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Chemical Composition of Chips from Selected Cassava Varieties in Makurdi, Benue State

***StephenSule[1], Vivian Obiamaka Offiah[1], Kumaiin SundayOrjime[1]**

[1]*Department of Food Science and Technology, University of Agriculture, Makurdi, Benue State, Nigeria*

****Corresponding Author:*** *StephenSule, Department of Food Science and Technology, University of Agriculture, PMB 2373,Makurdi, Benue State, Nigeria.*

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ABSTRACT

Chemical composition(proximate composition, pH, mineral contents, and some anti-nutritional factors)of chips fromsweet, improved and local varieties of cassavawas carried out using standard analytical methods. Results obtained showed that the sweet variety was highest in ash (2.55%) and fibre (3.65%) contents.The improved variety was highest in protein (2.17%) and fat (1.24%)contents, while the local variety was highest in moisture (12.33%) and carbohydrate (79.20%) contents. pH content of the chips ranged from 5.82 to 6.66, with the local variety being the most acidic. There were significant (p<0.05) differences in mineral content of chips. The sweet variety was highest in iron (1.58 mg/100g) and magnesium (44.00 mg/100g) contents, while those from the improved variety were highest in calcium (17.00 mg/100g)and zinc (2.37 mg/100g) contents. All anti-nutrients assessed fell within recommended limits, therefore, chips from these cassava varieties can be safely processed into consumer products.

Keywords: *Chips, Cassava varieties, Anti-nutrients, Proximate composition, Mineral content, pH*

INTRODUCTION

Cassava (*ManihotesculentaCrantz*) is among the most important foods for humans. It is well thought to be the most important tropical root crop and a major source of dietary energy for over 500 million people [1]. According to Burns *et al.*[2], cassava is the third most important indigenous source of calories in the tropics, after rice and maize, and millions of people in Africa, Asia and Latin America depend on it as a staple part of their diet and for income generation. Over 248 million tons of cassava was produced worldwide in 2012, of which Africa accounted for 58% [3]. World production of cassava in 2015 was 281.1 million tonnes fresh roots eq., of which 39.3 million tonnes were used in trade [4]. Cassava is the basis for a multitude of products, including food, flour, animal feed, alcohol, starches, sweetenersand bio-degradable products[1, 5, 6, 7].

According to FAO [8], Nigerian was ranked the largest producer of cassava globally; a third more than production in Brazil and almost double the production of Indonesia and Thailand. More recently, it is documented that Nigeria produces an estimated 54 million metric tonnes of cassava per annum [9].FAO [8]identified the North Central Zone in Nigeria as the highest producing zone for cassava on a per capita basis, of which Benue and KogiStateswere the highest contributors. However, Nigeria is not an active participant in cassava trade in the international markets because most of her cassava is targeted at the domestic food market. The production methods are primarily subsistence in nature and therefore unable to support industrial level demands [10]. One of the major challenges faced by processors is the poor storage capacity of fresh cassava produce, as tubers may contain up to 70% moisture. This has led to Traditional marketing and storage systems being adapted to avoid root perishability [11]. In Nigeria, as with most African countries, cassava roots are processed into different products as a means of preservation due to their perishability. These products vary depending on culture of the individuals.Someinclude *gari*, *fufu (akpu)*,*lafun*, starch, flour, *tapioca* and chips [12]. The increasing demand for cassava and its products for export and other utilization purposes has necessitated its conversion into chips, prior to further processing. This practice has become a widespread practice for both small and large scale processors. Size reduction shortens the drying time with the added advantage of eliminating the cyanide component present in the fresh root[13].

Cassava chips are dried irregular slices of roots, which vary in size but should not exceed 5 cm in length [14]. The tuberous roots, either peeled or unpeeled, are cut up into chips and dried, to be used for human consumption and in the animal feed industry. Chips are the most common forms in which dried cassava roots are marketed and most exporting countries produce them. The recovery rate of dried chips from fresh roots is 20 to 40% depending on the initial dry matter content of the cassava roots and final moisture of the chips. Drying may be achieved by sun drying, use of ovens or other drying equipment [15]. Cassava chips offer flexibility to processors and marketers because of its ease of handling, transportability and storage stability [16].Therefore, there is a need to elucidate the quality of chips from different cassava varieties in order to identify any varietal advantages which may exist. This research aimed at evaluating chips from sweet, improved and local cassava varieties from Makurdi, Benue state.

