-industrial by-product which could be utilised as animal feed. However, it is noteworthy that Nigeria is the world's leading cassava producer (Orunmuyi, Bawa, Adeyinka, Daudu & Adeyinka, 2006) and its availability in Nigeria is non-seasonal. The suitability of cassava for pig feeding and the capacity of cassava meal as a maize feed replacement for all groups of pigs were previously verified by several researchers (Adesehinwa, 2008; Adesehinwa, Dafwang, Ogumnodede, & Tegbe, 1998). However, some steps need to be taken to ensure that animals work on cassava meal diets satisfactorily. This include the removal of cyanide by boiling, drying, grating, soaking, fermenting or combining this processes to produce final products containing not more than 100 ppm HCN and the prevention of microbial development, especially in humid environments, during sun-drying (Tewe & Egbunike, 1988). It has been shown that high levels of cyanide and the involvement of microorganisms reduce efficiency and cause haematological changes in rising pigs fed sun-dried cassava dependent rations (Tewe, 2006). Cassava meal is the powdered residue of the chips and roots to remove edible starch after processing. Chips, pellets and split roots with lower starch content are typically of poor consistency (Tewe, 2006). PKC can be commonly enriched with a lack of protein and essential fatty acids that distinguish cassava flour. A mixture of PKC and CFW with a ratio of 1:1 or 2:1 is being experimented as a substitute for maize, the traditional source of oil, in an effort to satisfy the need for small-scale farmers who produce their own feedstuff.

Palm kernel cake (PKC) has been reported to be a high-energy and cost-effective feed portion that can be used for livestock feeding in ration formulations (Zahari & Alimon, 2006; Adesehinwa, 2007). It is plentiful in the world's tropical regions, and due to its abundance and low cost it is an excellent feed ingredient for animal production (Orunmuyi et al., 2006). Proximate research has shown that it can be categorised as energy feed, with the chemical portion being very close to that of corn gluten or rice bran (Alimon, 2006; Adesehinwa, 2007). As a by-product of the palm oil industry, the oil content may lower the feed value, but PKC has shown that its caloric content is high, and therefore desirable for non-ruminants. The shell quality, which can reach up to 10 percent, contributes significantly to its high content of crude fibres (Alimon, 2006). Analysis has shown that...
more than 60% of PKC, consisting of 58% of mannan, 12% of cellulose and 4% of xylan, is a cell wall part (Jaafar & Javis, 1992; Adesehinwa, 2007). However, pigs are known to have large caecum, so the fibre in PKC could be digested to a considerable extent. For pigs the reported metabolizable energy (ME) of 10-10.5 MJ kg-1 is higher than for poultry (6.5-7.5 MJ kg-1) (Alimon, 2006). The 20-25 percent inclusion rate was successfully used for growing-finishing pigs in Malaysia (Zahari & Alimon, 2006), while the 25-35 percent inclusion rate was recorded in Ghana for the same pig class (Rhule, 1996 as cited in Adesehinwa, 2007). However, if the inclusion rate is greater than 30 percent, intake may be decreased. For most ruminants, the crude fibre content of most PKC samples, 16-18 percent, is appropriate, but considered strong for nonruminants. Hence the reason it was deemed unacceptable if it was used in poultry or pig diets at high levels (Alimon, 2006; Adesehinwa et al., 2008) Therefore improving PKC's nutritional value for monogastric animals can require supplementation with a more digestible ingredient, such as cassava flour or meal. The purpose of this study is therefore to determine the impact on growth, feed conversion, serum biochemistry, immunological response, carcass and economic evaluation of the cassava peel supplemented with palm kernel cake diet of growing pigs.

II. METHODS AND MATERIALS

3.1. Site of study

The experiment was conducted at the Swine unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State. Nigeria. The university runs a multi-campus system which include; main campus, town campus, annex campus and college of health sciences campus. It has both male and female hostels located inside the campuses. Uyo is the capital of Akwa Ibom state. The town became the state capital following the creation of the state on September 23, 1987 from the then erstwhile cross river state. Uyo serves a dual purpose of being the state capital and local government headquarters and shares common boundaries with Itu, Uruan, Ibekikpo Asutan, Abak and Etinan local government areas. The core language of Uyo people is Ibibio. They are predominantly Christians with some fraction of traditional worshipers.

According to 2006 Nigeria census which comprised of Uyo and Itu is 427873, while the urban area like Uruan has a population of 554,906 people. The state is located in the south-south geopolitical zone of the country, lying between latitude 4°32°1 and 5°33°1 north and longitude 70°25°1 and 80 east. The state is bounded on the east with Cross River state, west with Rivers state and Abia state and on the South with Atlantic Ocean. The state has 31 local government areas and a population of 5 million people leaving in the state.

3.2 Collection and preparation of test ingredients

In the Uyo Local Government Area of Akwa Ibom District, Cassava was purchased from the Urua Akpan Anem local market. The cake from the palm kernel was procured from an allied dealer with Agro. The cassava tubers were washed and rubbed with a traditional cassava grating machine which was made locally. The resulting pulp was blended with a 3:1 (w / w) ratio of the palm kernel cake and thoroughly mixed manually to produce a homogeneous mass. In order to avoid gaseous movement in / out of the jar, the mixture was placed into plastic drums (50 litres of capacity) and securely closed. The weight was permitted to ferment for 6 days. The jar was opened on the 7th day and the contents were spread thinly (1 cm thick) on a polythene mat and allowed to diversify into a dry friable mass. This took up to 3 days at most. The dried samples were then processed for diet formulation in plastic containers until appropriate. Within 21 days of sun drying all dried fermented samples were used.

3.3 Experimental diets

Five diets were multiplied such that as the primary energy source, diet 1 (control) included maize. The dried fermented mixture of cassava root pulp and palm kernel cake (FCP mix) was used in diets 2, 3, 4 and 5 to substitute maize by 0%, 25%, 50%, 75% and 100 % respectively. Soybean meal proportions have also been modified to reach a reasonably 25 is oprotein diets. The Tables 3.1 and 3.2 below show the compositions of the experimental rations.

3.4 Experimental Animals

A total of 40 large white grower pigs were used for the research. The pigs were divided into 5 groups based on average initial weights (20-25 kg) and each group of rising pigs was assigned in a totally randomised design (CRD) to one of the five treatment diets. 2 replicates of 4 pigs (2 male and 2 female) were found in each treatment group. These pigs were fed twice daily and water supplied adlibitum. These pigs were fed twice a day and adlibitum was provided in water. The treatment diets were based on the following formulations of cassava peels / PKC at 0, 25, 50, 75 and 100% maize substitution in the control diet. The 50:50 ratios of cassava peels and palm kernel cake was extracted from a manual scale equivalent weight (kg) of the two test ingredients percentage in the diet, both diets were formulated as iso-nitrogenic and iso-caloric.

