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ORIGINAL RESEARCH ARTICLE

Effects of fermented cassava root-leaf meal as a replacement for maize on performance, carcass yield and gut microflora of ducks

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ABSTRACT

This study investigated the effect of replacing maize with fermented cassava root – leaf meal (FCRLM) on growth performance, carcass yield and gut micro flora of mallard ducks. A total of one hundred and fifty, one-day old unsexed Mallard ducklings with average initial weight of 60g were randomly assigned to 5 dietary treatments in a completely randomized design over a 42- day feeding trial. Each treatment was replicated thrice with 10 ducks each. Dietary treatment consisted of 0%, 25%, 50%, 75% and 100% replacement level of maize with FCRLM. Highest (P<0.05) final live weight, weight gain and feed intake were recorded with ducks fed diet containing 25% FCRLM. The least (P<0.05) final live weight and weight gain was recorded with 75 and 100% replacement of maize. Ducks fed control diet, 25 and 50% replacement of maize recorded the best (P<0.05) feed conversion ratio. Control group and those fed with 25% replacement of maize had higher(P<0.05) dressed weight while the rest treatment showed reduced (P<0.05) values. Ducks fed with 50%, 75% and 100% replacement of maize with FCRLM showed higher (P<0.05) Lactobacillus count than other treatments. It can be concluded that cassava root when fermented with cassava leaves (at ratio 1: 0.3; cassava root: cassava leaf) can successfully replace maize up to 50% replacement value with improved growth, carcass yield and gut microflora.

Keywords: *Ducks, cassava root- leaf meal, fermentation, gut micro flora, carcass yield.*

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) root is a cheap and sustainable energy feedstuff with potential to replace most conventional cereal grains in the tropics (Oso *et al*. 2014). This situation stimulated the drive to search for alternative energy sources. Cassava root is rich in digestible starch (El-sharkawy, 2012) supplying approximately thirteen times energy/ha yield than maize or guinea corn (Ojewola *et al.,* 2000). Cassava root has been used to a limited extent as energy feed-stuff in poultry nutrition (Idowu *et al*., 2005; Oso *et al.,* 2014). The major limitations to its utilization in poultry ration consist of low quantity and poor quality protein, presence of cyanogenic glucosides, linamarin and lotaustralin (Oso *et al*. 2014).

The inclusion of leaf meal in poultry nutrition serves as sources of proteins, vitamins, minerals and carotenoids at a relatively reduced cost (D'Mello *et al*., 1987; Opara, 1996). However, the major constraints to the utilization of leaf meal in monogastric nutrition is the fibrous nature of the meal and bulkiness of the resultant feed. Fermentation has been employed to break down fibrous feedstuffs and reduce toxicity of hydrocyanide in cassava leading to nutritionally enriched product due to the increase in growth and proliferation of fungi or bacterial complex in the form of single cell proteins (Antai and Mbongo, 1994; Oboh, 2002).

Duck keeping has been regarded as one of the possible means of breaking out poverty trap of resource-poor small holder families in low income countries (Pym *et al*., 2002). Ducks are considered to be the most important asset and source of income for subsistent rural livestock women. Small scale duck farming has not only been proved to be a beneficial occupation for small, marginal and landless farmers, but also a source of income for poor rural farmers (Jabber, 2004). There are many advantages of duck production: its production needs less care and management, easy to raise, need less space for rearing and require low inputs of feed, housing facilities and management. Ducks are hardy and can easily adapt to different climates and they are also relatively resistant to diseases (Holderread, 1990). It is evident that in spite of the innate potentials of ducks as an alternative source of animal protein in all regions of agro-ecological zones, its exploration as food suffered major set back due to the negative effects of taboos, myths, superstitions and stigmas (Ogunjimi, 2014). Based on these, there is a compelling need to integrate duck production into Nigerian agricultural system, for they are not only important as source of nutritious meat, but as a veritable source of eggs for human consumption. Ducks have higher percentage of meat than chickens weighing 2.48 to 2.93 kg at 8 to 9 weeks of age, their eggs are very big and delicious, suffer less from local diseases which are common in chickens and do not necessarily need sophisticated compounded feeds (World Bank, 1996; FAO, 1996; Nworgu *et al*., 1997). The current study seeks to upgrade the low protein level of unpeeled cassava meal by combining it with a cassava leaf (a rich protein source) in a bid to completely replace maize in diets for ducks.

