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Evaluation of Moisture, Total Cyanide and Fiber Contents of Garri Produced from Cassava (*Manihot utilissima*) Varieties Obtained from Awassa in Southern Ethiopia

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Abstract: Cassava *(Manihot esculent crantz)* as one of the most important root crops in Sub-Saharan Africa plays a vital role in the diet of many African countries especially the grass root people, being the major source of daily carbohydrate intake. Traditionally processed staple foods from cassava are available in Western and some Eastern African countries, such as garri, foofoo, boiled cassava meal, etc. Several varieties of *M. Utilissima* obtained from Awassa, Ethiopia, were processed, fermented and converted into garri. The moisture, total cyanide and fibre contents of the processed garri were analyzed. The results showed that the moisture, total cyanide and fiber contents varied from 26.12-40.02 %, 1.51-2.81 mg HCN/100 g and 1.80-2.40% respectively. The largest reduction in cyanide content (41%) between the third and fourth day fermentation was found in the MM 96/5280 variety which had an increase of 32% fiber content when compared with other varieties. These results compared favorably with similar garri products obtained from Ghana and Nigeria. The ease of preparation and potential nutritional value resulting from fermentation, the low moisture, cyanide and improved fiber contents found, indicate the suitability of the garri products as nutritional food items. The Kello44/72 and MM96/5280 varieties with the lowest cyanide and comparable fiber contents are most suitable. In order to enrich the nutritional contents of the garri product, fortification with leguminous plants or fish is recommended so as to make it more suitable as an alternative food product to injera in Ethiopia.

Key words: Cassava, fermentation, garri, total cyanide, fiber

Introduction

Cassava is one of the few most important root crops known and used in many countries of Africa, Latin America and some Asian countries. Though it has its origin in South America, cassava has become an indigenous crop in the tropics having been widely grown and used. It has played vital roles in the diets of many African countries as a major source of low cost carbohydrate (O'Hair, 1990). Cassava contains significant amount of iron, phosphorus, calcium, and is relatively rich in vitamin C. In many parts of Western and Central Africa, cassava is being processed into a number of traditional staple foods. Dried tubers of cassava can be milled into flour. Maize may be added during the milling process to add protein to the flour. The flour can be used for baking breads. Typically, cassava flour may be used as partial substitute for wheat flour in making bread. Bread made wholly from cassava has been marketed in the U.S.A. to meet the needs of people with allergies to wheat flour (O'Hair, 1995).

Garri, one of the staple food products from cassava is obtained by fermentation and subsequent frying; a process similar to the production of *injera* (Ethiopia staple food) from teff. Garri can be fortified with legume like soybean to offer a nutritionally rich meal.

The major factor that limits the use of cassava as food is the toxicity of hydrogen cyanide (HCN) which occurs as a result of the hydrolysis of cyanogenic glucosides (Rickard, 1985). The cyanide present in cassava may be considered to be of two types: Bound cyanide present as the cyanogenic glucoside and free cyanide present as the cyanohydrin, that is, free hydrogen cyanide which is a gas above 26°C (under alkaline conditions) and as cyanide ion, CN^- (Bradbury and Holloway, 1988). The total cyanide which comprises both the bound and the free cyanide indicate the potential of the cyanogenic glucoside in the root tubers or leaves. Cyanide is widely distributed in nature and is normal constituent of blood, usually at low concentration, <12μ mol 1^{-1} (Solomonson, 1981).

Using improperly processed cassava can increase the cyanide content in the human body and eventually cause goiter, cretinism, paralysis and neurological disorders (Delange and Ahluwalia, 1983) as cited in Bradbury *et al.* (1991). There is a great concern about the levels of cyanide in many varieties of cassava products including garri. There is equally good evidence that some fibre depleted diets cause pathological effects (Umoh *et al.*, 1984). These effects are manifested not only in the gastro - intestinal tract but other anatomical structures such as the arteries, lower limb veins and gall bladder. Cyanide in cassava has been linked with tropical amploipia (blindness that is common in West Africa) and tropical ataxic neuropathy (TAN) (Umoh *et al.*, 1984). The effects of storage and cooking practices on the total cyanide content of two cultivars have been investigated. The highest total cyanide reduction was obtained when the tubers were soaked in water, sun-dried and baked (Taye and Biratu, 1999). The cyanide and fibre contents of different garri samples obtained from various sources in Nigeria have been determined by (NIS, 1988; Ukpabi and Ndimele 1990; Nwokoro *et al.*, 2005). The fibre content in garri and feeds generally has been regarded as being of no nutritive value, but its importance in recent times has been appreciated both clinically and in animal husbandry. Through the various processing operations which involve peeling, washing, grating, fermentation, drying/dewatering, milling/ pulvering and frying/roasting, the level of the hydrogen cyanide content has been significantly reduced if not completely eliminated (Ihekoronye and Ngoddy 1985; O'Hair, 1990; Massaquoi *et al.*, 1990). Recently, Malu *et al.* (2007) reported a 36% reduction in cyanide content between the third and fourth day fermentation with a minimal increase in the fiber content of processed garri from Nigeria.

