Journal of Agriculture and Veterinary Sciences
Volume 5, Number 2, 2013
ISSN: 2277-0062

Quality Evaluation of Plantain Chips Sold in Makurdi Metropolis

IKYA, J.K.[1*], ABAH, J.O.[1] AND HAMID, A.F.[2]

[1]Department of Food Science and Technology, University of Agriculture, Makurdi, Benue State, Nigeria.
[2]Adamawa State College of Agriculture Mayo Belwa, Adamawa State, Nigeria.
E-mail: aveyina2012@gmail.com

ABSTRACT

In this study, plantain chips sold in three selected locations (High Level, Wurukum and North Bank) in Makurdi metropolis were purchased and subjected to proximate composition, microbiological and nutritional quality analyses. Results obtained showed that; the proximate composition (on dry weight bases) ranged as follows: 5.76 – 6.25%, 3.20 – 5.08%, 0.44 – 0.52%, 2.23 – 2.38%, 85.85 – 88.36% and 405.28 – 414.12 Kcal for protein, fat, fibre, ash, carbohydrate and energy respectively. The mean microbial counts (CFU/g) for the samples of plantain chips purchased showed that they were all contaminated but safe for consumption. The values ranged from $1.71 \times 10^4 - 3.60 \times 10^4$, $3.80 \times 10^3 - 1.82 \times 10^4$ and $3.20 \times 10^4 - 1.48 \times 10^5$ for total aerobic bacterial, coliform and fungal counts respectively. The result of nutritional quality evaluation indicated that casein (control) supported more gain in weight (5.42 g) of rats after 14 days of the feeding trial period than the test diets containing plantain chips (1.10 g, 1.25 g, and 1.15 g for High Level, Wurukum and North Bank respectively). The nutritional values of test diets especially in terms of PER (0.58, 0.65, and 0.51) and TND (98.95, 99.48 and 98.67) compared favourably to that of casein (control), with PER and TND of 0.69 and 99.87 respectively. No marked variation was observed in the overall quality of samples obtained from the different locations. Plantain chips sold in Makurdi metropolis was found to be of good quality and should be consumed as a nutritious and healthy snack.

Keywords: Plantain chips, Snacks, Food Poisoning, Nutrition.

Introduction

There has been tremendous increase in the quality and kinds of snacks found in the Nigerian market, plantain chips inclusive. According to Onyejegbu and Olorunda (1995), Chips or crisps are the most popular post harvest processed products of cooking bananas in East Africa and West Africa. They play a very

important role in the diet of the modern consumer (Amany *et al*., 2012) and tend to be adopted because they are inexpensive and nutritious meals (Mosupye and Von Holy, 1999). Plantain chips are well accepted in households and can be consumed at every meal time but mostly preferred as a snack taken for pleasure and in-between meals (Honfo *et al.,* 2007). Protein malnutrition coupled with calorie deficiency is widespread in many developing countries (Akusu and Kiin-Kabari, 2012). It is reported that ready-to-eat foods are easily available, affordable, provide diverse food source, employment and with a potential for improving food security and nutritional status and general social security (Draper, 1996). Plantain is considered an excellent source of energy and nutrients (Honfo *et al*., 2007) with consumption averaged at 150 kg/person/year or 348 calories per day in Nigeria (IITA, 2000). It is therefore believed that it can play a key role in meeting nutritional requirements for Nigerian populations (Ajayi and Aneke, 2002). Its carbohydrate supply in the humid tropical zones of Africa, Asia and South America (Robinson, 1996) makes it excellent ingredient for functional and convenience foods like chips (Agunbaide *et al*., 2006). Street foods however sometimes cause concern with respect to their potential for serious food poisoning outbreaks (FAO, 1995).

The nutritional composition of fried plantain is reported in literature (Pikuda and Ilelaboye, 2009; Ayodele and Erema, 2010). Plantain chips are also prone to contamination (Oranusi and Braide, 2012) and infestation (Babarinde *et al*., 2010). Environmental cleanliness, poor packaging and handling techniques are among factors influencing the quality of plantain chips. Research has however shown that, nutrient composition or proximate composition of food is not enough to determine nutrient bioavailability hence; the need for animal feeding experiment since nutrition studies the provision and fate of nutrients in the body. Also the biological utilization of a protein is primarily dependent on its digestibility (Hooda and Jood, 2005). This study was therefore aimed at evaluating plantain chips sold in Makurdi metropolis if they were nutritious and safe for consumers.

