IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 6, Issue 1 (Sep. - Oct. 2013), PP 47-50
www.Iosrjournals.Org

Evaluation of Cyanogen Contents of Cassava and Cassava Based Food Products in Karu, Nasarawa State, North Central Nigeria

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Abstract: *Cyanogen contents of seven most consumed cassava based food products in Nasarawa state were evaluated using the alkaline picrate method. These products were subjected to different processing methods such as peeling, washing, grating, fermentation, drying/dewatering, milling/pulvering and frying. The analyses showed reduction in cyanogens contents ranging from 56.33% to 89.58% compare to raw cassava tubers from which they were all produced. These results also showed that cassava processing methods in which fermentation is involved in the multistep processing stages greatly reduced cyanogen contents of the cassava. However, these processing methods did not remove all the cyanogen from the cassava products but reduced it below 10 ppm, recommended by the World Health Organization as safe limit, suggesting that the cassava underwent proper processing to produce safe products. Consumption of these products will not lead to the lethal dose of 35 mg hydrocyanic acid per kg body weight reported by some authors, hence marketing and consumption of these products should be promoted and efforts made to improve the processing methods to further reduce the cyanogen contents of the products.*
Keyword: *Cassava, cyanogens, fermentation, hydrocyanic acid, picric acid,*

I. Introduction

Millions of people in developing countries consume cassava and its products which represent important staple foods in these countries. Cassava is popular because it offers the advantage of a flexible harvesting time, allowing farmers to keep the roots in the ground until needed. In addition, the crop yields well under growth limiting conditions and are tolerant to drought or infertile soils, and possesses the ability to recover from disease and pest attacks [1,2,3].The different varieties of cassava can be distinguished by such features as size, colour and shape of the leaf, stem and petiole, branching habit, plant height, tuber and amount of the root tuber produced per plant, the nutritive content of the tubers, the resistance to certain diseases and weeds, the climatic and nutrient requirements for maximum yield of the plants and “sweet” or “bitter”(depending on the level of cyanide content which gives a bitter taste) [4,5,6].

A limiting characteristic for human or animal population that depend on cassava roots as food is the toxicity of hydrogen cyanide/hydrocyanic acid (HCN) which occurs as a result of the hydrolysis of cyanogenic glucosides[7,8,9], a group of nitrile containing compounds that yield cyanide following their enzymatic breakdown [10,11,12]. Many plant species produce and sequester cyanogenic glycosides but the most agronomically important of the cyanogenic crops is cassava (Manihot esculenta ,Crantz).The levels of the cyanogens vary considerably between tissues [13] depending on many factors such as cultivar[14,15];climatic conditions[14,16]; Age of Cassava at Harvesting[17,18] and Post Harvest Practices[19, 20,21].The cyanogenic glycosides is toxic to humans,if consumed without prior treatment leading to vomiting, exacerbate goitre, cretinism in iodine-deficient regions, nausea, dizziness, stomach pains, weakness, headache, diarrhea, paralysis, neurological disorders, Tropical Ataxic Neuropathy (TAN), stunting of children and occasionally, death [22,23,24]. Most Nigerians who consume cassava and its products do not develop most of these diseases because of the way the cassava is prepared [5] and variation in consumption of other foods and supplements, especially animal protein [6].However, there is a great concern about the levels of cyanogens in many varieties of cassava products, in order to prevent cyanide poisoning, medium and high cyanide cassava roots require some form of processing like peeling, washing, grating, fermentation, drying/dewatering, milling/ pulvering and frying/roasting, to significantly reduced the level of the cyanogens contents to the safe limit [20, 25, 26, 27] before they are consumed. The aim of this study was to assess the cyanogen contents in various cassava based food products to determine the effects of different processing methods on the cyanogen contents.

II. Materials and Methods

2.1 sites of the experiment

The survey and the analyses were carried out in the chosen markets in Karu, Nasarawa state North central Nigeria and Department of Biochemistry, Bingham University Karu Nasarawa state, Nigeria, respectively.

2.2 Survey and collection of samples

A survey of commonly utilized cassava (TMS 30572) and its food products that are commercially available in Nasarawa State North central Nigeria were carried out in the selected markets in this area. Cassava and cassava based food products that were available were selected for this study. The selection was made to reflect the most consumed products that are always available in the market. These products include: Boiled Cassava, Starch, Garri, Akpu, Abacha, Cassava flour and soaked cassava.