Materials And Methods

Sweet cassava (TMS 90257), improved cassava (TMS 30572), and a local cassava variety (*Akpu*) were obtained from Benue Agricultural and Rural Development Authority (BNARDA) in Makurdi, Benue state. All chemicals and reagents used were of analytical grade and obtained from the Department of Food Science and Technology, University of Agriculture, Makurdi, Nigeria.

Sample Preparation

The freshly harvested tubers were peeled, washed and chipped (5cm long, 2mm thick) prior to drying in an air draft oven (Gen lab Windness, T12H.England) at 65^{o}C for 8 h, as described by Cassava master plan [17].

Proximate Composition and pH

Moisture, crude protein, crude fat, crude fibre and ash contents of cassava chips were determined according to AOAC [18].Carbohydrate content was estimated by difference [19]. pH of the samples were read from an electronic pH meter.

Mineral Determination

Calcium, iron, zinc and magnesium contents were determined following AOAC atomic absorption spectroscopy methods [18].The ash obtained after incinerationat 500°C was dissolved in aquaregia (10mL nitric acid+30mL HCl) solution and boiled for 30min. The mixture wastransferred into a 250mL volumetric flask and boiled againfor 30min. The mixture was filtered into 100mL volumetricflask and made up to the mark with distilled water. Themineral concentration was estimated quantitatively using an atomic absorption spectrophotometer (scientific model VGP 210) using filters that match the different elements.

Anti-Nutritional Factors And Toxins

Hydrocyanic acid (HCN) was determined using the method of AOAC [18]. Oxalate was estimated according to the procedure described by Day and Underwood[20].Phytate content was determined using the method described by AOAC[18].

Statistical Analyses

Experiments were conducted in triplicates. Data obtained were statistically analyzed using analysis of variance (ANOVA). Means were separated by Fischer's Least Significance Difference Test and significant difference was accepted at 5% level of probability ($p < 0.05$) using the GenStatpackage (17th edition).

Results And Discussion

Proximate Composition and pH of Chips from Selected Cassava Varieties

Table 1 shows the proximate composition and pH of cassava chips from selected cassava varieties. Moisture content of samples ranged from 11.85% to 12.33%. Highest moisture was observed for chips from the local variety, whereas, chips from the improved variety was lowest in moisture. Moisture content of food is an index of storage stability[21] and also a measure of quantity of food solids [22]. The moisture content for cassava chips in the study were within the acceptable limits for dried foods and also closely conformed with values reported for chips and other dried samples by earlier studies [22, 23]. Ikujenlolaand Omosuli [24] reported a value 11.24% for*gari* processed from dehydrated cassava chips. Ash content, which is a measure of the mineral elements was lowest in the local variety (2.08%) and highest in chips produced from the sweet variety (2.55%). Protein contents of cassava chips varied from

1.85% to 2.17%, while crude fibre ranged from 3.47% to 3.65%. Fat content varied from 1.06% to 1.24% and carbohydrate content fell within the ranges of 78.81% and 79.20%. Significant differences (p<0.05)in moisture, crude fibre, and carbohydrate contents were observed between all varieties. pH values ranged from 5.82 to 6.66 with chips processed from the sweet variety having the highest pH of 6.66 while those from the local varietyhad the lowest pH value of 5.82 and therefore showed the highest acidity. There were significant differences (p<0.05) in pH values between chips obtained from the three cassava varieties.