Cassava has been grown and used as food for about a century in different regions of Ethiopia. In the Southern Ethiopia, particularly in Amaro-kello area (Gedeo Zone), cassava is almost used as a staple food. In Wolaita area (North Omo Zone), cassava roots are widely consumed after washing and boiling or in the form of bread and "*injera*" after mixing its flour with that of some cereal crops such as maize (Zea mays), sorghum (sorghum bicolor), or Tef (*Eragrostis tef*) (Taye, 1994). Several local and identified cultivars which vary in their morphology, agronomic characters and cyanogenic glucosides content are cultivated in the Southern and South Western regions of Ethiopia (Taye, 1993).

This paper reports on the levels of moisture, total cyanide and fiber present in garri products from several varieties of cassava obtained from Awassa, Ethiopia, in order to determine both their nutritional contents and suitability as an alternative staple food product to injera in Ethiopia.

Materials and Methods

Seven varieties of cassava (*Manihot utilissima*) tubers namely Kello 44/72, Quelle 104/72, MM96/7151, MM 96/5280, MM96/1871, MM96/3868 and Amarokello (local red) were obtained from Awassa Agricultural Research Centre (AARC) Awassa, Ethiopia. A sample of garri product was obtained from Uyo, Nigeria and another sample produced in Ghana was obtained from Shoa supermarket in Addis Ababa, Ethiopia. Grater, sifter, turning stick and bailing dish were fabricated using locally obtainable materials. *Injera* baking pot which served as the frying pot and plastic containers were obtained from the local market in Awassa town. Sticks used for the wooden pressing machine were also locally procured.

Sample preparation: 5kg each of fresh tubers from the seven varieties were peeled, washed with water, grated, packed in cotton cloth bags and fermented using the wooden pressing machine. Each sample was fermented for 3 and 4 days respectively. The fermented and semi-dry cassava pulp was pulverized and fried to produce garri.

Analysis: Total cyanide content of the garri samples was obtained through hydrolysis and the isolate determined by the method of A.O.A.C. (1975). The fiber content was determined by acid digestion as percentage of dry matter (%DM), while the moisture content was determined using the method of A.O.A.C. (1975).

Statistical analysis: The data on moisture, cyanide and fiber contents for the seven garri varieties and the Nigerian and Ghanaian products were subjected to Chi-square analysis. Significance was accepted at 5% probability level. Values were reported as the mean ± SD for five determinations.

Results

The results of moisture, cyanide and fiber contents of garri produced from seven varieties of cassava (*Manihot utillissima*) after 3 days of fermentation are presented in Table 1. There were significant differences ($p < 0.05$) in moisture and cyanide contents among the various garri products. Moisture contents were higher in MM96/3868, MM96/1871 and MM96/5280 and lower in the other varieties. The total cyanide in MM96/3868 and Quelle 104/72 were also higher than the other varieties with the lowest content found in Kello44/72. The fiber contents in all the samples were similar. Table 2 shows the results of the studies on the 4 days fermented garri. There were significant differences ($p < 0.05$) in the moisture, cyanide and fiber contents of the various garri products. Moisture contents were higher in MM96/5280, MM96/1871 and MM96/7151 and lower in the other varieties but all the varieties were lower in moisture content when compared with the varieties obtained from Nigeria and Ghana (produced after 4 days fermentation). The total cyanide content was higher in Quelle104/72 and MM96/3868 and lower in other varieties including the Nigerian variety with the lowest value found in Kello44/72 and MM96/5280. But the highest cyanide content compared with that obtained for the variety from Ghana. The fiber contents were however similar in all the varieties averaging 2.26% DM among the Awassa varieties but comparable

Table 1: Moisture, cyanide and fiber contents of garri produced after 3 days fermentation