MATERIALS AND METHODS

Experimental site: The project was carried out at the Teaching and Research farm of Yaba College of Technology Epe Lagos State. It is situated at latitude 6.58ºN, Longitude 3.98ºE. It is 42m above the sea level along the Epe- Ijebu Ode road. Epe lies in the low land rain forest, vegetation zone within the savannah agro ecological zones of south Nigeria (Google Earth, 2015). The average rainfall of 1694mm and temperature of 27.1ºC exist during the period of experimentation.

Cassava root- leaf meal processing: Fresh cassava root tubers (TMS30572) were harvested, washed and grated. The cassava leaves were harvested and chopped into smaller pieces using kitchen knife. A maize-soybean diet was formulated as control. Fresh grated cassava root and leaves was mixed at a ratio of 1kg cassava root meal with 300g cassava leaves, fermented for 5 days under an air-tight environment, air dried (for 2-3 days) and used to replace maize at varying proportions in the basal diet. Products obtained at the expiration of the fermentation were analyzed for proximate composition using the standard methods of (AOAC, 2002) and gross energy (Adiabatic Bomb Calorimeter).

EXPERIMENTAL BIRDS, MANAGEMENT AND DESIGN

A total of one hundred and fifty, one-day old unsexed Mallard ducklings were distributed randomly into 5 groups of 30 ducklings per treatment. Each treatment was further subdivided into 3 replicates with 10 ducklings per replicate in complete randomized design (CRD). The study is made up of 5 dietary treatments consisting of basal diet (control, Treatment 1), diets containing maize being replaced with 25% (Treatment 2), 50% (Treatment 3), 75% (Treatment 4) and 100% fermented cassava root-leaf blend (Treatment 5) levels, respectively. Diets were formulated to meet the NRC (1994) requirements. The ducklings were raised on deep litter in an open sided deep litter house. Feed were offered *ad libtum.* The study lasted for a period of 6 weeks.

Table 1: percentage composition of the experimental diet (duck starter 0-42days)

Ingredients	T1	T2	T3	T4	T5
Maize	54.00	40.50	27.00	13.50	0.00
Palm oil	1.00	1.00	1.00	1.00	1.00
Soybean meal	30.00	30.00	30.00	30.00	30.00
FCRLM	0.00	13.50	27.00	40.50	54.00
Wheat offal	6.00	6.00	6.00	6.00	6.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Lime stone	2.00	2.00	2.00	2.00	2.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Crude protein (%)	21.30	21.34	21.38	21.41	21.46
Crude fibre (%)	4.25	3.98	3.71	3.44	3.71
Calcium (%)	1.19	1.19	1.19	1.19	1.19
Phosphorus (%)	0.65	0.65	0.62	0.61	0.60
Energy (kcal/kg)	2864	2827	2870	2913	2956

Starter premix: - Vit. A 8, 500,000 (iu), Vit D3 1,500,000 (iu), Vit. E 10,000(mg), Vit K3 1,500 (mg), Vit B1 1,600 (mg), Vit. B2 4,000 (mg), Niacin 20,000 mg, Pantothenic acid 5,000mg, Vit. D6 1,500mg, Vit.B12 10mg, Folic acid 500mg, Biotin H2 750mg, Chlorine chloride 175,000mg, Cobalt 200mg, Copper 3,000mg, Iodine 1,000mg, Iron 20,000mg, Manganese 40,000(mg), Selenium 200mg, Zinc 30,000mg, Anti-oxidant 1,250mg. T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level),T4 (75% replacement level), T5 (100% replacement level). FCRLM- Fermented cassava root leaf meal.