Table1. *Proximate Composition and pH of Chips from Selected Cassava Varieties*

Parameters	Sweet variety	Improved variety	Local variety	LSD
Moisture (%)	12.05^{b}±0.04	11.85^{c}±0.02	12.33^{a}±0.03	0.05
Protein (%)	1.85^{b}±0.04	2.17^{a}±0.02	1.86^{b}±0.02	0.05
Ash (%)	2.55^{a}±0.03	2.09^{b}±0.03	2.08^{b}±0.02	0.06
Fat (%)	1.07^{b}±0.02	1.24^{a}±0.04	1.06^{b}±0.02	0.06
Crude Fibre (%)	3.65^{a}±0.02	3.57^{b}±0.02	3.47^{c}±0.03	0.05
CHO (%)	78.81^{c}±0.04	79.09^{b}±0.06	79.20^{a}±0.06	0.11
pH	6.66^{a}±0.05	6.22^{b}±0.02	5.82^{c}±0.03	0.07

Values are mean ± standard deviation of triplicate determinations. Mean within the same row with different superscripts vary significantly (p<0.05).

Key: Sweet variety (TMS 90257); Improved variety (TMS 30572); Local variety (Akpu); CHO=Carbohydrate; LSD=Least significant difference.

Mineral Contents of Chips from Selected Cassava Varieties

Mineral contents of chips from selected cassava varieties are presented in Table 2. Calcium content of chips differed significantly (p<0.05) between cassava varieties with values ranging from 9.00 to 17.00mg/100g. Theimproved variety displayed highest content of the mineral, while the local variety had the least calcium content. Values for calcium from published data were 10mg/100g fresh weight basis [25] and 136 to 369mg/100g dry weight basis [26]. Magnesium contents ranged from 27.00 to 44.00mg/100g with chips from the sweet variety having the highest content while the local variety had the lowest content. All varieties were significantly (p<0.05) different in their magnesium contents. Earlier studies reported magnesium contents in cassava as 30mg/100g, fresh weight [27] and 43mg/100g, dry weight [26]. Magnesium is required for normal functioning of the muscleand nervous systems, helps in supporting a healthy immunesystem, keeps bone strong and helps in regulating bloodsugar levels, thereby promoting normal blood pressure[28]. Iron contents ranged from 1.11mg/100gto1.58 mg/100g, compared to 29mg/100greported by Charles [26]. Iron is required for energy production, growth and development, immune functions, red blood cell formation, reproduction and wound healing[29]. Zinc contents ranged from 1.63mg/100g to 2.37mg/100g. All varieties were significantly different (p<0.05) in their zinc contents. Buitrago[25] reported zinc content of 1.4mg/100g fresh weight in cassava roots tubers, while Charles *et al*.[26] reported 13 mg/100g.

Table 2. *Mineral Content (mg/100g) of Cassava Chips from Selected Varieties*

Parameters	Sweet variety	Improved variety	Local variety	LSD
Calcium	13.00^{b}±0.01	17.00^{a}±0.03	9.00^{c}±0.04	0.12
Iron	1.58^{a}±0.04	1.22^{b}±0.04	1.11^{c}±0.06	0.05
Magnesium	44.00^{a}±0.02	36.00^{b}±0.05	27.00^{c}±0.02	0.04
Zinc	1.65^{b}±0.06	2.37^{a}±0.03	1.63^{c}± 0.06	0.01

Values are mean ± standard deviation of triplicate determinations. Mean within the same row with different superscripts vary significantly (p<0.05).

Key: Sweet variety (TMS 90257); Improved variety (TMS 30572); Local variety (Akpu); CHO=Carbohydrate; LSD=Least significant difference.

Anti-Nutritional Factors in Chips from Selected Cassava Varieties

Anti-nutritional factors in chips from selected cassava varieties are presented in Table 3. Hydrogen cyanide contents differed significantly (p<0.05) between chips from the selected cassava varieties. Values ranged between 0.02 and 0.18mg/100g, which fell below the recommended limit of 2.0mg/100g HCN for *gari* and cassava starch [30, 31, 32]. Hydrogen cyanide is considered highly harmful because it binds cytochrome oxidase and stops its action in respiration, which is a key energy conversion process in the body. The values obtained in this study were lower than 1.97 to 2.01 mg/100g reported by Taiwo and Okesola [22]. Cyanide contents may have been depleted as a result of processing to obtain chips. Irinkoyenikan*et al*.[15] reported a decrease in cyanide of chips with increase in thermal processing and attributed this decrease to the breakdown of cyanogenic glucosides in cassava chips during drying. Oxalate contents ranged from 0.63 to 0.85mg/100g,while phytates ranged from 1.94 to 2.33mg/100g. The values obtained inthis study were below the critical values stipulated by SON [32] and Oboh*et al*.[33].Oxalates bind calcium present in food, thus rendering itunavailable for body utilization.