2.3 Analysis

The cyanogen contents of the cassava products were determined using the alkaline picrate method with modifications [28]. 10g of cassava samples were weighed each and crushed into smaller pieces using mortar and pestle, a little quantity of water was added to form solution of each sample. The supernatant was collected and measured with measuring cylinder and was used for cyanogen content analysis. For this analysis, 1ml of the sample was pipette into test tube followed by 1ml of 0.04M picric acid and 1ml of 0.75M NaOH .The solution in the test tube was mixed and incubated for 15 minutes at room temperature. In this method, hydrocyanic acid (HCN) released during hydrolysis of the cyanogenic glycosides reacts with picric acid to produce a yellow coloured solution. Sodium hydroxide preserves the HCN released. Colour intensity was measured spectrophotometrically at the wavelength of 540nm. The same process above was used for all other samples and the reference standard.

Calculation:

$$CONC_{HCN} = \frac{O.D_{TEST}}{O.D_{STD}} \times \frac{CONC_{STD} \times \text{Volume obtained} \times 100}{\text{Volume of sample used}}$$

O.D = Optical Density/Absorbance

STD= standard

Conc= Concentration

2.4 Statistical analysis

The data are expressed as mean ± SD. Groups were compared using the one-way ANOVA. Statistical analysis was performed using SPSS (Version 17). A level of $p < 0.05$ was considered to be significant

III. Results

Table 1: Cyanogen Contents of Cassava and Cassava Products

Products	Cyanogen Contents (ppm)
Abacha	$4.22 \pm 0.67^{a,b}$
Akpu	$2.04 \pm 0.64^{a,b}$
Boiled cassava	$6.45 \pm 1.19^{a,b}$
Cassava flour	$5.68 \pm 0.95^{a,b}$
Starch	$5.14 \pm 1.09^{a,b}$
Garri	8.54 ± 0.30^{a}
Soaked cassava	$4.85 \pm 0.84^{a,b}$
Cassava tuber	19.55 ± 0.95^{b}

Values are expressed as mean ± standard deviation of the triplicates. a = significant decrease at $p<0.05$ compare with cassava tuber. b = significant difference at $p<0.05$ compare with garri

Table 2: Percentage Decrease in Cyanogen Contents of Cassava Based Food Products

Products	Methods of Preparation	Cyanogen Content (ppm)	Percentage Decrease Compare With Raw Cassava (%)
Abacha	peeling, washing, boiling and sun drying	4.22±0.67	78.41
Akpu	peeling, washing, fermentation, pulvering,dewatering, and boiling	2.04±0.64	89.58
Boiled cassava	peeling, washing and Boiling	6.45±1.19	66.99
Cassava flour	peeling,washing,fermentation, dewatering, drying and milling	5.68±0.95	70.97
Garri	peeling, washing, milling, fermentation, dewatering,and frying	8.54±0.30	56.33
Soaked cassava	peeling, washing, fermentation,dewatering,	4.85±0.84	75.19
Starch	peeling,washing,grating,fermentation, and dewatering	5.14±1.09	73.69

The result is expressed as mean ± standard deviation of the triplicates.

IV. Discussion

The cyanogen contents of seven most commonly consumed cassava-based food products in Nasarawa, North central Nigeria were examined and the cyanogen contents ranged from 2.04 to 8.54 mg per 1000g food sample (Table1). These products undergone different processing method such as peeling, washing, grating, fermentation, drying/dewatering, milling/pulvering and frying to significantly reduce the cyanogens contents before they were sold, total elimination of the cyanide may not be achievable because the methods of processing cassava roots are not 100% efficient[22,24,31].These different processing methods have different effects on the cyanogen contents of the products but they all showed significant reduction in the cyanogen contents compare to the raw cassava tubers from which they were produced (Table 1).

The percentage decrease in cyanogen contents and the processing methods of the products are shown in table 2.Akpu which was obtained from cassava fermented for three to four days after which excess water is squeezed out in a press, thus removing free cyanide from damaged cassava tissue due to extraction and cooked by heating over a wood fire in a metal or earthen pot with continuous stirring, has the highest reduction(89.58%)[29] while garri has the least. The unusually high level of cyanogens in garri which suppose to have low cyanogens contents may be due to the improper processing method as garri undergone almost the same processes with akpu. To make garri the peeled root is ground up using a mechanical grinder and placed in a hessian bag for 2–3 days leading to extensive fermentation with the excess water squeezed out in a press and the product roasted by heating over a wood fire in a metal pan with continuous stirring. The total cyanogen contents of garri (Table2) is still lower than WHO safe level of 10 ppm[30]. Garri is usually soaked in water for drinking during which the water is usually decanted to further remove some residual cyanide in the soaked garri or may be prepared with hot water to form eba which is taken with soup containing animal products this may also reduced the effect of cyanide on consumption because supplements, especially animal protein [6] reduces toxic effects of cyanide as cyanide poisoning from high-cyanogenic cassava is typically associated with insufficient consumption of Cysteine and Methionine in the diet [13,32]. Consumption of these products however, will not lead to the lethal dose of 35 mg hydrocyanic acid per kg body weight reported by Eneobong[33] because the consumers consume far lower quantity of these products than the quantity that can give this dose.