Cassava variety	Moisture content (%)	Cyanide content (mgHCN/100g)	Fiber content (% DM)
Kello 44/72	26.21±0.01	1.89±0.02	1.70±0.01
Quelle 104/72	26.90±0.02	2.80±0.02	1.75±0.01
MM96/7151	28.71±0.01	2.70±0.02	1.76±0.01
MM96/5280	30.02±0.02	2.59±0.03	1.78±0.01
MM96/1871	30.44±0.02	2.59±0.02	1.74±0.02
MM96/3868	30.61±0.04	2.81±0.01	1.80±0.01
Amarokello	26.12±0.13	2.69±0.01	1.79±0.02

Values are mean ±SD for five determinations.

Table 2: Moisture, Cyanide and Fiber Contents of Garri produced after 4 days Fermentation

Cassava variety	Moisture content (%)	Cyanide content (mgHCN/100g)	Fiber content (%DM)
Kello 44/72	25.09±0.26	1.51±0.13	1.98±0.01
Quelle 104/72	25.18±0.15	2.70±0.12	2.02±0.02
MM96/7151	27.20±0.07	2.05±0.03	2.30±0.04
MM96/5280	28.13±0.04	1.51±0.03	2.35±0.08
MM96/1871	27.48±0.14	2.26±0.17	2.40±0.05
MM96/3868	25.58±0.38	2.70±0.01	2.40±0.04
Amarokello	24.90±0.12	2.53±0.01	2.37±0.02
Nigeria	29.47±0.20	2.05±0.02	2.35±0.07
Ghana	29.48±0.16	2.76±0.03	2.30±0.05

Values are mean ± SD for five determinations.

to the samples obtained from Nigeria and Ghana, with the lowest value found in Kello44/72 variety. The percentage reductions in moisture and cyanide contents of the processed garri between the third and the fourth day fermentation are presented in Fig. 1.

Discussion

As shown in Table 1, Kello 44/72, Quelle 104/72 and Amarokello (local red) showed similar moisture contents which averaged 26.41% but much lower than the 29.95% average obtained for MM96/7151, MM96/5280, MM96/1871 and MM96/3868. The cyanide content (1.89 mgHCN/100g) in Kello 44/72 was lower than the average of 2.6 mgHCN/100g observed in the other samples. The results of 4 days fermentation presented in Table 2 showed that, Kello 44/72, Quelle 104/72, MM96/3868 and Amarokello (local red) had similar moisture contents but these were lower than that of MM96/7151, MM96/5280 and MM96/1871. From the results, there are significant reductions in the cyanide contents of the four-day fermented garri in the range of 3.6-41.7% and the moisture contents in the range of 4-16% (Fig. 1). Corresponding increases in the levels of fiber which ranged from 15-37% were observed for all the samples with the lowest in Kello44/72 (15%) and the highest in MM96/1871 (37%). In comparison with 29.47 and 29.48% moisture, 2.05 and 2.76 mgHCN/100g cyanide and 2.35 and 2.30 (%DM) fiber contents obtained from garri samples produced in Nigeria and Ghana respectively, the cyanide content in Kello44/72 and MM96/5280 were significantly lower, while the

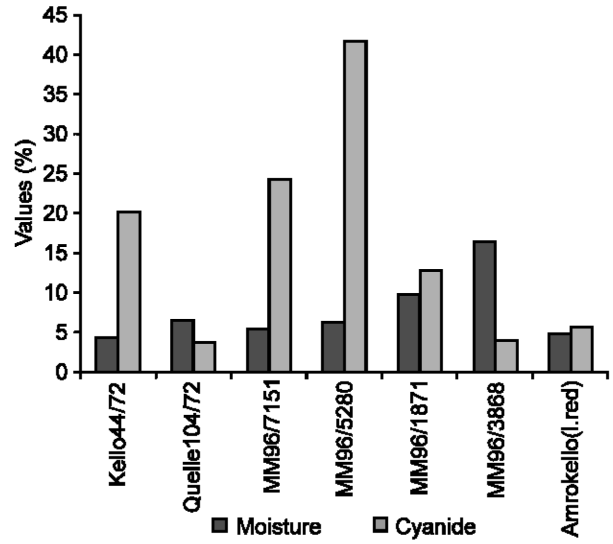

Fig. 1: Percentage reduction in moisture and cyanide contents of garri between 3 and 4 days fermentation.