Table3.*Anti-nutritional Compounds/Toxins (mg/100g) in Cassava Chips from Selected Varieties*

Parameters	Sweet variety	Improved variety	Local variety	LSD
HCN	$0.08^{b}\pm0.003$	$0.02^{c}\pm0.004$	$0.18^{a}\pm0.003$	0.01
Oxalate	$0.85^{a}\pm0.008$	$0.63^{c}\pm0.007$	$0.74^{b}\pm0.053$	0.06
Phytate	$2.25^{b}\pm0.03$	$1.94^{c}\pm0.004$	$2.33^{a}\pm0.005$	0.04

Values are mean ± standard deviation of triplicate determinations. Mean within the same row with different superscripts vary significantly (p<0.05).

Key: Sweet variety (TMS 90257); Improved variety (TMS 30572); Local variety (Akpu); CHO=Carbohydrate; LSD=Least significant difference; HCN= Hydrogen cyanide.

CONCLUSION

The study has shown that chips from the selected cassava varieties contained appreciable levels of nutrients. The improved variety was however, higher in protein and fat contents and may find better application in product development. All chips were low in anti-nutritional factors, suggesting their safety for human consumption.

REFERENCES

[1] Morgan, N. K., and Choct, M., 2016, Cassava: Nutrient composition and nutritive value in poultry diets, Animal Nutrition, 4, 253-261.

[2] Burns, A., Gleadow, R., Cliff, J.,Zacarias, A., andCavagnaro, T., 2010, Cassava:The Drought, War and Famine Crop in a Changing World. Sustainability, 2: 3572-3607.

[3] Onyenwoke, C.A., andSimonyan, K.J., 2014, Cassava post-harvest processing and storage in Nigeria: a review, African Journal of Agricultural Research, 9(53), 3853-3863.

[4] FAO, 2016, Food outlook-biannual report on global food markets, Food and Agriculture Organization of the United Nations. [Online]. Available: www.fao.org/3/a-i6198e.pdf

[5] Aloys, N.,and Ming, Z. H., 2006, Traditional cassava food in Burundi, Food Reviews International, 22: 1-27.

[6] Balagopalan, C., 2002, Cassava utilization in food, feed and industry. In: Hillocks, R. J., Tresh, J.M. and Belloti, A.C. (eds), Cassava: biology, production and utilization, Centro Internacional de Agricultura Tropical, Colombia, 301-318.

[7] Taiwo, K. A., 2006, Utilization potentials of cassava in Nigeria: the domestic and industrial products, Food Reviews International, 22, 29-42.

[8] FAO, 2004,A cassava industrial revolution in Nigeria-the potential for a new industrial crop, Food and Agriculture Organization of the United Nations, Rome.

[9] FAO, 2015, Foodand Agriculture Organization year book, FAO, Rome, Italy, 215-225.

[10] FAO, 2013, FAOSTAT, Food and Agriculture Organization of the United Nations Statistical Database. [Online]. Available: http://faostat.fao.org/

[11] Aristizabal, J., and Sanchez, T.,2007,Guíatécnicaparaproducción y análisis de almidón de yuca. Boletindeserviciosagricolas de la FAO 130 FAO Rome., Italy P. 134.

[12] Andrew, W., 2002, Cassava utilization, storage, and small scale processing, Natural Resource Institute, Chatham maritime, UK, 14, 270-290.

[13] Oluwole, O. B., Olatunji, O. O., and Odunfa, S. A., 2003, A process technology for conversion of dried cassava chips into *gari*, Nigerian Food Journal, 22 (1), 65-77.

[14] Onyenwoke C. A. and Simonyan K. J. (2014). Cassava post-harvest processing and storage in Nigeria: A review, African Journal of Agricultural Research, 9(53): 3853-386.