Materials and Methods

Selection of Study Areas

The study areas selected within the metropolis were based on the level at which the plantain chips are traded. These areas include High Level, Wurukum and North Bank. Plantain chips can be sometimes found with migratory hawkers or in supermarkets in High Level area. Wurukum has the greatest demand for the product owing to the concentration of motor parks in this area and travellers

showing much liking for it. Around North Bank, it is commonly found at fuel stations, especially when there is queue in times of fuel scarcity.

Collection of Samples

The plantain chips used for this study were purchased from the selected areas twice in the morning (at an interval of 3 hours), January, 2013. For each study area, they were randomly selected from different hawkers into labelled polyethylene bags and immediately transported to the laboratory for analysis.

Preparation of Samples for Analysis

The collected samples were milled together but according to the location of purchase and that not to be used for immediate analysis were kept in polyethylene bags and stored in refrigerator.

(1) **Proximate Analysis:** Standard procedures of AOAC (2005) were used to determine parameters such as moisture, ash, crude fibre, fat, and protein. The tests were performed in duplicate and the mean was recorded as the observed value for each parameter. Carbohydrate was determined by difference as reported by Onyeike (1995) while energy values were determined using the Atwater factors as described by Shresthna and Noomhorm (2002).

(2) **Microbiological Analysis:** The aerobic plate count was determined using the method described by Adegoke (2004). 1.0g of blended sample was used to make a homogeneous solution with distilled water. Serial dilutions of the resultant homogenates were made to obtain 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4}. 0.1 ml of the dilutions was pour plated using Nutrient agar and incubated at 37^0C for 18 – 24 hours. Visible colonies were counted and expressed in log cfu/g per sample. The method of Adegoke (2004) and Collins *et al.,* (1987) were used for coliform count and fungal count respectively.

(3) **Nutritional Evaluation:** The nutritional assessment was done via feeding trial using 20 albino rats comprising both sexes of the Wistar strain. The rats, which were about 7 weeks old, were randomly selected and distributed into five groups consisting four rats per group for weight equalization. The mean initial weight of the rats ranged from 125.45 g – 129.83 g. They were fed with three experimental diets prepared using plantain chips as the test protein (A, B, C), a casein or reference protein diet (CD) and a non-protein diet (NP) – meant to adjust to zero the protein content of protein diets **(Table 3).** All diets and water were

served *ad libitum* for a period of 14 days. Faecal output were collected during the last 7 days (balance period); dried to constant weight and then ground into powder for faecal nitrogen determination. During the experiment period, records were kept of the feed consumption (intake) by weighing the feed given and that which remained together with the amount of feed that spilled after 24 hours and the difference determined. Protein intake was computed from the dietary protein content and feed intake. The method of Pellet and Young (1980) was followed for FER, PER, C-PER, PU, NPR, RPER and RNPR determinations while TPD was determined as described by Sarwar and Peace (1987).

(4) **Statistical Analysis:** The data obtained from the analysis were subjected to statistics using analysis of variance (ANOVA) and significant means were separated using the least significant difference (LSD) test (Ihekoronye and Ngoddy, 1985).

Results and Discussion

Proximate Composition (Dry Weight Bases) of Plantain Chips Sold in Selected Locations in Makurdi Metropolis

The proximate composition (dry weight bases) of plantain chips sold in selected locations in Makurdi metropolis are shown in **Table 1**. The mean values ranged from 5.76-6.25%, 3.2-5.08%, 0.44-0.52%, 2.23-2.38%, 85.85-88.36% and 405.28-414.12 Kcal for protein, fat, fibre, ash, carbohydrate and gross energy respectively. These mean values observed are similar to the report of Pikuda and Ilelaboye (2009) and Ayodele and Erema (2010) for fried plantain. There was no significant difference ($P \leq 0.05$) in the protein, fat, fibre and ash content between samples. This is expected since the chips are made from same kind of raw materials and subjected to the same processing technique.