3.5 Statistical analysis

Both results from the experiment is analysed using a fully randomised design (CRD) variance test analysis. As defined by Hoshmand (1993), substantially different meanings were differentiated using the least sense difference test.
III. RESULT AND DISCUSSION

Table 1: Composition of Experimental Diet for Weaners Pig

| Ingredients          | 0      | 25%   | 50%   | 75%   | 100%  |
|----------------------|--------|-------|-------|-------|-------|
| Maize                | 55.00  | 41.25 | 27.50 | 13.75 | -     |
| Cassava peels / PKC  | -      | 13.75 | 27.50 | 41.25 | 55.00 |
| Ground Nut Cake      | 25.60  | 26.78 | 27.92 | 29.06 | 30.21 |
| Wheat Offal          | 14.10  | 12.72 | 11.51 | 10.26 | 9.02  |
| Bone Meal            | 1.50   | 1.50  | 1.50  | 1.50  | 1.50  |
| Limestone            | 2.00   | 2.00  | 2.00  | 2.00  | 2.00  |
| Palm Oil             | 1.00   | 2.00  | 2.20  | 2.40  | 2.60  |
| Weaner Premix*       | 0.25   | 0.25  | 0.25  | 0.25  | 0.25  |
| Salt                 | 0.35   | 0.35  | 0.35  | 0.35  | 0.35  |
| Ronozyme**           | 0.20   | 0.20  | 0.20  | 0.20  | 0.20  |
| Total                | 100.00 | 100.00| 100.00| 100.00| 100.00|

Calculated Analysis:
- Crude Protein (%): 19.00
- ME (Kcal/Kg): 2878
- Fibre (%): 5.35
- Ash (%): 5.94
- Calcium (%): 0.80
- Starch (%): 39.20
- Fat (%): 6.48

*Grower Premix given the following diets per kg: Vit A 10,000,000 IU; Vit D32,000,000 IU; Vit E 8,000 IU; Vit K 2,000 mg; Vit B12,000 mg; Vit B25,500 mg; Biotin 30 mg; Folic Acid 600 mg; Niacin 10,000 mg; Pantothenic Acid 7,000 mg; Choline Chloride 500,000 mg; Vit B12 12 mg; Biotin 30 mg; Folic Acid 600 mg; Vit C 10,000 mg; Iron 60,000 mg; Mn 80,000 mg; Cu 8,000 mg; Zn 50,000 mg; Iodine 2,000 mg; PKC-Palm Kernel Cake, GNC = Groundnut cake, C.P. Cobal 450 mg; Selenium 100 mg; Mg 100,000 mg; Non Oxidant 6,000 mg; = Crude protein, ME = Energy metabolizable.

** Ronozyme Stock composition: sodium sulphate (52.7%), calcium carbonate (15%), kaolin (9%), dextrin and sucrose (8%), cellulose (6%) and vegetable oil (7%) Volume density 1.100 kg / m3. The product’s particle size distribution shows that 98 per cent of the particles are in diameter between 150 and 1,200 μm, and fewer than 1 per cent of the particles are below 150 μm.

Table 2: Performance characteristics of weaner pigs fed experimental diet

| Levels of inclusion (%) | 0     | 25   | 50   | 75   | 100  |
|-------------------------|-------|------|------|------|------|
| Parameters              | 1     | 2    | 3    | 4    | 5    | SEM (±) |
| Ave. initial weight(kg) | 9.32  | 8.88 | 9.00 | 9.00 | 9.00 |       |
| Ave. final weight(kg)   | 23.84 | 25.67| 22.00| 21.50| 20.84| 0.46   |
| Ave. total weight gain(kg) | 14.52 | 16.79| 13.00| 12.50| 11.84| 0.44   |
| Ave. weekly weight gain(kg) | 2.07 | 2.40 | 1.86 | 1.78 | 1.69 | 0.64   |
| Feed intake(kg)         | 35.00 | 35.00| 35.00| 35.00| 35.00| 0.01   |
| Feed conversion ratio   | 2.41  | 2.06 | 2.69 | 2.80 | 2.96 | 0.68   |
| Protein efficiency ratio| 2.18  | 2.52 | 1.95 | 1.88 | 1.78 | 0.08   |
| Mortality (%)           | -     | -    | -    | -    | -    |        |

a, b, c, d, e means along the same row with different superscripts are significantly (p< 0.05) different from each at her, Ave: Average, SEM: Standard error of mean.

Initial live weight of weaner pigs ranged from 8.88 kg to 9.32 kg, average final weight gain of weaner pigs collected in Table 2 showed that experimental animals (P<0.05) were greatly influenced by experimental diets. Animal fed 25 per cent inclusion of cassava peels / PKC meal gave the maximum final weight (25.67 kg), followed by control (23.84 kg), and while values obtained for experimental diets of 50, 75 and 100 per cent decreased with increased replacement levels of cassava peels / PKC meal. Related substantial variations (P<0.05) were, however, observed in the average overall weight gain and weekly weaner pig weight gain fed experimental diets ranging from 25(2.40) to 100 percent.
In the weaner process, feed intake levels were not greatly impacted; outcomes over the classes were the same. The conversion ratio of feed in laboratory animals varied greatly (P<0.05), whereas the 25% (2.06) diet of animals was the highest in contrast with other diets with equivalent amounts of 0(2.41), 50(2.69), 75(2.80) and 100% (2.96), respectively. Weaner pigs’ protein quality ratio was dramatically (P<0.05) affected by experimental diets, the highest benefit was reported in 25% (2.52) diets, followed by tests (2.18), 50(1.95), 75(1.88) and 100% (1.78). No mortality has occurred during this feeding trial process.

The effect of feeding cassava peels / PKC meal on production characteristics such as average final weight, average overall weight gain, average weekly weight gain, feed conversion ratio and protein quality observed a steady drop in values as the levels of cassava peels / PKC increased and this drop was crucial at 100 percent for full maize replacement with cassava peels / PKC. The study, however, agrees with Igene (2006), who found that the use of cassava in feeding pigs at levels greater than 50 percent typically resulted in a decrease in the efficiency of both live weight and feed conversion. Amare fuel et al. (2006) and Ekenyem (2007) have also indicated that the addition of cassava peels above 60% would also have a detrimental influence on the efficiency of weaner pigs. With increased levels of cassava peels / PKC in the diets, the reduced average weekly body weight gain is due to the ability of cassava peels / PKC in pig diets to lower the amount of fat stored in the tissues. The decrease in average weekly body weight gain with higher levels of cassava peels / PKC in the diets is due to the ability of cassava peels / PKC in pig diets to decrease the amount of fat. The bad results found in the diet with high cassava peels / PKC are also related to the cassava peels / PKC meal processing techniques, which are in line with Ubalua (2007). They recorded that when large amounts of cassava peels are fed to certain animals due to the presence of cyanogenic potential and high variable fibre content in cassava peels, digestive disturbance was frequently found, which increased the osmosis pressure in the gastrointestinal tract and subsequently induced digestive disturbance. This condition might result in decreased intake of feed with increased levels of cassava peels / PKC in diets due to high dehydration and increased weaner salivation, resulting in decreased body weight. The dustiness of the cassava peels / PKC ration has also led to a decline in the intake of feed due to nasal dysfunction caused by elevated levels of cassava peels in the diet. Therefore, due to its fibrous nature, the greater inclusion of a by-product in monogastric feeding or in the formulation of diets with cassava peels as the primary source of energy is reduced. With increased levels of cassava peels/PKC in the diet, feed quality was found to improve, suggesting a decreased quality of the weaner pigs’ use of cassava peels/PKC diet in this study. This is in line with Bimrew's (2014) work which showed that early weaned pigs have restricted amylase, protease, lipase function, and enhancing the level of nutrient digestion would boost efficiency and reduce the incidence of diarrhoea resulting from undigested nutrients hitting the bacteria-fermented gut.