[15] Irinkoyenikan, O. A., Taiwo, K. A., Gbadamosi, S. O., and Akanbi, C. T., 2008, Studies of *fufu* production from cassava chips, Proceedings of conference held at the ObafemiAwolowo, University, Ile-Ife, Nigeria, 117 – 132.

[16] Graffham, A. J., Dziedzoave, N. T., and Ayernor, G. S., 1999, Crop Post Harvest Programme, Expanded markets for locally produced cassava flours and starches in Ghana. Final Technical Report, 1 January 1996 - 31 March 1999.

[17] Cassava Master Plan, 2006,A strategic action plan for the development of Nigeria cassava industry. [Online]. Available: http://eucord.org/wp-content/uploads/2014/01/cassava_master_plan.pdf.

[18] AOAC, 2005, Association of Official and Analytical Chemists, Official Methods of Analysis, 12th Edition, Washington D.C.

[19] Ihekoronye, A. I., and Ngoddy, P. O., 1985, Integrated Food Science and Technology for the Tropics, 1st Edn.,MacmillianPublishers Ltd. London.

[20] Day, R.A., and Underwood, A.L., 1986, Quantitative analyses, 5th edition, Prentice Hall Publication, London.

[21] Sengev, I. A., Nwobi, I. and Sule, S., 2016, Effect of Crayfish Inclusion on the Chemical and Sensory Properties of *Ogi* Prepared from Maize, Millet and Sorghum. International Journal of Nutrition and Food Sciences, 5 (6): 378-383.

[22] Taiwo, K. A., and Okesola, C. O., 2009, A study of some processing factors on the production of *gari* (a fermented product) from dehydrated cassava chips, Proceedings of AICHE 2009 Conference, Nashville, Tennessee, USA.

[23] Oluwole, O. B.,Olatunji, O. O., and Odunfa, S. A., (2004),A process technology for conversion of dried cassava chips into *gari*. Journal of Food Science and Technology 22: 65 -77

[24] Ikunjelola, A. V., and Omosuli, S. V., 2009, Dehydrated cassava chips utilisation in starch and *gari* production, Advanced Materials Research, 62-64, 203-207.

[25] Buitrago J.A., 1990. La yuca en la alimentacion animal, Centro Internacional de Agricultura Tropical (CIAT), Cali, CO, 450.

[26] Charles, A.L., Sriroth K., and Huang, T.C., 2005, Proximate composition, mineral contents, hydrogen cyanide and phytic acid of 5 cassava genotypes, Food Chemistry, 92, 615-620.

[27] Bradbury, J. H. and Holloway, W.D., 2006,Cassava (*M. esculenta*). Chemistry of tropical root crops: significance for nutrition and agriculture in the Pacific, Australian Centre for International Agricultural Research, monograph no. 6, Canberra, Australia, 76–104.

[28] Arinathan, V., Mohan V. R., and John De Britto, A., 2003,Chemical Composition of Certain Tribal Pulses in South India.International Journal of Food Sciences and Nutrition, 54, 209-217.

[29] Ullah, R. J. A., Khader, I., Hussain, N. M., Talha, A. M., and Khan, N., 2012, Investigation of Macro and Micronutrients inSelected Medicinal Plants. *African Journal of Pharmacy andPharmacology*, 69, 1829-1832.

[30] FIIRO, 2005,Cassava processing, Federal Institute of Industrial Research, Oshodi, Lagos state, Nigeria.

[31] IITA, 1990, Post-harvest technology, In: International Institute of Tropical Agriculture, (ed.), Cassava in tropical Africa-a reference manual, IITA Ibadan, 82-120.

[32] SON, 2004, Nigeria industrial standard for *gari*, Standards Organization of Nigeria, Lagos state, Nigeria.

[33] Oboh, G., Akindahunsi, A.A., and Oshodi, A.A., 2002, Nutrient and anti-nutrient content of *Aspergillusniger* fermented cassava products (flour and *gari*), Journal of Food Composition and Analyses, 15(5), 617-622.

AUTHOR'S BIOGRAPHY

StephenSule, is a researcher with the University of Agriculture, Makurdi, Nigeria with a specialty in food processing, which he believes is the hub of food security for any nation. He is available for collaborative research both locally and internationally and is willing to interact with researchers in the field of food processing.