The slight variation in values especially in percentage protein and fat could be attributed to the fact that different variety of plantain might have been used by the different processors (Belayneh, 2013). The stage of ripeness is also known to affect the quality of chips (Onyejegwu and Ayodele, 1995; Lamaire *et al*., 1997). It is true that oil uptake depend on variety, physicochemical properties of raw materials, starch content and apparent density (Diaz *et al*., 1999), the skill or technical know-how of the processor will have significant effect on fat absorption and moisture removal from plantains during frying. The removal of moisture from the composition led to slight concentration of the nutrients. The USDA and USDHHS (1995) recommended that not more than

30% of total energy be derived from fat, the plantain chips are therefore said to be healthy. The results also revealed that carbohydrate contribute more to the derivable energy from plantain chips than protein and fat. Therefore the derivable energy from plantain chips should not be neglected when considering the nutritional values because they are required for maintaining body metabolism.

Microbiological Quality

Table 2 shows the results for the mean total aerobic bacterial, coliform and fungal counts of the purchased plantain chips. The results were similar to the report of Oranusi and Braide (2012). It revealed that all the plantain chips samples were contaminated irrespective of the location of purchase. Total aerobic bacterial count gives an indication of the total bacteria in food. All the samples had total aerobic bacterial count of 10^4 cfu/g, which is less than 10^6 cfu/g. They are considered to be within satisfactory microbiological levels and present no food safety concern. They are therefore safe for human consumption (ICMFS, 1996; FSANZ, 2001; FAO/WHO, 2005). The coliform count recorded for sample B and C were in the order 10^4 cfu/g, which were considered to be high while sample A had satisfactory coliform count. It can be observed from the result that fungi make up more of the microflora of plantain chips. The highest fungal count was recorded for sample C (10^5 cfu/g), which was considered unacceptable while sample A and B had satisfactory level of fungi (10^4 cfu/g). It is suggested that samples with the unacceptable level of counts also present no food safety concern but further testing of the samples is required (FSANZ, 2001).

It is expected for fungi to dominate the microflora of the plantain chips because some carbohydrate foods confer some protective effects on some organisms such as yeast (Uriah and Ogbadu, 1980; Adams and Moss, 1995). Their growth is also supported by environmental temperature (Adams and Moss, 1995) and their ability to grow in low moisture foods. Poor post-processing handling of could contribute to the contamination of the product. Food poisoning/illnesses are however entirely preventable by practicing good sanitation and food handling techniques (Betty and Richard, 1994).

Nutritional Quality Based on Rat Performance and Nitrogen Balance

In our approach to evaluate the performance of rats fed plantain chips, the feeding trial diets were composed as shown in **Table 3. Table 4 and figure 1** summarise the performance of rats fed plantain chips as compared with a control (casein) diet. From the results, there was no linear relationship between

the feed intakes and/or protein intake and weight gain. The test protein diets (A, B and C) were consumed more than the control diet (CD). Diet C which was most consumed (36.04 g) differed significantly ($P \leq 0.05$) form A (32.91 g) and B (32.64 g). Animals are known to increase intake when fed palatable diets (Fox *et al*., 1994; Okoye, 1992; Fanimo *et al*., 1996). The greater acceptability of diets made of plantain chips can therefore be attributed to palatability of the diets among other factors (Onweluzo and Nwabugwu, 2009). **Figure 1** shows the weight changes during the experimental period, only the non-protein diet recorded loss in weight (-1.7 g).The control (casein) group which had the lowest feed intake however, supported more gain in weight (5.42 g). Although the FER of test diets did not differ significantly ($P \leq 0.05$), there was significant difference ($P \leq 0.05$) in the PU. Diet CD recorded the highest FE R but the lowest PU (Table 5). Their level of energy intake and utilization is possible to have influenced protein utilization (FAO/WHO/UNU, 2007). The results of nitrogen balance based on the feeding trial study applying the composed diets in