DATA COLLECTION

Performance: The performance of the experimental ducklings in term of feed intake, live weight gain and feed conversion ratio were recorded on weekly basis.

Carcass yield evaluation: At the expiration of 42 days, two ducks per replicate (6 birds per treatment) whose weights were similar or close to the average weight of the ducks contained in each replicate were selected for slaughter and designated for carcass analysis. Ducks selected were fasted overnight, slaughtered, plucked and eviscerated. Evisceration of the carcass was done manually following standard commercial procedures (Jensen, 1984). The live weight, plucked weight and eviscerated weight were recorded while weights of wing, back, thigh, drumstick and breast were also recorded.

Caecal microbial: Two ducks were randomly selected from each replicate (n=6 per treatment) and slaughtered while the intestinal segments dissected. Caeca content was collected aseptically into sample bottles and stored in a refrigerator (-20ºC) for microbiological analysis. Estimation of total bacteria counts, Coliform, Clostridium, Lactobacillus, Bacillus, Salmonella, Staphylococcus counts were done according to the method of Baker and Beach (1998).

Statistical analysis: Data obtained was analyzed using SAS statistical software (SAS, 2002). Differences between significant means were separated using Turkey's Test. Statements of significance was based on a probability of P<0.05.

RESULTS

The fermented cassava root-leaf meal used in this study contain 9.3% crude protein, 3.79% crude fibre, 2.05% ash, 3.14% ether extract and 51.91% nitrogen free extract. The result of the growth performance (Table 2) revealed the highest final live weight, weight gain and feed intake with ducks fed diet containing 25% FCRLM. The least final live weight and weight gain was recorded with 75 and 100% replacement of maize. Ducks fed control diet, 25 and 50% replacement of maize recorded the best feed conversion ratio. Ducks fed 100% replacement of maize had the worst feed conversion ratio.

Table 2. Performance of ducks fed fermented cassava root –leaf meal.

Parameters	T1	T2	T3	T4	T5	SEM
Initial weight (g)	60.00	60.00	60.00	60.00	60.00	0.00
Final weight (g)	1200.20[b]	1300.10[a]	1200.00[b]	1000.09[c]	1000.33[c]	32.07
Weight gain(g)	1140.20[b]	1240.10[a]	1140.00[b]	940.09[c]	940.33[c]	32.07
Daily feed intake(g)	87.32[b]	94.71[a]	86.98[b]	83.34[d]	85.84[c]	1,02
Total feed intake(g)	3667.44[b]	3977.82[a]	3653.16[c]	3500.14[e]	3653.16[d]	42.69
FCR	3.22[c]	3.20[c]	3.20[c]	3.73[b]	3.88[a]	0.07

abcd Means in the same column with different superscripts were significantly ($p<0.05$) different.
T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level), T4 (75% replacement level), T5 (100% replacement level).

Table 3 indicated a significant ($P<0.05$) effect on live weight, plucked weight, eviscerated weight, dressed weight, dressing, breast, thigh, wing drumstick percentages while there was no significant ($P>0.05$) effect of the dietary treatment on back weight. Higher values of plucked weights were obtained for control, 25% and 50% replacement of maize while the rest treatment showed lower values. Dressed weight recorded higher values for control and 25% replacement of maize while the rest treatment showed reduced values. Ducks fed with control, 25% and 50% replacement of maize showed higher values of breast meat than other treatments. Ducks fed with 50% replacement of maize showed the highest drum stick weight.

Table 3. Carcass yield of ducks fed fermented cassava root –leaf meal.