**Table 3: Economics and efficiency of weaner pigs fed experimental diets**

| Levels of inclusion (%) | 0  | 25 | 50 | 75 | 100 |
|-------------------------|----|----|----|----|-----|
| Parameters              | 1  | 2  | 3  | 4  | 5   |
| Ave. initial wght/pig (kg) | 9.32 | 8.88 | 9.00 | 9.00 | 9.00 |
| Ave. final wght/pig (kg) | 23.84 | 25.67 | 22.00 | 21.50 | 20.84 |
| Ave. total wght gain/pig (kg) | 14.52 | 16.79 | 13.00 | 12.50 | 11.84 |
| Feed cost (₦/kg)        | 99.91 | 90.90 | 79.86 | 66.44 | 56.50 |
| Total feed consumed/pig (kg) | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total cost of feed/pig (₦) live wght gain | 3496.75 | 3181.50 | 2795.40 | 2325.40 | 1977.50 |
| Revenue/total live wght gain/pig (₦) | 4646.40 | 5372.80 | 4160.00 | 4000.00 | 3788.80 |
| Gross profit/pig (₦)    | 1149.55 | 2191.30 | 1364.60 | 1674.90 | 1811.30 |

Ave: Average.

Table 3 demonstrates the economies and performance of the experimental diets. In diets containing maize, feed costs (₦ / kg) were higher, followed by diets 2, 3, 4 and 5 with corresponding amounts, respectively, of N99.91, N 90.90, N79.86, N66.40 and N56.50. N3496.75, N3181.50, N2795.40, N2325.40 and N1977.50 is the average cost of feed per weight gain per pig for diet 1, 2, 3, 4 and 5. Figures show that the diet focused on maize was the largest, followed in that order by diet 2, 3, 4 and 5. This may be traceable to high maize prices as a key energy source in the diet. Revenue / total live weight gain / pig (₦) ranged from diet 2 N5372.80 to diet 5 N3788.80. The highest income was achieved in diet 2 with 25 percent inclusion of experimental diet as the alternate source of energy, even on gross benefit / pig (₦), the highest generated by pigs in diet 2 and the highest profit was N2191.30, N1811.30, N1674.90, N1364.60 and N1149.55 for diet 2, 5, 4, 3 and 1 respectively.
The economy and productivity of weaner pigs fed experimental diets measured by feed cost (N / kg), overall feed cost consumed (N / kg), and feed cost per pig(kg) decreased as the amounts of inclusion of cassava peels / PKC meal increased in diets. Profit / pig (N) found that the most cost-effective diet for the development of weaner pigs was 25 percent. The feed cost / kg was less than 100% (N56.50) and the best (N99.91) in dietary management. Similarly, the average cost of feed eaten per pig was lower (N1977.50) in the 100% cassava peels / PKC diet and higher in the diet focused on maize (N3496.75), owing to the high cost of maize during the experimental study. This is in line with earlier studies by Balogun et al. (1997), Irekhore et al. (2006) and Adesehinwa et al. (2011) that cassava peels inserted in piglet diets up to 30% had no impact on growth rate and in pigs over 35 kg weight, that maize substitute in young pig diets was seen to be cost-effective by feeding up to 57% inclusion. Low feed cost / kg live weight gain in pig diets was seen to be cost-effective by feeding up to 35% maize substitutes in young piglet diets up to 30% had no impact on growth rate and in pigs over 35 kg weight, that maize substitute in young pig diets was seen to be cost-effective by feeding up to 57% inclusion. Low feed cost / kg live weight gain in pigs observed in a 25% diet converted into higher income and benefit. Thus, the most successful and cost-effective diet was 25 per cent. The benefit derived from a 25% diet was about double that of maize. The fact that other alternatives at 50, 75 and 100 percent are more profitable than a diet focused on maize is also of concern.

In a weaner pig’s diet, Oboh (2016) stated that substitution of cassava peel for maize up to 50 percent level resulted in higher revenue and benefit. Oboh et al. (2014) also confirmed, however, that substitution of whole maize with dried yeast mixture of maize offal with brewers up to 50 percent level resulted in higher benefit. Damisa and others (2009) further emphasised that the inclusion of cassava peels meals up to 38 percent with 5-4 percent palm oil yielded a greater economic result than other peel and palm oil combinations. This research reported that the most cost-effective ingredients for ration formulation in weaners are cassava peels / PKC meal at 25 percent as an energy source. The study's outcome is consistent with previous authors' findings and has justified the need for persistent exploration for alternate feed ingredients.

Table 4: Percentage carcass and organ weights of the experimental pigs

| Parameters               | 0     | 25    | 50    | 75    | 100   | SEM (±) |
|--------------------------|-------|-------|-------|-------|-------|---------|
| Slaughter weight (kg)    | 87.71 | 87.14 | 86.84 | 86.78 | 86.66 | 0.32    |
| cold weight(kg)          | 86.12 | 85.13 | 86.84 | 86.78 | 86.66 | 1.55    |
| Dressing weight (kg)     | 74.87 | 72.46 | 71.37 | 71.16 | 72.85 | 0.45    |
| Internal Organs (%)      |       |       |       |       |       |         |
| Kidney                   | 0.30  | 0.30  | 0.39  | 0.35  | 0.30  | 0.03    |
| Liver                    | 2.04  | 2.29  | 2.69  | 2.39  | 1.23  | 0.10    |
| Heart                    | 0.29  | 0.48  | 0.46  | 0.41  | 0.41  | 0.10    |
| Spleen                   | 0.21  | 0.30  | 0.32  | 0.33  | 0.35  | 0.20    |
| Leg                      | 34.43 | 34.88 | 34.52 | 53.12 | 35.39 | 0.20    |
| Abdominal fat            | 2.04  | 2.29  | 2.69  | 2.39  | 1.23  | 0.23    |
| Head                     | 2.90  | 1.86  | 2.00  | 2.18  | 2.22  | 0.37    |