Table 3 are shown in **Table 6.** The PER and TND values for all diets were not significantly different ($P<0.05$). For other parameters tested, the results of the test protein diets were of close proximity to that of control (casein) diet. Diet B even had a better RNPR (1.04) than casein (1.00). The low PER of casein obtained in this study may be due to the fact that the casein source used was from a commercial milk brand whereas the efficiency ratio; NPR-Net protein ratio; C-PER-Corrected protein efficiency ratio; RPER- Relative protein efficiency ratio; RNPR- Relative net protein ratio; TND-True nitrogen digestibility; LSD- least significant difference recommended casein was from Animal Nutrition Research Council (Babji and Letchunan, 1989). Also a procedure that made no mention for casein enrichment was used (Pellet and Young, 1980). The TND values observed in **Table 6** revealed that the plantain chips were highly digestible. This may be due to their similarity in chemical composition to the mucus of the stomach lining (INIBAP, 2003). Also heating food is known to increase palatability, digestibility and keeping quality.

Conclusion

This study has shown that plantain chips sold in Makurdi metropolis are of good quality in all the location traded. The consumption of this safe and nutritious snack is encouraged as they are capable of supporting normal growth and development in children and maintenance of tissues in adults. There is however, need to improve on the packaging to elongate shelf life of the processed plantain chips.

Acknowledgements
The authors wish to acknowledge the University of Agriculture Makurdi for creating an enabling environment for the study. We wish thank our families for showing interest in this research and to our friends who provided financial support.

References:

Adams, M.R. and Moss, M.O. (1999). Food Microbiology. Royal Society of Chemistry, Cambridge, London. 1-386.

Adegoke, G.O. (2004). *Understanding Food Microbiology*. Shalom Press, Ibadan, Nigeria. 2nd Edition, Pp. 1-216.

Agunbiade, S.O., Olanlokun, J.O. and Olaofe, O.A. (2006). Quality of Chips Produced from Rehydrated Dehydrated Plantain and Banana, *Pakistan J. Nutr*., 5 (5): 471-473.

Ajayi, A.R. and Aneke, M.O. (2002). Consumption and Expenditure Patterns of Banana and Plantain Consumers in Nsukka Urban, *Nigeria. Info- Musa*, 11 : 50-53.

Akusu, O.M. and Kiin-Kabari D.B. (2012). Protein Quality and Sensory Evaluation of Moin-Moin Prepared from Cowpea/Maize Flour Blends. *African Journal of Food Science,* Vol. 6(3), pp. 47-51.

Amany, B.M., Shaker, A.M. and Azza, A.A. (2012). Vacuum Frying: An Alternative to Obtain High Quality Potato Chips and Fried Oil. *Global Advanced Research Journal of Microbiology*, Vol. 1(2):019-026.

Association of Official Analytical Chemist (AOAC) (2005). *Official Methods of Analysis*, 18th ed. Washington, DC.

Ayodele, O.H. and Erema V.G. (2010). Glycemic Indices of Processed Unripe Plantain *(Musa paradisiaca)* Meals. *African Journal of Food Science*, Vol. 4(8) pp. 514 – 521**.**

Babarinde, S.A., Babarinde, G.O. and Olasesan, O.A. (2010). Physical and Biophysical Deterioration of Plantain Chips (*Musa sapientum)* Due to Infestation of *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae). *Journal of Plant protection Research*, 50(3):302-306.

Babji, A. S. and Letchumanan, S. (1989). Evaluation of Nutritive Value of Local and Soy-beef Hamburgers. In Applewhite, T.H (Ed). AOCS *Vegetable Protein Utilization in Human Foods and Animal Feedstuffs,* AOCS Chemists' Society USA, 39: 237-242.

Belayneh, M., Workneh, T.S. and Belew, D. (2013). Physicochemical and Sensory Evaluation of Some Cooking Banana *(Musa spp.)* for Boiling and Frying Processes. *Journal of Food Science*, 1: 1-12.

Betty, C.H. and Richard, J.B. (1994). *Bacterial Causes of Food Poisoning in Food Poisoning and Hygiene*, 8th Edition Edward Annod. Publishing Limited, London. pp. 250-257.

Collins, C.H., Lyne P.M. and Grange J.M. (1989). *Microbiological Methods*. Butterworth Publishing Coy, Ltd. London.