Parameters	T1	T2	T3	T4	T5	SEM
Live weight (g)	1200.00[b]	1300.00[a]	1200.00[b]	1000.00[c]	1000.00[c]	32.07
Plucked weight(g)	1081.67[a]	1136.67[a]	1091.67[a]	875.00[b]	808.33[c]	35.92
Eviscerated weight(g)	933.33[ab]	986.67[a]	881.67[b]	711.67[c]	675.00[c]	33.66
Dressed weight (g)	761.67[a]	746.67[a]	643.33[b]	531.67[c]	500.00[c]	29.92
Dressing percentage	63.70[a]	57.00[b]	54.68[bc]	52.33[bc]	50.00[c]	1.38
Breast (%)	13.89[ab]	14.97[a]	15.33[a]	11.00[bc]	9.83[c]	0.72
Thigh (%)	6.77[ab]	6.36[b]	7.10[a]	6.99[a]	6.83[ab]	0.08
Wing (%	12.34[a]	11.69[ab]	9.98[b]	11.00[ab]	10.18[b]	0.31
Drumstick (%)	7.89[b]	7.77[b]	9.11[a]	8.00[b]	7.87[b]	0.16
Back (%)	18.02	17.08	16.54	16.00	15.50	0.37

abcd Means in the same column with different superscripts were significantly ($p<0.05$) different.
T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level), T4 (75% replacement level), T5 (100% replacement level).

Table 4 shows the caecal microflora of duck fed with FCRLM. From the results, ducks fed with 50%, 75% and 100% replacement of maize with FCRLM showed higher Lactobacillus count than other treatments. Ducks fed with control diet recorded the highest Coliform count while the rest treatment showed reduced Coliform counts. All ducks fed diet containing 50%, 75% and 100% replacement of maize with FCRLM showed higher Bacillus counts. Total microbial count, total anaerobic count, Clostridium counts, and Staphylococcus counts were not affected by dietary treatment.

Table 4. Gut microflora of ducks fed fermented cassava root –leaf meal.

Parameters (x 10^6 cfu /ml)	T1	T2	T3	T4	T5	SEM
Total microbial count.	2.37	1.77	2.93	2.43	2.20	0.17
Salmonella count	0.13^b	0.30^a	0.23^{ab}	0.20^{ab}	0.10^b	0.02
Lactobacillus count	0.66^b	0.63^b	0.83^a	0.83^a	0.86^a	0.03
Coliform count	0.83^a	0.56^b	0.60^b	0.60^b	0.66^b	0.04
Total anaerobic count	0.46	0.43	0.50	0.50	0.56	0.03
Bacillus count	0.63^{ab}	0.53^b	0.80^a	0.80^a	0.76^{ab}	0.04
Clostridium count	0.26	0.20	0.23	0.23	0.30	0.03
Staphylococcus count	0.33	0.53	0.53	0.53	0.50	0.04

[abcd] Means in the same column with different superscripts were significantly ($p<0.05$) different.
T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level), T4 (75% replacement level), T5 (100% replacement level).

DISCUSSION

The fermentation process increased the nutrient composition most especially protein content due to the increase in growth and proliferation of the fungi or bacterial complex in the form of single cell proteins (Antai and Mbongo, 1994; Oboh, 2002). This may possibly be attributed to the increased crude protein content of fermented cassava root-leaf meal obtained in this study. The observed increase in crude protein value (2.5% to 9.76%) of fermented cassava root meal was in line with the studies of Igbabul *et al.*, (2014) who found an increase in protein percentage of fermented cocoyam from 15.61to 18.75%. Michodjehoun *et al*., (2005) also observed an increase in protein content of millet from 7.9% to 10% during fermentation.