Table 5: Meat quality of experimental pigs

| Parameters               | A     | B     | C     | D     | E     | SEM   |
|--------------------------|-------|-------|-------|-------|-------|-------|
| Cooking loss             | 44.57 | 40.01 | 37.58 | 37.41 | 40.54 | 4.76  |
| Water Holding capacity   | 17.13 | 15.88 | 18.56 | 29.87 | 32.76 | 2.66  |
| Tenderness               | 2.65  | 2.00  | 1.98  | 1.59  | 3.17  | 1.27  |
| Connective Tissues       | 5.00  | 5.17  | 6.14  | 6.00  | 5.57  | 1.83  |
| Juiciness                | 5.71  | 6.29  | 6.43  | 6.29  | 6.00  | 1.41  |
| Flavor intensity         | 7.17  | 6.67  | 7.33  | 7.17  | 6.67  | 1.13  |
| Hedonic Score            | 5.67  | 6.17  | 5.00  | 6.17  | 5.33  | 2.18  |

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Table 5 displays the effects on the meat content of the experimental pigs feeding varying amounts of FCP- mix. Important variations (P<0.05) were found in cooking loss, water holding ability and lack of drip. The cooking loss of meat from pigs fed control diets was slightly greater (P<0.05) than that of pigs fed 50 percent and maize substitution levels of 75 percent. No substantial variations (P>0.05) were observed in all sensory scores (tenderness, juiciness, strength of taste, connective tissue and hedonic) measured. The lowest meat tenderness score on control diet from the pigs was however. The greater cooking loss of these samples must have accounted for this seemingly lower score. This was also expressed in marginally higher score for the volume of connective tissue. Samples from birds fed 100 percent FCP level inclusion were reported with the best hedonic score / rating. Therefore it is judged that the addition of FCP-mix would not adversely influence the sensory quality of beef.

Table 6: Haematological indices of pigs with different level of FCP mix

| Parameters | A       | B       | C       | D       | E       | SEM  |
|------------|---------|---------|---------|---------|---------|------|
| Hb (g/dl)  | 8.97    | 8.77    | 9.68    | 9.73    | 9.25    | 0.88 |
| RBC (x106/UL) | 33.08  | 31.63   | 31.88   | 31.88   | 34.10   | 2.66 |
| MCV (fl)   | 2.56    | 2.59    | 2.69    | 2.53    | 2.69    | 0.27 |
| MCH (pg)   | 128.57a | 128.57b | 128.57c | 128.57d | 128.57e | 5.23 |
| MCHC (%)   | 30.67a  | 30.67b  | 30.67c  | 30.67d  | 30.67e  | 1.19 |
| PLT (x103/UL) | 38.88  | 38.88   | 38.88   | 38.88   | 38.88   | 0.27 |
| NEUT (%)   | 22.33a  | 22.33a  | 22.33a  | 22.33a  | 22.33a  | 8.00 |

Table 7: Serum chemistry of experimental Pigs

| Parameters | Diet 1 | Diet 2 | Diet 3 | Diet 4 | Diet 5 | SEM  |
|------------|--------|--------|--------|--------|--------|------|
| Calcium (Mg/dl) | 10.15a | 9.72a  | 8.97b  | 8.43b  | 8.72b  | 0.52 |
| Phosphat (Mg/dl) | 2.65ab | 2.13bc | 2.68a  | 2.09c  | 2.55ab  | 0.45 |
| Glucose (Mg/dl) | 143.07 | 152.50 | 156.02 | 145.00 | 149.20 | 27.08 |
| Uric acid (Mg/dl) | 2.80c  | 2.32c  | 3.57a  | 2.18c  | 2.30c  | 0.46 |
| Cholesterol (Mg/dl) | 92.52c | 99.18c | 105.85c | 106.37c | 95.87c | 15.77 |
| Triglyceride (Mg/dl) | 20.42b | 24.90c | 27.25c | 24.38c | 21.05c | 35.88 |
| Cl (mM/L) | 119.40 | 112.70 | 104.83 | 104.77 | 103.95 | 21.47 |
| Na (mM/L) | 145.00 | 143.77 | 135.68 | 137.72 | 137.13 | 20.30 |
| K (mM/L) | 3.50a | 4.88ab | 3.98a | 4.37ab | 4.60ab | 0.88 |
| HCO3 (mM/L) | 28.83 | 28.50 | 26.50 | 28.33 | 28.17 | 2.15 |
| Urea (Mg/dl) | 10.40c | 12.03b | 12.50a | 12.40a | 11.83bc | 1.45 |
| Creatinine (Mg/dl) | 0.24c | 0.35a | 0.28ab | 0.30ab | 0.28ab | 0.06 |
| Total Bilirubin (Mg/dl) | 0.11 | 0.13 | 0.07 | 0.13 | 0.05 | 0.08 |
| Conj. Bilirubin (Mg/dl) | 0.05a | 0.06a | 0.03bc | 0.02c | 0.03c | 0.01 |
| ALT (IU/L) | 2.50 | 2.42c | 2.50 | 2.42 | 2.33 | 0.211 |
| AST (IU/L) | 35.22a | 22.27c | 32.38ab | 21.00c | 27.27bc | 0.63 |
| ALP (IU/L) | 175.10 | 163.40 | 157.90 | 156.31 | 147.52 | 553.30 |

Table 6 and 7 respectively display the findings for haematology and serum analysis. No major variations (P>0.05) were observed for the content of haemoglobin, bundled cell volume and red blood counts, while there were substantial differences in (P<0.05) mean corpuscular volume (MCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH), platelet count, total white blood counts (WBC) and differential white cell counts. While variations were observed in the experimental pigs' red cell indices, the values were reported for healthy pigs of comparable age and in a similar setting within the standard range (Merck Veterinary Manual, 1979). But no consistent pattern has been identified. The leucocyte count of pigs on control and the replacement standard of 100 percent were identical while those on replacement levels of 75 percent were lower than the control. This drop may have been due to the heat intensity inside a procedure of the birds affected. It is also probable that the test substance was not
responsible for the observed differences. Pigs on 75 percent and 100 percent FCP-mix substitution levels had slightly higher lymphocyte levels (p<0.05) and lower heterocyte levels. Lymphocyte counts under stress and infection are known to rise (Ghareeb et al., 2012). There was no substantial change in cholesterol levels (P>0.05) between the therapies. In accordance with the results of Kilic et al. (2006), who recorded that the enzyme greatly (P < 0.05) affects fat deposition in broilers, the lowest cholesterol level was registered for the enzyme supplemented diet. The concentrations of glucose, triglyceride (Trig), chloride bicarbonate, potassium, sodium, complete bilirubin (TB), conjugate bilirubin (CB), alkaline phosphatase (ALP), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) between the treatment groups were not substantially different (P>0.05). Pigs on control diet had elevated levels of aspartate aminotransferrase substantially (p<0.05) . There was no strong pattern in regards to nutritional care and obviously there was no biochemical or physiological adversity on any of the pigs. Ses findings also suggest that no physiological abnormalities or impediments will result in 100 percent substitution of maize with FCP- mix in swine diets. However, the results of the results of the Adesehinwa studies (2004, 2007 and 2008b) were consistent with the influence of cassava peel supplemented with palm kernel cake on serum biochemistry and immunology reaction.