V. Conclusion

The percentage cyanogen lost to multistage processing showed that the processing methods involved are efficient resulting in cyanogen levels that are not high enough to cause cyanide toxicity when the amount of cassava product consumed in a meal is taken into consideration. Hence, the processed cassava products are safe for consumption and combinations of many processing methods which enable maximum removal of cyanogens contents of the cassava should be encouraged.

Reference

[1] A. C. Allem, The origins and technology of cassava. In: R. J. Hillocks, J. M. Tres, and A. C Belloti, Cassava: biology, production and utilization. (CABI publishing, 2002): 1-16.

[2] C. Iglesias, J. Mayer, A.L. Ch´avez and F. Calle, F,Genetic potential and stability of carotene content in cassava roots. *Euphytica* , *(94),*1997,367–373.

[3] R.D. Cooke And E.N. Maduagwu, The effect of simple processing on the cyanide content of cassava chips. *Journal of food technology (13)* 1985, 299-366.

[4] Raw Materials Research and Development Council, RMRDC, Cassava Report on Survey of Agro Raw Materials in *Nigeria-Raw Materials Research and Development Council* (Maiden Edition), 2004. 1-2, 18-19.

[5] C.L. Asadu, A. Felix and I. Nweke, Soils of Arable Crop Fields in Sub-Saharan Africa: Focus on Cassava Growing Areas. Collaborative Study of Cassava in Africa (COSCA). Ibadan, Nigeria: *International Institute of Tropical Agriculture*. *Working Paper (18)* 1999

[6] F.I. Nweke, B.O.Ugwu, A.G.O. Dixon, C.L.A. Asadu and O. Ajodo, Cassava Production in Nigeria: Afunction of Farmer Access to Markets and Improved Production and Processing Technologies. . IITA, Ibadan. *COSCA working paper (20),* 1999.

[7] E.A. Uyo, O.Udensi, V. Natui And I.Urua, Effect of different processing methods on cyanide content of garri from four cultivars of cassava. *J. of Food, Agriculture and Environment, 5(3&4)* 2007, 105-107.

[8] P. Nicholls, and T Soulimane, The Mixed Valence State of the Oxidase Binuclear Centre: How Thermus thermophilus Cytochrome ba3 Differs from Classical aa3 in the Aerobic Steady State and When Inhibited by Cyanide. *Biochem. Biophys. Acta, 1655(1-3), 2004,* 381-387.

[9] J.H. Bradbury and D.W. Holloway, 1988. Chemical composition of tropical root crops from the south pacific: Significance for human nutrition. Canberra: *Australian center of int. Agric. Res.,* 1988, 103-104.

[10] J.McMahon, W. White, R.T. Sayre, Cyanogenesis in cassava (*Manihot esculenta* Crantz*). J Exp Bot,(46*)**,** 1995,731–741

[11] A. Belloti and B. Arias, The possible role of HCN on the biology and feeding behavior of the cassava burrowing bug (*Cyrtomenus bergi* Froeschner). *In* WM Roca, AM Thro, eds, *Proceedings of the First International Scientific Meeting of the Cassava Biotechnology Network, Centro Internacional Agricultura Tropical,Cali, Colombia*, 1993,406–409

[12] D. Selmar, Transport of cyanogenic glycosides: uptake of linustatin by *Hevea* cotyledons. *Planta,* (191)**,** 1993, 191–199

[13] B. Nambisan, Cyanogenesis in cassava. *In* WM Roca, AM Thro, eds, *Proceedings of the First International Scientific Meeting of the Cassava Biotechnology Network, Centro Internacional Agricultura Tropical, Cali, Colombia,* 1993,424–427

[14] A.P.Cardoso,E. Mirione, M. Ernesto, F. Massaza, J. Cliff, M.R Haque, J.H.Bradbury, Processing of cassava roots to remote cyanogens. *J. Food. Comp. Anal. (*18), 2005,451-460.