Replacing maize with fermented cassava root-leaf meal appeared to have a positive impact on ducks' performance up to 50% replacement level in the present study. Ducks fed control diet, 25 and 50% replacement of maize recorded the best feed conversion ratio while those fed 100% replacement of maize had the worst feed conversion ratio. The least final live weight and weight gain was recorded with 75 and 100% replacement of maize. Previous study confirmed successful utilization of cassava root when compared with broken rice and maize in diets of male Cherry valley ducks (Saree *et al*., 2012). The difference between the current study and the findings of Saree *et al*., (2012) could be attributed to the breed and sex effect introduced since only males were used as experimental animals. Feed intake increased from group fed control to 25% replacement levels. Beyond this level, intake reduced appreciably. The reduction in feed intake beyond 25% replacement value of cassava root could be linked with the fibrous nature of the test ingredient used. This is because poultry are known to be poor digester of fibre. Aside this, it is likely that at this replacement level, ducks have comfortably satisfied their dietary energy requirements. Birds are known to eat more to satisfy their energy requirement (Tewe and Egbunike, 1992), This observation agreed with those of Osei (1992) and Oruwari, *et al.* (1996), who indicated that feed intake decreased with increase in energy level. It also corroborates the scientific evidence that birds eat to satisfy their energy requirement (Akinfala, *et al*., 2002; Aderemi, *et al*. 2006). The trend of the feed conversion ratio showed that replacing maize with fermented cassava root-leaf meal appeared to have a positive impact on ducks' performance up to 50% replacement level.

The carcass yield and the primal cut up parts of breast, thigh, drumstick and wing were within the level reported by Isikwenu *et al.,* (2010). The results of the study showed that the dietary inclusion of FCRLM in diets for ducks had no adverse effect on dressed weight and primal cuts. These results are in agreement with the findings of Huyen *et al*. (2007), who reported that using cassava starch residues (product) up to 150 g/kg did not show any adverse effect on broilers' dressing percentage or carcass traits. Sahle *et al.,* (1992) also found out that including cassava root meal up to 450 g/kg in geese diet had no significant effect on dressed carcass percentage or carcass characteristics.

It is possible that differences in feed composition could have considerably different effects in gut environment as observed with the *Lactobacillus* population which increased with increase in the level of fermented cassava root- leaf meal inclusion in the diet. Coliform and Salmonella bacteria in higher population in the gut of poultry are known to be indicative of poor gut health. *Escherichia coli* and Lactobacillus are known to be the normal microflora largely colonized in poultry gut. Lower counts of *Clostridium, Salmonella, and Escherichia coli* and higher count of *Lactobacilli* has been reported to have a stabilizing effect on gut microbiology and improved digestibility of nutrients (Brenes and Roura, 2010).

Studies has shown that diet has the greatest potential impact on the intestinal microbiome in poultry as dietary components that escape host digestion and absorption serve as the substrates for the growth of intestinal bacteria. It has been suggested that fibrous feed stuffs lead to increased digesta viscosity, decreased digesta passage rate, and a decline in nutrient digestibility, which in turn favors the growth of *Clostridium perfringens* (Choct *et al*., 1996; Timbermont *et al*., 2011). The increased Lactobacillus and reduced Coliform counts obtained in the current study with ducks fed diet containing FCRLM indicated improved gut microflora. Dietary composition has been reported to potentially affect the intestinal bacteria of poultry species (Tarok *et al*., 2008; Shakouri *et al*., 2009). The diversity of bacterial species in the gut is one of the most important factors for the establishment of a stable ecosystem in the intestinal tract (Aro *et al*., 2017).

CONCLUSION

It can be concluded based on findings of this study that cassava root when fermented with cassava leaves (*at ratio 1: 0.3; cassava root: cassava leaf*) can successfully replace maize up to 50% replacement value with improved growth performance, carcass yield and gut microflora.

CONFLICT OF INTEREST

Authors declare that no conflict of interest exist concerning this manuscript.

REFERENCES

Aderemi, F. A., Lawal, T. E., Alabi, O. M., Ladokun, O. A. and Adeyemo, G. O. 2006. Effect of enzyme supplemented cassava root sieviate on egg quality gut morphology and performance of egg type chickens. *International Journal Poultry Science* 5 (6): 526-529

A.O.A.C, (2002). Association of Official Analytical Chemists, *Official Methods of Analysis of AOAC International*, 17th ed, Association of Official Analytical Chemists, Washington.