moisture and fiber contents were similar. Generally, the cyanide range of 1.51 to 2.81 mgHCN/100g obtained from the three and four days fermentation experiments are within the reported values of 0.84 and 2.12 mgHCN/100g by Nwokoro *et al.* (2005) and 0.00 and 3.20 mgHCN/100g by Hahn (1983). The results are also within the 2-3 mgHCN/100g regarded as acceptable level of cyanide in garri (IITA, 1989). The fiber contents also agree with the crude fiber range of 0.5 to 3.0 (%DM) reported by Ukpabi and Ndimele (1990), for commercially available garri although the Nigerian Industrial Standard, NIS (1988) had recommended that garri should have crude fiber of less than 2.0%. The importance of fiber clinically has been reported by Umoh *et al.* (1984) which stated that fiber depleted diets cause pathological effects which manifest in the gastro-intestinal tracts as well as other anatomical structures such as the arteries, lower limb veins and gall bladder, suggesting therefore that there is need for minimum obtainable level of fiber in diets.

As cyanide is very poisonous because it binds cytochrome oxidase and stops its action in the electron transport chain, which is a key energy conversion process in the body, excess cyanide content in cassava products could have deleterious effects on the consumer. Non-fatal amounts of cyanide cause acute intoxication with symptoms of dizziness, headache, stomach pains, vomiting and diarrhea (CCDN, 2006). As has been shown in the studies, the extension of fermentation period from 3 to 4 days had the advantage of greater reduction in cyanide through further breakdown of cyanogenic glucosides in the cassava pulp as well as leaching out of HCN along with the cassava fluid. The 4-41% reduction in cyanide content in the 4-day fermentation product (Fig.1), is in accordance with the FAO report that longer fermentation period reduces the content of free hydrocyanic acid, as well as the moisture content (FAO, 1981). Odoemelam (2005) also reported that, the longer the fermentation period, the less the residual cyanide content in the final garri product. However, the variation in the cyanide concentration of the individual garri samples is attributable to differences in the cassava cultivars as reported by O'Brien *et al.* (1992). Asegbeloyin and Onyimonyi (2007) also reported that the crude protein content of garri product obtained by fermentation was higher (2.65%) than that obtained (2.03%) without fermentation. In view of the low protein content and lack of essential amino acids of most cassava products, methods of upgrading the protein content of cassava and reducing the anti-nutrient content such as cyanide, phytate and tannin have been developed (Odetokun *et al.,* 1998). Fortification of garri with proteinous plants such as soybeans and melon has been reported Oshodi (1988). Recently, Ugwu and Odo (2008) reported that protein content in Soy-garri ranged from 5.15 to 6.17% as against protein content of 0.7 to 1.2% in normal garri.

From the results, the garri produced from the various cassava species obtained from Awassa, with their low moisture and cyanide contents along with considerable amount of fiber indicate their suitability as nutritional food products. The Kello44/72 and MM96/5280 are more suitable in view of their considerably low moisture and cyanide contents. The garri products can however be fortified to enrich their nutritional value with leguminous plants such as soybean, melon or fish in order to make them more suitable and attractive as an alternative staple food to injera particularly in Ethiopia.

Conclusion: Garri produced from Awassa cassava tubers compared favorably with similar garri products obtained from Ghana and Nigeria. The low moisture, cyanide and increased fiber contents indicate their suitability as nutritional food product. The Kello44/72 and MM96/5280 varieties with the lowest cyanide and comparable fiber contents are most suitable. For improved nutritional value, fortification with such proteinous plants as legumes (soya bean and melon) or fish is recommended.

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References

A.O.A.C., 1975. Association of Official Analytical Chemist. Philip Harries Holding Ltd. England, pp: 203.

Asegbeloyin, J.N. and A.E. Onyimonyi, 2007. Effect of different processing methods on the residual cyanide of 'Garri'. Pakistan J. Nutr., 6: 163-166.

Bradbury, J.H. 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., pp: 103-104.

Bradbury, J.H., S.V. Egan and M.J. Lynch, 1991. Cassava Toxicity and Food Security. Analysis of cyanide in cassava using acid hydroloysis of cyanogenic glucosides. J. Sci. Food Agric., 55: 277-290.

CCDN, 2006. Cassava Cyanide Diseases Network (CCDN): http://www/anu/edu/au/BoZo/CCDN/two.html.

Delange, F. and R. Ahluwalia, 1983. Cassava toxicity and thyroids. Research and Public Health issues, IDRC-207e. IDRC, Ottawa.