IV. CONCLUSION

This study was conducted to determine the effects of cassava peel supplemented with palm kernel cake the growth, serum biochemistry, carcass evaluation and immunological response of pigs. A total of 40 grower pigs of large white were randomly selected at the Swine unit of the Teaching and Research Farm, University of Uyo, Akwa Ibom State and used for the study. The pigs were divided into 5 groups based on average initial weights (20-25kg) and each group of grower pigs were respectively allocated to each of the five treatment diets in a completely randomized design (CRD). Each treatment group contained 2 replicates of 4 pigs (2 male and 2 female). These pigs were fed twice daily and water supplied adlibitum. The treatment diets consisted of the following of cassava peels/PKC at 0, 25, 50, 75 and 100% replacement of maize in the control diet were formulated. The study utilized a randomized design and the statistics used in analyzing the result in the study were mean + stem and one way Analysis of variance (ANOVA). The following were the concluded:

Total (100%) replacement of maize with FCP-mix was significant with the growth, economic evaluation, and growth performance of pigs (P = 0.05). Dietary treatment had effect on the feed conversion ratio and feed cost per unit weight gain. Birds fed the control diet (0% FCP-mix) were lowest in dressing percentage whereas counterparts on 100% maize replacement with FCP-mix where highest in abdominal fat compared to pigs on other dietary treatments. This shows that feeding FCP-mix had muscle production and therefore results in significantly increment in carcass fat. The substitution of maize with FCP-mix at any stage of inclusion has affected the meat consistency. Data from haematology and serum biochemical research reveal that the replacement of FCP-mix maize had no adverse effect on bird physiology and metabolism.

The findings of this study therefore implies that cassava peel supplemented with palm kernel cake can be a great meal in for all monogastric animals as it will increase the body weight, aid growth and promote large meat production. Also, it will reduce the cost expenses on the farmers as the cost of making or getting this feed is relatively easy and low. It is therefore advised that the mixture of fermented cassava and palm kernel cake should be promoted in the feeding of broilers to reduce our farmers’ reliance on maize, contributing to high costs of raising chickens, thus preventing farmers from investing in the poultry sector. Public extension / advice personnel should be organised to relay these findings to farmers working. In order to decide the most efficient and economical form, further studies on various fermentation processes should be performed.

REFERENCES

[1] Acholonu, U. K. (1996). Comparative Poultry Production and the Need for Strategic Policy Objectives. A Paper Presented at the 1996 Annual Conference of the Nigeria Society for Animal Production, Uyo, Akwa-Ibom State. FAO (1995).

[2] Aderemi, F. A., Alabi, O. M. & Lawal, T. F. (2006). Utilisation of whole cassava leaf meal by egg-type chicken. Proceedings of the 11th Annual Conference of Animal Science Association of Nigeria (ASAN). Sept.18 – 21, 2006. I. A. R. & T. Ibadan, Nigeria. Pp. 153 – 155

[3] Adesehinwa, A. O. K.; Obi, O. O.; Makunjuola, B. A.; Oluwole, O. O. and Adesina M.A. (2011). Growing Pigs Fed Cassava Peel Based Diet supplemented with or Without Farmazyme 3000 Proenx: Effect on Growth, Carcass and Blood. African Journal Biotechnology, 10 (14), 2791-2796.

[4] Adesehinwa, A.O.K. (2007). Utilization of palm kernel cake as a replacement for maize in diets of growing pigs: Effects on performance, serum metabolites, nutrient digestibility and cost of feed conversion. Bulgarian Journal of Agricultural Science, 13(5), 593-600.

[5] Adesehinwa, A.O.K., Dafwang, I.I., Ogunmodede, B.K., & Tegbe, T.S.B. (1998). A review of utilization of some agro-industrial byproducts in pig rations. Nigerian Journal of Agricultural Extension 11(1-2), 50-64.

[6] Adesehinwa, A.O.K., Dairo F.A.S., & Olagbegi B.S. (2008). Response of growing pigs to Cassava peel based diets supplemented with Avizyme® 1300: growth, serum

