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Chemical assay of cyanide levels of short-time-fermented cassava products in the Abraka area of Delta State, Nigeria

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Abstract

Five cassava products, commonly consumed in and around the Abraka area of Delta State, Nigeria were analysed for their cyanide levels. This study, to determine safe levels of cyanide, became necessary as the fermentation time in the processing of these products has been observed to be drastically shortened to as low as 6 h for quick economic returns. In all the products, the cyanide levels were reduced from 30.0–58.0 mg HCN equivalent kg^{-1} of product. These levels fall below the reported 30.0 mg HCN equivalent kg^{-1} safe (fresh weight) of raw cassava to 5.4–24.0 mg HCN equivalent kg^{-1} level for cassava products. Nevertheless, some of the products containing up to 20.0–26.5 g HCN equivalent kg^{-1} of products are dangerous to health as these levels are higher than the 20.0 mg HCN equivalent kg^{-1} safe level recommended by the Standard Organization of Nigeria. The current practice of short-time fermentation should therefore be discouraged. © 1998 Elsevier Science Ltd. All rights reserved.

1. Introduction

Cassava (*Mainihot esculenta* Crantz) is one of the most important food plants in the world. It is grown throughout South America, Africa and Asia with Brazil as the largest world producer. The root or tuber is used in a variety of forms, mainly as a staple food in Africa. Its products are also consumed in many parts of the world such as the Asian and Latin American countries (McGraw-Hill, 1977; Almazan, 1986). Nigeria is a major producer and consumer of cassava. The estimated production for the year 1992 is 21.3 million tonnes and this constitutes over 33% of the total output of 64.3 million tonnes for the staple crops (Odigbe, 1990; C.B.N., 1992).

Cassava is processed into many products which are widely consumed in the country (particularly in the South). it is a major component of the Nigerian diet and an excellent source of dietary energy, being a primary and typical source of carbohydrates (Ngoddy, 1988; Ihekoronye and Ngoddy, 1985; Onabolu, 1988). High rates of consumption of cassava in this country make it serve as an excellent food security crop. The nutrient compositions of cassava and some cassava products have been well documented (Ihekoronye and Ngoddy, 1985; Oyenuga, 1968).

One major factor which limits or affects the utilization of cassava as a food for man is its content of the toxic hydrogen cyanide in both free and bound forms. The bound forms, known as cyanogenic glucosides, occur as linamarin and lotaustralin. When subjected to heat treatment, or the presence of the appropriate hydrolytic enzymes and conditions, these glucosides release hydrogen cyanide. If this reaction takes place in the human system, cyanide toxicity results, the degree of which depends on the quantity of cyanide released. The outcome of cyanide toxicity can be instant death or it may be manifested by several diseases and disorders which may also result in death if untreated (Oyenuga, 1968; Ihekoronye and Ngoddy, 1985; Onabolu, 1988; Okoh, 1992). Cassava is therefore sometimes described as the most dangerous staple food (*Sunday Republic*, 1990).

The presence of this toxic substance and the danger inherent in the consumption of unprocessed cassava are well known. Scientists and technologists have developed traditional technological processes to completely or partially eliminate the toxic substance, making the products safe for consumption. In present-day Nigeria, cassava products, particularly gari, are nutritionally

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essential. The traditional processes which have been modernized to produce (i) gari, (ii) fufu or akpu, (iii) starch, (iv) abacha and others (except local tapioca or kpokpo gari which is a delicacy among the Urhobos and their immediate neighbours in Delta State) have been investigated (Ihekoronye and Ngoddy, 1985; Ngoddy, 1988; Onabolu, 1988). The most critical stage in the processing line is the fermentation. Fermentation of peeled tubers or grated tubers for 3–4 days, coupled with frying in the case of gari and boiling/pounding in the case of fufu, reduces the cyanide level from 10–49 mg HCN equivalent kg^{-1} raw cassava to 5.4–29 mg HCN equivalent kg^{-1} product (Ngoddy, 1988; Odigbe, 1990) which is well below the safe level of 30 mg HCN equivalent kg^{-1} recommended by Akinrele et al. (1962) as cited by Almazan (1986).

Recently, however, alarms have been raised in the print media about the toxicity of cassava products (*Daily Times*, 1989; Odigbe, 1990; *Sunday Republic*, 1990). Most disturbing was the report that five people and a cat died after a meal of fufu (*Sunday Republic*, 1990). In addition, it has been personally observed in many areas including Abraka, a University Town and a major gari producing community, that the fermentation time for these products, particularly gari, has been drastically shortened to as low as 6 h instead of 3–4 days for quick economic returns. It therefore became necessary to determine the cyanide levels of some cassava products available in and around Abraka to assess their safety for residents in the areas, Delta State, Nigeria and other countries to which the products may be exported.