Akinfala, E. O., Aderibigbe, A. O. and 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*14:16.

Aro, S. O., Aletor, V. A. and Oladunmoye, M. K.2017. Feeding Microbe-Fermented Cassava Tuber Wastes Modulates Gut Microbiota and Faecal Characteristics of Growing Pigs. *Fermentation Technology* 6:145 doi: 10.4172/2167-7972.100014

Antai, S. P. and Mbongo, P.N. (1994). Utilization of cassava peels as substrate for crude protein formation. *Plant Foods for Human Nutrition, v.46,* p.345-351.

Baker, F. J and Beach, M. R. 1993.Total and value count technique. Medical microbiology techniques. 5th Edition Oxford publisher pp 418-422.

Brenes, A. A. and Roura, E.2010. Essential oils in poultry nutrition : main effects and modes of action. *Animal Feed Science Technology.* 158 : 1-14

Choct M, Hughes RJ, Wang J, Bedford MR, Morgan AJ, Annison G. (1996): Increased small intestinal fermentation is partly responsible for the anti-nutritive activity of non-starch polysaccharides in chickens. *British Poultry Science.* 37:609–21.

D'Mello, J., Acamovic, T. and Walker, A. G. 1987. Evaluation of leucaena leaf meal for broiler growth and pigmentation. *Journal of Tropical Agriculture*. (Trinidad), 64: 33-35.

El-Sharkawy, M. 2012.''Stress – Tolerant Cassava: the role of Integrative Ecophysiology Breeding Research in crop Investment. *Open Journal of Soil Science.* 2, 162-186.

FAO (1996). World Food Summit Plan of Action. Rome Google Earth, 2011. http/www.google, earth.

Huyen, L.V., Len, N. T. and Nguyen, T. P., 2007. Effect of supplementation of cassava residue meal in diets on the growth performance of Luongphuong broilers. MEKARN Regional Conference. Matching Tropical Animal Health Production Livestock Systems with Available Resources.

Holderread, D. 1990. Raising the house duck flock. 7th Printing. A Garden Way Publishing Book, Storey Communications Inc.

Idowu, O. M. O., Eruvbetine, D., Oguntona, E. B. and Biobaku, W.O. 2007. Response of laying hens to long terms feeding of unpeeled cassava based diets. *Ghana Journal of Animal Science. 3*, 53-63.

Igbabul B.D, Amove J. & Twadue I. 2014. Effect of fermentation on the proximate composition, antinutritional factors and functional properties of cocoyam (*Colocasia esculenta*) flour. *African Journal Food Science Technology* 5(3):67-74

Isikwenu, J. O, Akpodiete, O. J. Omeje, S. I. and Okagbare, G. O. 2010. The effect of replacing groundnut cake and urea treated and ferment brewer's dried grains on nutrient digestibility, retention and carcass characteristic of broilers finishers. *Nigeria Journal Animal Production*. 37:1-12

Jabber, M. A. 2004. Smallholder livestock for poverty alleviation: issues and prospects. Keynote paper presented at BARC, Dhaka.

Jensen, J. F.1984. Method of dissection of broiler carcass description of parts. Page 32 in World's Poult. Sci. Assoc., Eur. Fed. Work. Group V. Papworth's Pendragon Press, Cambridge, UK

Michodjehoun, L. H., Joseph, O. and Christian, M. 2005. Physical, chemical and microbiological changes during natural fermentation of 'gowe' a sprouted or non-sprouted Sorghum beverages from West Africa. http://www.academicjournal.org. pp. 677-768

NRC (National Research Council) 1994. Nutrient requirements of poultry. 9th Rev. ed National Academy Press, Washington, DC.