[15] C.C. Wheately,J.I. Orrego, T. Sanchez and E. Granados, Quality evaluation of cassava core collection at CIAT. In Roca, A.M. and Thro, A.M., Eds: *Proceedings of the First International Scientific Meeting of Cassava Biotechnology Network; CIAT, Cali Columbia*, 1993,379-383.

[16] D.N.Gitebo,J.P. Banea-Mayabu, R,N,Matadi ,T. Tylleskar T, M.Gebre-Medhin,H. Rosling Geogarphical and Seasonal Association between Linamarin and Cyanide Exposure from Cassaca and the upeer motor neuron disease Konzo in DRC. In CCDN News, (14), 2009

[17] A.Hidayat, N. Zuraida and I. Hararida 2002. The Cyanogenic Potential of Roots and Leaves of Ninety Nine CASSAVA cultivars. *Indonesian Journal of Agricultural Science 3(1),* 2002, 25-32

[18] S. Chotineeranat, T. Suwansichon,P. Chompreeda,K. Piyachomkwan, V. Vichukit, K. Sriroth,V. Haruthaithanasan, Effect of root ages on the quality of low cyanide cassava flour from Kasetsart 50. *Kasetsart J. Nat. Sci. (40)*, 2006, 694-701.

[19] Bradbury, J.H. 2006. Simple wetting method to reduce cyanogens content of cassava flour. *J. Food Comp. Anal. (19),* 2006, 388-393.

[20] A.Cumbana,E. Mirione, J. Cliff, J.H. Bradbury, Reduction of cyanide content of cassava flour in Mozambique by the wetting method. *J. Food Chem. 101 (3),*2007, 894-897.

[21] M.A Idowu and S.A. Akindele, Effect of storage of cassava roots on the chemical composition and sensory qualities of gari and fufu. *Food Chem. 51 (4)*, 1994, 421-424.

[22] O.S.A. Oluwole, A.O. Onabolu, I.A. Cotgreave, H. Rosling, A. Persson and H. Link, Incidence of ataxic polyneuropathy and its relationship to exposure to cyanide in a Nigerian community. *J. Neurol. Neurosurgery Psychiatry (74),* 2003, 1412-1416.

[23] K. Stephenson, R. Amthor, S. Mallowa, R. Nungo, B. Maziya-Dixon and S. Gichuki, 2010. Consuming cassava as a staple food places children 2-5 years old at risk for inadequate protein intake, an observational study in Kenya and Nigeria. *Nutr. J., (26),* 2010, 1-9.

[24] A.O. Onabolu, O.S. Oluwole and M. Bokanga, 2002. Loss of residual cyanogens in a cassava food during short-term storage. *Int. J. Food Sci. Nutr.,*(53),2002, 343-349.

[25] J.H. Bradbury, J. Cliff, I.C. Denton, Uptake of wetting method in Africa to reduce cyanide poisoning and konzo from cassava. In *Food and Chemical Toxicology, (49),* 2011, 539-542.

[26] G. Oboh and C.A. Elusiyan, Changes in the nutrient and anti-nutrient content of Micro-fungi fermented cassava flour produced from low- and medium-cyanide variety of cassava tubers. In *African Journal of Biotechnology,(6),*2007, 2150-215

[27] S.C. Kobawila, D.Louembe,S. Keleke, J. Hounhouigan, C. Gamba, Reduction of the cyanide content during fermentation of cassava roots and leaves to produce bikedi and ntoba mbodi, two food products from Congo. In *African Journal ofBiotechnology*,(4), 2005, 689-696.

[28] G.I. Onwuka, G.I *Food Analysis and Instrumentation. Theory and Practice. Napthali Prints*,2005,140-146.

[29] J.A.Montagnac, C.R. Davis, S.A. Tanumihardjo, Processing techniques to reduce toxicity and antinutrients of cassava for use as a staple Food. In *Comprehensive Reviews in Food Science and Food Safety*,.(8), 2008,17-27.

[30] *B. Chand (2013).*Effect of processing on the cyanide content of cassava products in fiji. *Journal of Microbiology,Biotechnology and Food Sciences*, *2 (3),*2013, 947-958.

[31] O.S.A. Oluwole, A.O. Onabolu and.A. Sowunmi, Exposure to cyanide following a meal of cassava food. *Toxicol. Lett. 135(1-2),* 2002, 19-23.

[32] J.H. Bradbury and W.D. Holloway, Chemistry of tropical roots: significance for nutrition and agriculture in the Pacific. Canberra, Australia: *Australian Centre for International Agricultural Research ,* 1988:102.

[33] H.N.Eneobong, Eating Right (A Nutrition Guide). Zoometer Print Communications Ltd. Nigeria.2001