2. Materials and methods

2.1. Material collection and preparation

Five cassava products in addition to raw bitter cassava (*Manihot utilissima*) and raw sweet cassava (*Manihot palmata*) were used for the study.

1. Raw bitter and sweet cassava tubers of no specific identity were collected from farmers in Abraka. These were peeled, washed and grated. The pulp and the grated peeled cassava were used. Also peeled sweet cassava tuber (pulp) was cut into pieces and boiled.
2. Gari; Yellow gari (produced from the grated pulp to which some quantity of palm oil is added before dewatering and frying). This is the most common type of gari in these areas. Samples of these products were collected from markets in Abraka, Sapele and Ughelli. White gari (produced with no added palm oil). This is not commonly produced in these areas.
3. Gelled gari (Eba). The samples in (2) were gelled with boiling water and made into a moderately stiff dough or paste.
4. Fufu (Akpu). Balls of samples wrapped in transparent polythene wrappers and which were ready for consumption were purchased from retailers in Abraka.
5. Cassavita. A sample was purchased from the Federal Government owned Gari factory at Abraka.
6. Local Tapioca (Kpokpo Gari). Samples were collected from Abraka, Sapele and Ughelli (The flow diagram for kpokpo gari production is shown in Fig. 1)

2.2. Methods of analysis

Moisture content was determined by drying 2 g each of the grated, mashed or powdered sample in a hot-air oven at 100°C for 5 h. Cyanide content was determined using 20 g each of the grated, mashed or powdered sample. The AOAC (1970) method of alkaline titration of the steam distillate of the sample using silver nitrate was adopted. All results are the mean ± SEM of triplicate analyses.

3. Results and discussion

All the results of analysis are presented in Table 1. The pulp and peels of the bitter cassava contain higher

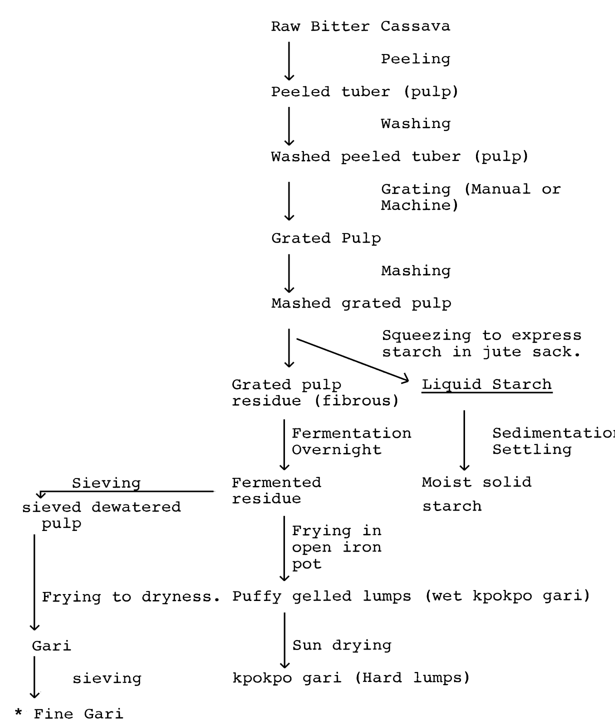

Fig. 1. Flow diagram for kpokpo gari production. Gari obtained in this way, i.e. as a by-product of kpokpo gari and starch production, is usually very light with little or no starch.

concentrations of cyanide, 54.0 ± 4.40 and 59.0 ± 0.80 mg HCN equivalent kg^{-1} of sample, respectively, than the pulp and peels of the sweet cassava 29.6 ± 1.60–40.9 ± 1.9 mg HCN equivalent kg^{-1} of sample, respectively. The dewatered bitter cassava pulp contained lower concentrations of cyanide 29.70 ± 1.70 mg HCN equivalent kg^{-1} sample than the fresh pulp. Thus dewatering had reduced the cyanide concentration of bitter cassava from 54.0 mg to 29.7 HCN equivalent kg^{-1} sample. This is evidenced by the much higher concentration in the whey; 62.5 ± 1.90 mg HCN equivalent kg^{-1}. These findings are in agreement with published reports (Ngoddy, 1988; Onabolu, 1988; Odigbe, 1990). The sweet cassava is simply detoxified by boiling and roasting and it is safe for consumption (Ihekoronye and Ngoddy, 1985; Odigbe, 1990). This has been confirmed by boiling the cut pieces of the sweet cassava tuber which contained no trace of cyanide (Table 1).