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and hematological indices. Bulgarian Journal of Agricultural Science, 14 (5), 491-499.
[7] Akinfala E.O, Aderibigbe A.O, & Matanmi, O. (2002). Evaluation of the nutritive value of whole cassava plant as replacement for maize in the starter diets for broiler chicken. Livestock Research for Rural Development, 14, 1-6
[8] Alimon, A.R. (2006). The nutritive value of palm kernel cake for animal feed. Palm Oil Development 40(1),12-14.
[9] Amaefule, K.U.; Ibe, S. N.; Abasiekong S. F. and Onwudike, O. C. (2006). Response of Weaner Pigs to Diets of Different Proportions and High Levels of Palm Kern rain in the Humid Tropics. Pakistan Journal of Nutrition 5, 461-466.
[10] Apata, D.F & Babalola, T.O. (2012). The use of cassava, sweet potato and cocoyam, and there by-products by non- ruminants. International Journal of Food Science and Nutrition Engineering.2(4), 54-62
[11] Armas, A.B. and. Chicco, C.F. (1977). Use of the palm kernel meal of the oil palm (Elaeis guineensis, Jacq) in broiler chicken diets. Agronomy in Tropics., 27, 339 -343
[12] Aro S.O, Aletor V.A., Tewe O.O., Fajemisin, A.N, Usifo B. & Falowo A.B. (2008). Preliminary investigation on the nutrients, anti -nutrients and mineral composition of microbially fermented cassava starch residues. In Proceedings of 33rd Annual Conference of Nigerian Society for animal production; pp 248-251
[13] Bakrie, B., Hendra, J.& Nazar, A. (1995). Effects of using different techniques in bio-process to the nutritive value of cassava leaves. Proceedings of XI National Biology Seminar. University of Indonesia, Jarkata
[14] Banday, M.T & Gowdh. C.V. (1992). Replacing maize with raw and processed tapioca meal in broiler diets. Indian Journal. Of Animal Nutrition. 9, 43-46
[15] Bello, K.M., Oyayowe, E.O., Bogoro, S.E & Dass, U.D. (2011). Performance of broilers fed varying levels of palm kernel cake. International Journal of Poultry Science; 10, 290-294
[16] Bimrew, A. (2014). The Effect of Common Feed Enzymes on Nutrient Utilization of Monogastric Animals. International Journal of Biotechnology Molecular Biology Resources., 5(4), 27-34.
[17] Borin, K., Lindberg, J.E & Ogie, R.B. (2006). Digestibility and digestive organ development in indigenous and improved chickens and ducks fed diets with increasing inclusion levels of cassava leaf meal. Journal of Animal Physiology, 90(5-6), 230-237.
[18] Bradbury, J.H & Holloway, W.D. (1988). Cassava, M. esculenta. Chemistry of tropical root crops. Significance for nutritional and agriculture in the pacific. Australian centre for international agricultural research, monograph 6, Canberra, Australia, P76-104
[19] Bradbury, J.H. (2004). Wetting method to reduce cyanide content of cassava flour. Cassava Cyanide Diseases Network News, 4, 3-4.
[20] Brum, P., Guidoni, A.L., Albino, L.F.T & Cesar, J.S. (1990). Whole cassava meal in diets for broiler chickens. Pesq Agropec Bras, 25, 1367-1373.
[21] Chandrasekariah, M., Sampath, K. T. Thulasi, A. Anandan, S. (2001). In situ protein degradability of certain feedstuffs in cattle. Indian Journal of Animal Science, 719(2), 261-264.
[22] Chaunyrong, N., Elangovan, A.V & Iji. P. A. (2009). The potential of cassava products in diets for poultry. World Poultry Science Journal. 65. P23-35.
[23] Chin, F. Y. (2001). Palm kernel cake (PKC) as supplement for fattening and dairy cattle in Malaysia on Feed Resources for South East Asia, Manado, Indonesia
[24] Damisa, M. A. and Bawa, G. S., (2009). Evaluation of Grower-Finisher Pigs Fed with Cassava Peel Meal Incorporated with Palm Oil. Pig Journal 62, 39-42.
[25] Darma, J., Putvadaria, T., Haryati, T., Sinurat, A.P & Dhasana, R. (1994). Upgrading the nutritional value of cassava leaves through fungal biotechnology. Research Institute for Animal Production. Research Report for FAO/ANBAPH. Ciawi, Bogor.
[26] Duke, G.E (1986) Alimentary canal: Secretion and digestion, special digestive functions and absorption, In: Sturkie, P.D. (Ed) Avian Physiology, pp. 289-302, New York, Springer Verlag.
[27] Egbusike, G.N. (1997). What is animal science and how can Nigeria get out of malnutrition of livestock products, proceeding of the 2nd Annual conference of Animal Science Association of Nigeria 1-12.
[28] Ekenyem, B.U., (2007). The Growth Responses of Weaner Pigs Fed Varying Levels of palm kernel cake. Proceedings 27th Annual Conference, Nigerian Society Animal Production (NSAP),March 17-21, Federal University of Technology,Akure, Nigeria, Pp, 156-159.
[29] Ekpenyong, T.E., & Obi, A.E., (1986). Replacement of maize with cassava in broiler rations. Archiv für Geflügelkunde, 50, 2-6.
[30] Enyenih, G.E., Udedibie, A.B.I., Akpan, M.J., Obasi, O.L. & Solomon, I.P. (2009). Effects of 5 hour wetting of sun-dried cassava tuber meal on the hydrocyanide content and dietary value of the meal for laying hens. Asian Journal of Animal Veterinary Advances, 4, 326 – 331.
[31] Ernesto, M., Cardoso, A.P., Nicola, D., Mirione, E., Massaza, F & Cliff. J. (2002) Persistent Konzo and Cyanogens toxicity from cassava in northern Mozambique. ActaTropica, 82, 357-362
[32] Eruvbetine, D., Tajudeen, I.D., Adeosun, A.T. & Olodeke, A.A. (2003). Cassava (Manihot esculenta) leaf and tuber concentrate in diets for broiler chickens. Bioresource Technology, 86, 277 – 281.
[33] Eshiet, N.O., Ademosun, A.A & T.A. Omole. (1980). The effect of feeding cassava root meal on the reproductive performance of rabbits. Journal of Nutrition 110(4), 697702.
[34] Esonu, B.O., Emenalom, O.O., Udedibie, A.B.I., Anyanwu, G.A., Madu, U. & Inyang, A.O. (2005).
Evaluation of Neem (Azadirachta indica) leaf meal on performance, carcass characteristics and egg quality of laying hens. International Journal of Agricultural, Rural Development, 6, 208-212.

[35] Ezieshi, E.V. & Olomu, J.M. (2004) Comparative performance of broilers chickens fed varying levels of palm kernel meal and maize offal. Pakistan Journal of Nutrition 3(4), 254-257

[36] FAO (2004). Food and Agricultural Organization. Guide line for Slaughtering meat cutting and Utilization of meat Rome Italy.

[37] FAO.(2002). FAOSTAT Agriculture Data. http://appps.fao.org

[38] FAO. (2005). Food and Agricultural Organization of the United Nations Statistics (FAO) STADatabase. P.I.D 561

[39] FAO. (2011). Food and Agriculture Organization of the United Nations. 2009. Production Quantity of Cassava in Fiji - 1961-2009, downloaded from FAOSTAT on 07/17/2011

[40] Fatufe, A.A, Akabi, I.O, Saba, G.A., Oluwofeso, O & Tewe O.O. (2007) Growth performance and nutrient digestibility of growing pigs fed a mixture of palm kernel meal and cassava peel meal. Livestock Research for Rural Development; 19(180), 129-136

[41] Favier, J.C. (1977). Valeur alimentaire de deux aliments de base Africains: le manioc et le sorgho. Paris, France: ORSTOM (Editions de l’office de la Recherché Scientifique et Technique Outré Mer). Travaux et documents nr 67.

[42] Favier, J.C. (1977). Valeur alimentaire de deux aliments de base Africains: le manioc et le sorgho. Paris, France: ORSTOM (Editions de l’office de la Recherché Scientifique et Technique Outré Mer). Travaux et documents nr 67.

[43] FMARD (2011). Federal Ministry of Agriculture and Rural Development. National Agricultural Sample Survey, 2011.

[44] Gregory, K.F. (1977). Cassava as a substrate for single cell protein production: microbiological aspects. Pages 72-78 in Cassava as animal feed. Proceedings, Cassava as Animal Feed Workshop, edited by B. Nestel and M. Graham, University of Guelph, 18-20 April 1977, Canada. IDRC-095e: Ottawa.

[45] Harresign, W & Cole, D.J.A (1982). Recent advances in animal nutrition. London. Butter Worths.

[46] Hudson, B.J.F. & Ogusua A.O. (1974) Lipids of Cassava (Manihot esculenta crantz) tubers. Journal of Science of Food and Agriculture 25,1503-1508

[47] Hutagalung, R.L., Mahyuddin, M & Jalaludin, S.C (1982). Feeds for farm animals from the oil palm. In: The oil Palm in Agriculture in the Eighties, Volume 11. Editors: Pushprajah and C Poh-Soon, Incorporated Society of Planters, Kuala Lumpur, pp 609 – 622

[48] Ibe, S. N. (2004). The Role of Genetic and Livestock Breeding in the Nigerian Animal Protein Self Sufficiency: A Case Study of Day – Old Chicks/Poults: In Proceedings of the 9th Annual Conference of Animal Science association of Nigeria held 13th – 16th 2004; Abakaliki, Ebonyi State, Nigeria, Pp 13-17

[49] Igene., F.U. (2006). Essentials of Pigs Production in Nigeria J.L.G Publishers, Ibadan 1st Edition.