FAO, 1981. Food loss prevention in perishable crops. Food and Agricultural Organization of the United Nations Agricultural Services Bulletin No. 43; 1981.

Hahn, S.K., 1983. Cassava research to overcome the constraints to production and use in Africa. In: Cassava toxicity Research and Public Health issues F. Delange and R. Ahluwalia, (Eds.). Proc. Workshop, Ottawa, Canada. May 31- June 2, 1982., pp: 92-103.

Ihekoronye, A.I. and P.O. Ngoddy, 1985. Integrated Food Science and Technology for tropics. Macmillan publisher Ltd, London.

IITA, 1989. Cassava processing and utilization. International Institute for Tropical Agriculture, Ibadan, 28: 16-18.

Malu, S.P., A.B. Utu - Baku, E.E. Esu, G.O. Oboche, G.A. Bassey and P.A. Adie, 2007. Defibrenation and time course fermentation impact on the cyanide content of industrially and locally processed garri food in Cross River state of Nigeria. Global J. Pure and Appl. Sci., 13: 527-531.

Massaquoi, J.G.M., J.D. Sormana and A.M. Koroma, 1990. Technological capability in the formal food processing sector: The case of Rice and cassava processing. International Development Research Centre, Ottawa, ON, Canada. WATPS programme report.

Nigerian Industrial Standard, NIS, 1988. Standard for garri. Standard Organization of Nigeria. Federal Min. of Industries, Lagos 10.

Nwokoro, S.O., H.D. Adegunloye and A.F. Ikhinmwin, 2005. Nutritional composition of garri sievates collected from some locations in Southern Nigeria. Pakistan J. Nutr., 4: 257-261.

O'Brien, G.M., L. Mbome, A.J. Taylor and N.H. Poultier, 1992. Variation in cyanide content of cassava during village processing in Cameroun. Food Chem., 44: 131-136.

O'Hair, S.K., 1995. Cassava. Tropical Research and Education Center, University of Florida.

O'Hair, S.K., 1990. Tropical root and tuber crops. Timber press, Portland, pp: 424-428.

Odetokun, S.M., F.A. Aiyesanmi and K.O. Esuoso, 1998. Enhancement of nutritive value of *pupuru,* a fermented cassava product. La Rivista italiana Delle Sostanze Grasse, 75: 155-158.

Odoemelam, S.A., 2005. Studies on Residual Hydrocyanic acid (HCN) in Garri flour made from cassava (Manihot spp.) Pakistan J. Nutr., 4: 376-378.

Oshodi, A.A., 1988. Protein enrichment of foods that are protein deficient 11: Fortification of processed cassava (Garri) with bovine blood plasma protein concentrate. Niger. J. Appl. Sci., 6: 61-64.

Rickard, J.E., 1985. Physiological deterioration of cassava roots. J. Sci. Food Agric., 36: 167-176.

Solomonson, L.P., 1981. Cyanide as a metabolic inhibitor. In: Chemistry of Tropical Root Crops: Singificance for Nutrition and Agriculture in the pacific, Bradbury, J.H. and D.W. Holloway, (Eds.). Australian centre of international Agricultural Research, Canberra, Australia, pp: 101-102.

Taye, M. and E. Biratu, 1999. Effect of storage and cooking practices on the total cyanide content of two cassava (*Manihot utillissima crantz*) cultivars. Sinet: Ethiop. J. Sci., 22: 55-66.

Taye, M., 1993. Study on the growth and utilization of cassava plant in the different regions of Southern Ethiopia: Characterization, yield and yield components and cyanide determination. Annual Research Report; Awassa College of Agriculture, Awassa, Ethiopia, pp: 73-79.

Taye, M., 1994. Cassava in Southern and South Western Ethiopia. Cassava News letter, 18: 6-7. CIAT, Colombia.

Ugwu, F.M. and M.O. Odo, 2008. Effect of cassava variety on the quality and shelf stability of Soy-Garri. Pak. J. Nutr., 7: 381-384.

Ukpabi, U.J. and C. Ndimele, 1990. Evaluation of the quality of garri produced in Imo state. Nig. Food J., 8: 105-109.

Umoh, I.B., F.O. Ogunkoya, E.N. Maduagwu. and O.L. Oke, 1984. Effects of Thiamin status on the metabolism of linamarin in rats. Anim. Nutr. Metabolism. Switzerland, pp: 319-324.