Unlike the sweet cassava which is considered non-poisonous and is sometimes eaten raw or grated directly into food both for man and animals (Dent, 1978), the bitter cassava is subjected to complex detoxification processes in products like gari, gelled gari, fufu, kpokpo gari, to make it innocuous or harmless. The yellow gari from the three areas contained lower concentrations of cyanide 18.9 ± 1.30–21.6 ± 0.00 mg HCN equivalent kg^{-1} than the corresponding white gari; 24.3 ± 1.60–26.5 ± 2.00 mg HCN equivalent kg^{-1}. This finding is in agreement with published reports that the addition of palm oil to the pulp during processing causes increased reduction in cyanide levels (Ihekoronye and Ngoddy, 1985; Odigbe, 1990). The gelling of gari (both white and yellow), on the other hand, eliminated the cyanide. Thus, while the gelled gari is safe for consumption, both types of gari produced in these areas are a source of danger to health as, on the average, their cyanide levels are above the safe level of 20.0 mg HCN equivalent kg^{-1} sample recommended by the Standard Organization of Nigeria (Almazan, 1986). The relatively high cyanide contents of the gari is probably due to the short-time fermentation of less than 24 h, as gari fermented for 1–4 days is known to contain less than 5.0 mg HCN equivalent kg^{-1} (Odigbe, 1990; Ihekoronye and Ngoddy, 1985; Almazan and Hahn, 1987). Recent reports have shown that short-cuts in gari processing are associated with high dietary cyanide exposure and acute intoxications (Sanni et al., 1994). The reason for short-cuts in urban gari processing in Nigeria is linked to the need for rapid capital turnover for poor urban female processors who hire most of the utensils they use (Sanni et al., 1994). In this study, short time fermentation was found to be a common practice in both rural and urban gari processing, in order to achieve quick economc returns. Gari which is not further treated by gelling into eba can be eaten dry or drunk after soaking in cold water. Continuous consumption of the gari produced in these areas in the dry or soaked forms, therefore, means regular intake of small amounts of cyanide which may not result in death but can cause several diseases such as goitre, reproductive problems, neurological disorders, and cellular respiration problems which affect energy-producing processes in the body (Okoh, 1992).

Fufu produced in Abraka has been found to contain as high as 24.3 ± 1.60 mg HCN equivalent kg^{-1}. It is usually sold in the ready-to-eat form without further treatment. In this form, therefore, it is also not very safe for consumption, as in the case of the gari considered above.

The cassavita, in its powdered form (flour), contained 5.50 ± 0.30 mg HCN equivalent kg^{-1} which is well below the safe level. It is usually gelled into a gelatinous dough such as semolina or semovita or gound rice. This further heat treatment is bound to completely or further reduce the cyanide levels. The local tapioca or kpokpo gari from the three areas are also safe for consumption as their cyanide contents of 10.8 ± 0.0–13.5 ± 1.4 mg HCN equivalent kg^{-1} sample fall well below the safe level.

Table 1
Cyanide concentrations of some cassava products[a]

Samples	Moisture	mg HCN equivalent kg^{-1} ± SEM
(1) Raw bitter cassava		
Grated peeled tuber (pulp)	54.50	54.0 ± 0.41
Dewatered pulp	40.06	29.7 ± 0.17
Peeled	41.10	59.6 ± 0.08
Whey (expressed liquid)		62.5 ± 0.19
(2) Raw sweet cassava		
Grated peeled tuber (pulp)	57.02	29.6 ± 0.16
Peels	46.00	40.5 ± 0.19
Boiled peeled tuber (pulp)	50.03	N.D. ± 0.00
(3) (a) Yellow gari		
Abraka	4.00	21.6 ± 0.00
Sapele	4.01	20.9 ± 0.05
Ughelli	4.00	18.9 ± 0.13
(b) White gari		
Abraka	4.01	24.3 ± 0.16
Sapele	4.00	26.5 ± 0.20
Ughelli	4.00	24.6 ± 0.16
(4) Gelled gari (eba)		
Abraka (white)	63.52	N.D. ± 0.00
Abraka (yellow)	63.53	N.D. ± 0.00
(5) Fufu (akpu)	85.05	24.3 ± 0.16
(6) Cassavita	11.00	5.5 ± 0.03
(7) Kpokpo gari		
Abraka	7.50	11.0 ± 0.16
Sapele	4.50	10.8 ± 0.00
Ughelli	4.50	13.5 ± 0.14

[a] Values are based on fresh weight of raw sample or weight of product as sold or consumed.

N.D., not detectable by the assay method employed.

4. Conclusion

The study has revealed that, while boiled sweet cassava, gelled gari (eba), cassavita and kpokpo gari produced in Abraka, Sapele and Ughelli areas are safe for consumption, the gari from these areas and Akpu from Abraka are not very safe. This is because their cyanide levels, even though lower than the reported safe level of 30.0 mg HCN equivalent kg^{-1} (Akinrele et al., 1962) are higher than the safe level of 20.0 mg HCN equivalent kg^{-1} for gari recommended by the Standard Organization of Nigeria (Almazan, 1986). For the safety of Nigerians and foreigners resident in these areas, other parts of the country and in other countries to which those products, particularly gari, may be exported, the current practice of short-time fermentation of less than 24 h should be discontinued.

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