Diaz, A., Trystram, G., Vitrac, O., Dominique, D. and Raoult-Wack, A. (1999). Kinetics of Moisture Loss and Fat Absorption During Frying for Different Varieties of Plantain. *J. Food Sci*., 79: 291-299.

Draper, A. (1996). Street Foods in Developing Countries: The Potential for Micronutrient Fortification. *John Snow, INC/OMNI Project London School of Hygiene and Tropical Medicine.*

Fanimo, A.O., Muduma, E., Umukoro, T.O. and Oduguwa, O.O. (1996). Substitution of Shrimp Wastes Meal for Fish Meal in Broiler Chicken Rations. Tropical Agriculture (Trinidad), 73(2):1-5.

FAO **(**1995). Quality Assurance for Small-scale Rural Food Industries, by P. J. Fellows, B. Axtell & M. Dillon, *FAO Agricultural Services Bulletin*, No. 117, Rome.

FAO/WHO (2005). *Regional Conference on Food Safety for Africa*. Harare, Zimbabwe, 3-6 October, 2005.

FAO/WHO/UNU (2007). Protein and Amino Acid Requirement in Human Nutrition. *Report of a Joint WHO/FAO/UNU Expert Consultation. FAO/WHO/UNU,* 276.

Fox, C.J., Blow, P., Brown, J.A. and Watson, I. (1994). The Effect of Various Processing Methods on the Physical and Chemical Properties of Shrimp Head Meal and Their Utilization. *Fab. Aquaculture*, 122:209- 226.

FSANZ (2001). *Guideline for the Microbiological Examination of Ready-To-Eat Foods*. Food Standards Australian New Zealand.

Honfo, F.G., Kayodé, A.P.P., Coulibaly, O. and Tenkouano, A. (2007). Relative Contribution of Banana and Plantain Products to the Nutritional Requirements for Iron, Zinc and Vitamin A of Infants and Mothers in Cameroon. *Fruits*, 62(5): 267-277.

Hooda, S. and Jood, S. (2005). Organoleptic and Nutritional Evaluation of Wheat Biscuits Supplemented with Untreated and Treated Fenugreek Flour. *Food Chem*., 90: 427-435.

ICMSF (1996). Sampling for Microbiological Analysis. *Principles and Specific Application*. University of Toronto, 1-18.

Ihekoronye, A. and Ngoddy, P. (1985). *Integrated Food Science and Technology for Tropics*. 1st Ed. Macmillan Publishers Ltd., London.

IITA (2000). Improving Plantain and Banana Based Systems. *International Institute of Tropical Agriculture Project 2, Annual Report*, Ibadan, p.67.

INIBAP (2003). The Many Uses of *Musa*. International Network for the Improvement of Banana and Plantain, *Parc Scientifique Agropolis* 2, Montpellier, France.

Lemaire, H., Reynes, M., Ngalani, J.A., Tchango Tchango, J. and Guillaumont, A. (1997). Aptitude à la friture de cultivars de plantains et bananes à cuire. *Fruits,* 52 (4): 273-282.

Mosupye, F.M. and Von Holy, A. (1999). Microbiological Quality and Safety of Ready-To-Eat Street-Vended Foods in Johannesburg, South Africa. *J. Food Protection*, 62: 1278-1284.

Okoye, Z. S. C. (1992). *Biochemistry Aspects of Nutrition Practice*. Hall of India Private, New Delhi, pp. 151-155.

Onweluzo, J.C. and Nwabugwu, C.C. (2009). Development and Evaluation of Weaning Foods from Pigeon Pea and Millet. *Pakistan Journal of Nutrition*, 8 (6): 725-730

Onyeike, E.N., Olungwe, T. and Uwakwe, A.A. (1995). Effect of heat treatment and De-fatting on the Proximate Composition of Some Nigerian Local Soup Thickeners. *Food Chem*. 53: 173-175.

Onyejegbu, C.A. and Ayodele, O. (1995). Effects of Raw Materials, Processing Conditions and Packaging on the Quality of Plantain Chips. *J. Sci. Food Agric.*, 68: 279-283.