Nworgu, F. C., Olupona, J. U., Oredein, J. A. and Oghosuka, G. N. 1997. Effect of various protein sources on broiler performance. *Proceeding of 2nd Annual Conference Animal Science Association of Nigeria*, held at Airport Hotel, Ikeja, Lagos. pp. 104-113

Oboh, G. 2002. Nutritional, toxicological and by-products utilization potentials of micro-fungi fermented cassava (*Manihot esculenta*, *Crantz*) tuber roots. Akure: Federal University of Technology. Thesis (PhD).

Oguntunji, A. O.2014. Taboos, Superstitions, Myths and Stigmas against duck production in South-West Nigeria. *Wayamba Journal of Animal Science* 1416311791

Ojewola, G. S.; Okpara, O. E. & Ndupu, O. 2000. The substitution value of cassava meals supplemented and not supplemented with palm oil for maize in broiler diet. *Journal of Animal and Veterinary Advances* 5, 478–482.

Opara, C. C. 1996. Studies on the use of *Aklchornia cordifolla* leaf meal as feed ingredient in Poultry diets. MSc Thesis. Federal University of Technology, Owerri, Nigeria.

Oruwari, B. M., Sese, B. T. and Mgbere, O. O.1996. Whole palm kernel in diets for broiler. *Bulletin of Animal Health and Production in Africa,* 44 (3): 179-183

Osei, S. A. 1992. Sun-dried cassava peel meal as a feed ingredient in broiler diets. *Tropical Agriculture* 69*;*273-5

Oso, A.O, Akapo, O., Sanwo, K.A. & Bamgbose, A.M. (2014). Utilization of unpeeled cassava *Manihot esculenta* Crantz root meal supplemented with or without charcoal by broiler chickens. *Journal of Animal and Physiology Nutrition*. *98***:** 431- 438.

Pym, R. A. E, Lanada. E. B. and Morbos, E. Y. 2002. Case studies of family poultry development. 2nd INFPD-FAO, Electronic conference. May 13-July 5, 2002.

Sahle, M., Coleou, K. and Haas, C., 1992. Nutritional value of cassava meal in diets for geese, *Animal Feed Science and Technology*, 36:29–40.

Saree S, Kaewtapee, C., Poeikhampha, T. and Bunchasak, C. A. 2012. Comparative study on effects of cassava,corn and broken rice based diets on growth performance and carcass quality of male cherry valley ducks during 0-47 days of age. In: Proceedings of the 50th Kasetsart University Annual Conference, Thailand: Kasetsart University; 2012.31 January – 2 February 2012.

SAS (2002). Statistical Analysis System Institute User's Guide. 9th Edition, North, Carolina, USA

Shakouri, M. D, Iji, P. A., Mikkelsen, L. L. and Cowieson, A. J. 2009. Intestinal function and gut microflora of broiler chickens as influenced by cereal grains and microbial enzyme supplementation. *Journal of Animal Physiology and Animal Nutrition* (Berl); 93:647–58.

Tewe, O.O and Egbunike G. N. 1992. Utilization of cassava in non-ruminant livestock feeds. In: Hahn, S. K., Reynolds, L., Egbunike, G. N. editors. Cassava as livestock feed in Africa. *Proceedings of IITA/ILCA/University of Ibadan workshop* on the potential utilisation of cassava as livestock feed in Africa; p. 28-38.

Timbermont, L., Haesebrouck, F., Ducatelle, R. and Van Immerseel, F. 2011. Necrotic enteritis in broilers: an updated review on the pathogenesis. *Avian Pathololog*.; 40:341–7.

Torok VA, Ophel-Keller, K. Loo, M. and Hughes, R. J. 2008. Application of methods for identifying broiler chicken gut bacterial species linked with increased energy metabolism. *Applied Environmental Microbiology*, 74:783–91.

World Bank (1996). Nigeria poverty in the mist of plenty: The challenge of growth with Inclusion. A World Bank Poverty Assessment Report, No14733, UN, May, p. 231.