[50] Iiyemii, F.B Hanafi, M.M. Radziah, O & Kamarudin, M.S. (2006) Fungal solid state culture of palm kernel cake, Bioresource Technology. 97(3), 477-482

[51] Irikohre, O. T.; Bamgbose, A. M. and Olubadewa, G. A. (2006). Utilization of Cassava Peel Meal as Energy Source for Growing Pigs. Journal Animal Veterinary Advance 5 (10): 849-851

[52] Irikohre, O. T.; Bamgbose, A. M. and Olubadewa, G. A. (2006). Utilization of Cassava Peel Meal as Energy Source for Growing Pigs. Journal Animal Veterinary Advance 5 (10), 849-851

[53] Iyayi, E.A & Davies, B. I. (2005). Effect of enzyme supplementation of palm kernel meal and brewer’s dried grains on the performance of pigs. International Journal of Poultry Science 4 (2), 76-80

[54] Jaafar, M.D. & Jarvis, M.C. (1992). Mannans of oil palm kernels. Phytochemistry, 31(2), 463-464.

[55] Kanto, U & Juttupornpong, S. (2005). Advantages of cassava in animal rations. Cassava in animal nutrition: With reference to Thailand cassava. 99, 19-50.

[56] Lagemaat, J.V & Pyle D.L (2001) Solid state fermentation and bioremediation: development of a continous process for the production of fungal tannase. Chemical Engineering Journal 84,115–123

[57] Lateef, A., Oloke, J.K., Kana, E.B., Oyeniyi, S.O, Onifade, O.R., Oyeleye, A.O., Oladosu, O.C & Oyelami A.O. (2008). Improving the quality of agro-wastes by solid state fermentation: enhanced antioxidant activities and nutritional qualities. World Journal Microbiology and Biotechnology 24, 2369-2374.

[58] Luis, E.B. (2002) Use of hemicell in palm kernel meal rations to improve broiler performance.

[59] Manilal, V.B., Narayanan, C.S. & Balagopalan, C. (1985). Amyloglucisidae and cellulose activity of Aspergillus niger in cassava starch factory wastes. In proceedings of the natural symposium and production and utilization of tropical crops held at Trivandrum Nov. 27-28, 1995, pp: 211-213.

[60] Maust, L.R., Scott, M.L & Pond, W.G (1972).The metabolisable energy of rice bran, cassava flour, and blackeye cowpea for growing chickens. Poultry Science 51, 1397-1401

[61] Muller, Z., Chou K.C & Nah K.C. (1975).Cassava as a total substitute Agwunobi, L.N & Okeke, J.E. (2000) Metabolisable energy of some improved cassava cultivars for pigs. African Journal of Root and Tuber Crops 4, 35-37. for cereals in livestock and poultry rations. UNDP/SF Project 37-44.

[62] Mustafa, M.F., Alimon, A.R., Zahari, M.W., Idris, I & Hair Bejo. M. 2004. Nutrient digestibility of palm kernel cake for Muscovy ducks. Asian-Australaian Journal of Animal Science. 17, 514-517.

[63] Muzanila, Y.C, Brennan, J.G & King R.D. (2000). Residual cyanogens, chemical composition and aflatoxins
in cassava flour from Tanzanian villages. Food Chemistry, 70, 45-49.

[64] Naa, A.A, Maxwell, S & Josephyne, T. (2010). Fermentation in cassava (Manihotesculenta Crantz) pulp juice improves nutritive value of cassava peel. African Journal of Biochemistry Research, 4 (3), 51-56

[65] Nseroko, V.L, Morgavi D.P., Rode L.M., Beauchemin KA, & McAllister, T.A (2000) Effects of fungal enzyme preparations on hydrolysis and subsequent degradation of alfalfa hay fibre by mixed rumen microorganisms in vitro. Animal Feed Science and Technology 88,153–170

[66] Nwofor, O.E & Ejukonenu, F.E. (2004). Bioconversion of cassava wastes for protein enrichment using amylolytic fungi: a preliminary report. Global Journal Pure Applied Science. 10(4), 505-507

[67] Obiakoenu, H.O & Udediebe, A.B.I. (2006). Comparative evaluation of sun-dried and ensiled cassava peel meals as substitute for maize in broiler starter diets. International Journal of Agriculture and Rural development 7, 52-55

[68] Oboh S.O, Moseri H, and Okosun S.E “Assessment of Cassava Peels and Palm Kernel Cake (PKC) on the Performance of Grower Pigs” International Journal of Research in Agriculture and Forestry, 5(10), pp 1-5.

[69] Oboh, G & Akindahunsi A.A (2003). Chemical changes in cassava peels fermented with mixed culture of Aspergillus niger and two species of Lactobacillus integrated bio - system. Applied Tropical Agriculture, 8, 63-68.

[70] Oboh, S.O. (2016). Nutritionist view of waste wealth and endless search for animal feed raw materials. 54th inaugural lecture, Ambrose Alli University, Ekpoma, Edo State, Nigeria.

[71] Odukwe, C.A. (1994). The feeding value of composite cassava root meal for broiler chickens. PhD. Thesis, University of Nigeria, Nsukka, Nigeria

[72] Ofuya, C.O. & Nwaajuja C.J. (1990). Microbial degradation and utilization of cassava peel. 6, 144-148. 

[73] Okai, D.B., Abora, P.K.B., Davis, T., & Martin, A. (2005). Nutrient composition, availability, current and potential uses of “Dusa”: A cereal by-product obtained from “Koko” (porridge) production. Journal of Science and Technology, v. 25, 33-42.

[74] Oke, O.L. (1978). Problems in the use of cassava as animal feed. Animal Feed Science and Technology 3, 345-380.

[75] Okeudo, N.J., Ebob, K.V., Ndidi, V., Izugbekwe, & Akanno. E.C. (2005). Growth rate, carcass characteristics and organoleptic quality of broiler fed graded levels of palm kernel cake. International Journal of Poultry Science. 4, 33

[76] Okeudo, N.J., Ebob, K.V., Ndidi, V., Izugbekwe, & Akanno. E.C. (2005). Growth rate, carcass characteristics and organoleptic quality of broiler fed graded levels of palm kernel cake. International Journal of Poultry Science. 4, 33

[77] Okon, B.I. & Ogunnmedede, B.K. (1996). Carcass characteristic of broilers fed pennoinkle flesh and palm kernel cake. Nigerian Journal of Animal Production. 23, 16-20.

[78] Olowofeso, O and Omisanmi, O.O (2008). Utilization of cassava peels treated with yeast culture by egg-laying chickens. Proc. 33rd Annual Conf. of Nigerian Society for Animal Production (NSAP), Ayetoro, Ogun State, Nigeria: 492-495.

[79] Olson, D.W., M.I. Sunde, & H.R. Bird. 1969a. Amino acid supplementation of manioca meal in chick diets. Poultry Science 48, 1949-1953.

[80] Omeje, S.T., Marere F.U.C. & Isikwenu, J.O. (1999). Comparative affect of usual commercial feeds and cassava based formulation on the performance of Harco and Yaafa cockerels. Proceedings of the 26th Animal conference of the Nigeria Society for Animal Production (NSAP)

[81] Omeje, S.T., Marere F.U.C. & Isikwenu, J.O. (1999). Comparative affect of usual commercial feeds and cassava based formulation on the performance of Harco and Yaafa cockerels. Proceedings of the 26th Animal conference of the Nigeria Society for Animal Production (NSAP)

[82] Onifade, A.A & Babatunde G.M (1998). Comparison of the utilization of palm kernel meal, brewer's dried grains and maize offal by broiler chicks. British Poultry Science 39, 245- 250.