Onyejugbu, C.A. and Olorunda, A.O. (1995). Effects of Raw Materials Processing Conditions and Packaging on the Quality of Plantain Chips. *J. Sci. Food Agri*., 68: 279-283.

Oranusi, U.S. and Braide, W. (2012). A Study of Microbial Safety of Ready-To-Eat Foods Vended on Highways: Onitsha-Owerri, South East Nigeria**.** *International Research Journal of Microbiology*. (IRJM), 3(2): 066-071.

Pellet, P. L. and Young, V. R. (1980). *Nutritional Evaluation of Protein Foods*. The United Nations University, Tokyo.

Pikuda, O.O. and Ilelaboye, N.O.A. (2009). Proximate Composition of Street Snacks Purchased from Selected Motor Parks in Lagos. *Pakistan Journal of Nutrition*, 8 (10): 1657-1660.

Robinson, J.C. (1996). *Bananas and Plantains*. Institute of Tropical and Subtropical Crops, South Africa. University Press, Cambridge.

Sarwar, G. and Peace, R. W. (1986). Comparison Between True Digestibility of Total Nitrogen and Limiting Amino Acids in Vegetable Proteins Fed to Rats. Journal of Nutrition, 116: 1172-1184.

Shrestha, A.K., and Noomhorm, A. (2002). Comparison of Physico-chemical Properties of Biscuits Supplemented with Soy and Kinema Flour. *International Journal of Food Science and Nutrition,* 37, 361-368.

Uraih, N. and Ogbadu, G. (1980). Incidence of Aflatoxin in Nigerian sorghum. *Microbios.,* 10:139-142.

USDA and USDHHS. 1995. Nutrition and Your Health: Dietary Guidelines for Americans. 4th ed., *Home and Garden Bulletin*, No. 232., U.S. Dept. Agriculture and U.S. Dept. Health and Human Services, Washington, D.C.

Table 1: Proximate Compositions of Plantain Chips from Three Locations in Makurdi Metropolis (Dry Weight Bases)

Parameter (%)	Sample			
	A	B	C	LSD
Crude protein	5.76[a]	5.85[a]	6.25[a]	0.68
Crude fat	3.20[a]	4.70[a]	5.08[a]	2.40
Crude fibre	0.45[a]	0.52[a]	0.44[a]	0.08
Total ash	2.23[a]	2.37[a]	2.38[a]	0.39
Carbohydrate	88.36[a]	86.56[b]	85.85[b]	1.08
Energy (Kcal)	405.28[c]	411.94[b]	414.12[a]	2.02

[abc] means in the same row with varying superscripts differ significantly (P<0.05)
Key: A = High Level, B = Wurukum, C = North Bank, LSD = Least Significant Difference

Table 2: Mean Microbial Counts of Plantain Chips Sold in Makurdi Metropolis

Counts (cfu/g)	Sample		
	A	B	C
Total aerobic Bacterial	1.71×10^4	3.60×10^4	3.30×10^4
Coliform	3.80×10^3	1.15×10^4	1.82×10^4
Fungal	3.20×10^4	9.45×10^4	1.48×10^5

Key: A = High Level, B = Wurukum, C= North bank

Table 3: Composition of Feeding Trial Diets

Ingredients (g)	Diets				
	CD	**NP**	**A**	**B**	**C**
Casein	2	-	-	-	-
Plantain chips meal	-	-	2	2	2
Corn starch	78	80	78	78	78
Vegetable oil	10	10	10	10	10
Non-nutritive cellulose	5	5	5	5	5
Mineral/vitamin premix	1	1	1	1	1
Salt	4	4	4	4	4
Total	**100**	**100**	**100**	**100**	**100**

Key: CD = Casein; NP = Non-Protein; A= High Level; B=Wurukum; C= North bank

Table 4: Mean Weight Gain, Protein and Feed Intakes of Rats Fed Plantain and Casein