[83] Onjoro, P.A., Bhattacharjee, M & Ottaro J.M (1998). Bioconversion of cassava tuber by fermentation into broiler feed of enriched nutritional quality. Journal of Root Crops 24 105-110

[84] Onwudike, O.C. (1986). Palm kernel meal as a feed for poultry. 3. Replacement of groundnut cake by palm kernel meal in broiler diets. Animal Feed Science and Technology, 16, 195-202.

[85] Onyimomnyi, A.E. & Onukwuofo J.O. (2003). Effect of toasted Bambara (Voandzeia subterrenea Thouars) waste on Performance of growing pullets. Proceedings of the 28th Annual Conference of Nigerian Society for Animal Production (NSAP). 16th - 20th March, 2003, University of Ibadan, Nigeria, Pp: 237 – 239.

[86] Orunmuyi, M., Bawa, G. S., Adeyinka, F.D., Daudu, O.M., & Adeyinka, I.A. (2006) Effects of graded levels of palm-kernel cake on performance of grower rabbits. Pakistan Journal of Nutrition, .5, 71-74.

[87] Osei S.A & Amos, J. (1987) Palm kernel cake as a broiler feed ingredient. Poultry Science 66, 1870-1873

[88] Osei, S.A. (1992). Sun-dried cassava peel as a feed ingredient in broiler diets. Tropical Agriculture. 69, 273-275

[89] Ozosanya, T. O. (2004). Chemical Composition and Dry Matter Digestibility of Broiler Litter Based Diets in West African Dwarf Sheep: in Proceedings of the 9th Annual Conference of Animal Science Association of Nigeria held 13th – 16th, 2004: Abakaliki, Ebonyi State, Nigeria, Pp. 115-117.
[90] Oyebimpe, K., Fanimo, A.O, Oduguwa, O.O & Biobaku, W.O. (2006). Response of broiler chickens to cassava peel and maize offal in cashew nut meal-based diets. Archivos de Zootecnia 55, 301-304

[91] Padmaja, G & Balagopalan, C. (1990). Evaluation of single cell protein enriched cassava wastes as an energy source in broiler rations. Paper presented at National Symposium on recent advances in production and utilization of tropical tuber crops. Trivandrum, 7- 9th Nov, 1990

[92] Panigrahi, S., Rickard, J., O’Brien, G.M & Gay, C. “Effects of different rates of drying cassava root in its toxicity to broiler chicks” British Poultry Science 33, 1025-1041, 1992.

[93] postharvest/ivstock_1.htm.

[94] Ramin, M., Alimon, A.R & Ivan, M. (2010). Effects of fungal treatment on the in vitro digestion of palm kernel cake. Livestock Research for Rural Development. 22, Article 82

[95] Ravindran, V., Kormegay, E T, Rajaguru A S B, Potter L M & Cherry J A. (1986). “Cassava leaf meal as replacement for coconut oil meal in broiler diets” Poultry Science 65, 1720-1727

[96] Rhule, S.W.A (1996). Growth rate and carcass characteristics of pigs fed on diets containing palm kernel cake. Animal Feed Science and Technology, 61(1), 167-172.

[97] Silva, H.O., Da Fonseca., R.A & Guedes, R.D. (2000) Production traits and digestibility of cassava leaf meal in broiler diets with or without addition of enzyme. Revista Brasileira De Zootecnia-Brazilian Journal of Animal Science.

[98] Soltan, M.A. (2009) Growth performance, immune response and carcass traits of broiler chicks fed on graded levels of palm kernel cake with or without enzyme supplementation. Livestock research for rural Development 21, 1-15.

[99] Sundu B & Dingle J. (2003). Use of enzymes to improve the nutritional value of palm kernel meal and copra meal. Proceedings of Queensland Poultry Science Symposium. Australia 1(14), 1-15

[100] Sundu, B., Kumar, A & Dingle, J. (2005). Response of birds fed increasing levels of palm kernel meal supplemented with enzymes. Australian Poultry of Science Symposium. 12, 63-75.

[101] Sundu, B., Kumar, A & Dingle, J. (2005a). Response of birds fed increasing levels of palm kernel meal supplemented with enzymes. Australian Poultry of Science Symposium. 17, 227-228.

[102] Sundu, B., Kumar, A & Dingle, J. (2006) Palm kernel meal in broiler diets: Effect on chicken performance and health. World’s Poultry Science Journal.62, 316-337.

[103] Tabayoyong, T. T. (1935). The value of cassava refuse meal in the rations for growing chicks. Philippine Agriculture 24, 209.

[104] Tejada, H.L & Brambilla S. (1969). Valor nutritivo de la yuca para el pollito. Tec. Pec. Mex. 3, 329-333.

[105] Tewe, O. O. (1997) “Sustainability and Development: Paradigms from Nigeria Livestock Industry”. In: Inaugural Lecture delivered on behalf of Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria. Ibadan: University of Ibadan,. p. 1-37.

[106] Tewe, O.O. & Egbutike, G.N. (1988). Utilization of cassava in non-ruminant livestock feeds. In: Workshop on the potential utilization of cassava as livestock feed in Africa, Ibadan, 1988. Proceedings… Ibadan, Nigeria: IITA/ILCA/Univ. of Ibadan,. p 28-38.

[107] Tewe, O.O. (2004). Cassava for livestock feed in Sub- Saharan African. Plant Production and Protection Division, Food and Agricultural Organization Rome, Italy

[108] Tewe, O.O. (2006) Cassava products for animal feeding. In: Integrated Cassava project. p. 1-3. http://www.cassavabiz.org/

[109] Ubalua, A. O. (2007). Cassava Wastes: Treatment Options and Value Addition Alternatives. African Journal of Biotecnology 6 (18), 2065-2073.

[110] Udedibie, A.B.I, Anyaebu, B.C, Onwuchekwa G.C & Egbuokporo O.C. (2004) Effect of feeding different levels of fermented cassava tuber meals on performance of broilers. Nigerian Journal of Animal Production. 31, 211 - 219.

[111] Ugwu, S.O.C., Onyimonyi, A.E. & Ozonoh, C.I (2008). Comparative performance and haematological indices of finishing broilers fed palm kernel cake, bambara offal and rice husk as partial replacement for maize. International Journal of Poultry Science. 7, 299-303.

[112] Waldroup, P.W., Ritchie, S.J., Reese, G.L., & Ramsey, B.E. (1984). The use of blends of cassava flour and extruded full-fat soybeans in diets for broiler chickens. Arch Latinoam Nutrition. 34, 550–563.

[113] Wood- Tseun, W.L, Busson, F & Jardin, C. (1968). Food composition table for use in Africa. FAO corporate document repository. Rome, Italy.

[114] Zahari, M.W. & Alimon, A. R. (2006). Use of palm kernel cake and oil palm by-products in compound feed. Palm Oil Development, 40(1), 5-9.