Parameters	Diets				
	CD	**A**	**B**	**C**	**LSD**
Mean initial weight (g)	129.83	126.28	125.45	125.73	-
Feed intake (g/day)	29.20^{c}	32.91^{b}	32.64^{b}	36.04^{a}	0.59
Protein intake (g/day)	7.88^{a}	1.90^{c}	1.91^{c}	2.25^{b}	0.17
Mean weight gain (g)	5.42^{a}	1.10^{b}	1.25^{b}	1.15^{b}	0.44
Faecal protein output (g)	0.09^{a}	0.10^{a}	0.09^{a}	0.11^{a}	1.42
Mortality (%)	0.00	0.00	0.00	0.00	-

^{abc} ***means in the same row with varying superscripts differ significantly (P<0.05)***

Key: CD = Casein, A = High Level, B = Wurukum, C = North bank
LSD- Least Significant Difference

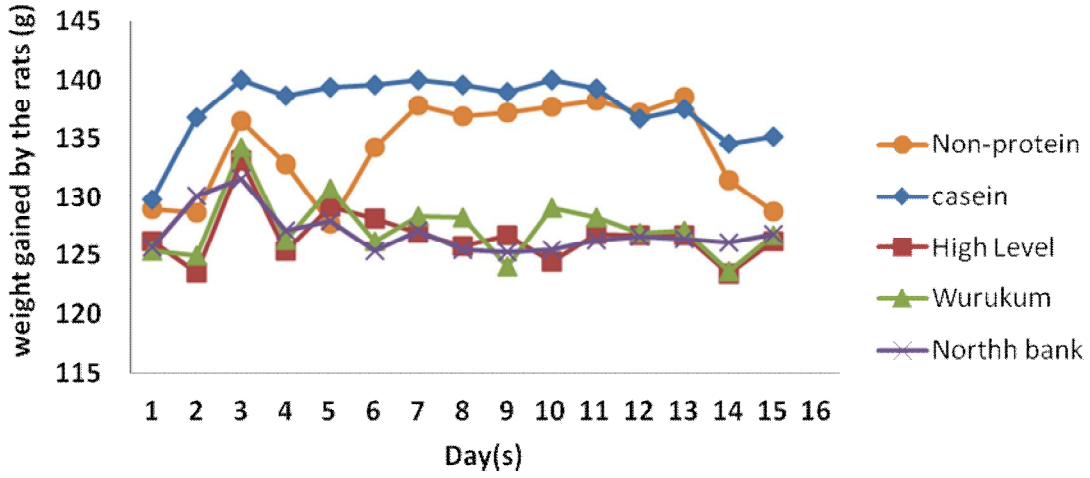

Fig. 1: Weight Changes and Growth Rates of Albino Rats Fed with Plantain Chips Compared with Casein and a Non-protein Diet.

Table 5: Feed Efficiency Ratio and Protein Utilization of Rats fed Plantain Chips

Parameter	Diets				
	CD	A	B	C	LSD
Feed efficiency ratio	0.186[a]	0.033[b]	0.038[b]	0.032[b]	0.011
Protein utilization	1.454[c]	1.727[b]	1.528[c]	1.957[a]	0.018

[abc] mean in the same row with varying superscripts differ significantly (P<0.05)
Key: CD = Casein Diet, A = High Level, B = Wurukum; C = North Bank
LSD- Least Significant Difference

Table 6: Values Indicating Protein Quality of Experimental Diets

Parameters	Diets				
	CD	A	B	C	LSD
PER	0.69[a]	0.58[a]	0.65[a]	0.51[a]	0.16
NPR	0.71[a]	0.67[ab]	0.74[a]	0.59[b]	0.11
C-PER	2.50[a]	2.10[b]	2.36[a]	1.85[c]	0.17
RPER	1.00[a]	0.84[bc]	0.90[ab]	0.74[c]	0.12
RNPR	1.00[ab]	0.94[b]	1.04[a]	0.83[c]	0.08
TD	99.87[a]	98.95[a]	99.48[a]	98.67[a]	1.45

[abc] Mean in the same row with varying superscripts differ significantly (P<0.05)
Key: CD= Casein diet; A= High Level; B= Wurukum; C= North Bank; PER-Protein

References to this paper should be made as follows: Julius K.I. *et al.,* (2013), Quality Evaluation of Plantain Chips Sold in Makurdi Metropolis. *J. of Agriculture and Veterinary Sciences,* Vol. 5, No. 2, Pp. 81 – 94.