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Studies on Residual Hydrocyanic Acid (HCN) in *Garri* Flour Made from Cassava (*Manihot Spp.*)

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Abstract: *Garri* flour was produced from mashed cassava (*Manihot spp*) roots, which had been subjected to fermentation for time periods of between 6 and 72 h. The hydrocyanic acid content of each batch was estimated by spectrophotometric alkaline picrate method. White and yellow *garri* flour samples procured from markets in Abia State, Nigeria were also analyzed for their HCN contents using the above-mentioned method. The HCN content decreased significantly with the length of fermentation period of the grated cassava mash. Levels of residual HCN were also significantly influenced by the source and type of *garri* flour (whether white or yellow). The white *garri* flour had higher HCN levels than the yellow.

Key words: *Garri* flour, hydrocyanic acid, hydrocyanic acid

Introduction

Cassava (*Manihot spp*) has been a staple crop of the tropics for many years. *Garri* flour derived from cassava is a major staple food for many people in most African and Latin American countries. Owing to the presence of cyanogenic glycosides in cassava, various methods of detoxification have been employed. The traditional method of reducing cassava toxicity in Nigeria is by fermentation. Products from such fermentation include *garri* flour and *fufu*.

Garri is the most popular form in which cassava is consumed in Nigeria. Traditionally, *garri* is prepared from cassava (*Manihot spp*) roots by fermenting peeled and mashed cassava pulp in jute bags for a period of about 3 days. This is followed by light roasting in shallow metal vats placed on open fires, after sieving to remove coarse particles. Nowadays the production of *garri* involves the traditional, semi-mechanized and the integrated accelerated methods of processing. However, the traditional method has gained wide acceptance and is indeed the most popular amongst households.

The yellow *garri* flour is prepared by mixing the mashed cassava pulp with palm oil prior to fermentation or the palm oil may be added during roasting. Otherwise, cassava mash roasted without the addition of palm oil constitutes the white *garri* flour.

Several authors have reported the toxicity of cassava products with respect to HCN content (Montgomery, 1969; Coursey, 1973; Maduagwu and Adewale, 1981 and Almazan, 1986). Omoike and Adediran (1991) observed that the number of processing steps involved in the production of cassava foods influenced the level of residual cyanide in the products. The mashing of cassava roots and subsequent dewatering encourage the leaching out of cyanogen. Admittedly the integrated accelerated method of processing results in the detoxification of cassava (Ngoddy, 1989). However, all the known methods of production of *garri* flour do not completely remove the cyanide. It is, therefore, necessary to estimate levels of residual cyanide in *garri* so as to know what quantities consumers ingest. Data on HCN levels in *garri* will also help in formulating public health policies aimed at regulating cyanide levels in *garri*. It was on this premise that a study on the residual HCN content of *garri* was conducted.

In this communication the effects of the length of fermentation, the type of flour (whether white or yellow) and the source of the flour on the HCN content of *garri* are being reported.

Materials and Methods

Garri flour was produced from mature cassava roots harvested from a farm at Osusu, Isiala Ngwa in Abia State of Nigeria. The cassava roots were peeled manually with a knife to expose the pulp, washed in clean water and then grated in a lister (6 HP) engine-powered grating machine made for that purpose. The mashed cassava pulp was divided into two; one portion was mixed with palm oil in the ratio of 20 ml oil: 1 kg of cassava mash while the other was not. The former yielded the yellow garri sample A on roasting. The two were separately packed into two different jute bags and dewatered using a locally fabricated mechanical press. Pressure was applied to express the unwanted liquid from the mashed cassava pulp by tightening two big nuts fitted to the pressing machine.

The cassava pulp in each case, was left to ferment from 6 to 72 h at ambient conditions with occasional application of pressure to squeeze out the unwanted fluid. At predetermined intervals as indicated in Table 1,

Table 1: The HCN contents of white and yellow *garri* samples and the effects of length of fermentation periods

Hours of Fermentation	Level of HCN (µg/g dry matter)		
	White *garri*	Yellow *garri* (A)	Yellow *garri* (B)
6	32.2±0.9	20.3±0.7	19.6±1.4
12	26.6±0.6	16.6±0.8	15.6±0.2
24	24.8±1.2	14.2±0.3	14.7± 0.9
36	17.3±0.7	8.63±0.04	8.0±0.9
48	10.7±0.1	5.82±0.9	4.5±2.1
72	3.8±0.6	0.62±0.13	0.8±1.4

[a]Results are expressed as means of triplicate determinations ± SE. [A]Yellow *garri* sample with palm oil added during roasting
[B]Yellow *garri* sample with palm oil added prior to fermentation

some quantity of the fermenting cassava pulp was taken, sieved and subsequently roasted (60-82°C) in a circular frying pan (diameter = 70 cm). Each sample taken from the fermenting white cassava pulp was divided into two equal portions. One portion was roasted without the addition of oil to yield the white *garri* flour while the other, roasted with the addition of palm oil (15 ml palm oil: 1kg cassava mash) during roasting, yielded the yellow *garri* sample B.

In addition 40 *garri* flour samples (20 white and 20 yellow) were procured from markets in Aba and Umuahia in Abia State of Nigeria. Traders usually bring *garri* flour from remote villages into these two towns. *Garri* flour samples were randomly selected from markets in the two towns on a fortnight basis and mixed together to obtain 20 lots of white and yellow *garri* samples, respectively. Samples were later taken from each lot for analysis.

Estimation of cyanide contents of the *Garri* flour samples: The market-purchased *garri* flour samples and those from samples fermented for differing time periods (6, 12, 24, 36, 48 and 72 h) were analyzed for their residual cyanide contents using the spectrophotometric alkaline picrate method of Williams and Edwards (1980). Absorbance was measured at 510 nm on a Unicam UV-Vis spectrophotometer (Model: Helios Gamma. Helios Delta; Cambridge, Great Britain).

Results and Discussion

The HCN contents (µg/g dry matter basis) of white and yellow *garri* samples as a function of the length of fermentation period (6-72 h) are presented in Table 1. Table 2 shows the HCN contents of the market - purchased *garri* samples obtained from different locations in Abia State of Nigeria. The results were tested statistically (ANOVA, standard error (SE) and t - test) using the Statistical Analysis System (SAS) package. The levels of residual HCN in the white and yellow *garri* flour obtained from cassava root mash that was allowed to ferment for time periods ranging from 6-72 h (Table 1) decreased significantly ($p<0.05$) with length of the fermentation period. The decrease may essentially be due to break down of the cyanogenic glycosides in cassava roots during fermentation. Leaching of HCN along with fluid may also contribute to reduction in the HCN level. Since the longer the fermentation period the less the residual cyanide content of the final *garri* product, it is necessary to discourage, for toxicological reasons, the common practice by many *garri* processors of reducing fermentation period of cassava mash from 3 days in an attempt to increase turnover rate.

The HCN levels in the market - purchased *garri* from various locations (Table 2) which presumably had the normal 3 days fermentation were found to be higher than the residual cyanide levels in the 3 - day fermented reference *garri* samples (Table 1). This situation could possibly arise from the reduced lengths of fermentation periods from 3 days and, therefore, reduced levels of detoxification in the market- purchased *garri* samples. Some producers of *garri* are in a habit of reducing fermentation periods in a bid to increase turnover and, hence, maximize profits.

The results presented in Table 2 show wide variations in the HCN contents of the market-purchased *garri* samples. The variations, which were statistically significant ($P<0.01$) as determined by ANOVA, can be attributed to the apparent lack of standardization in the traditional methods of *garri* production and also to the type of cassaava roots (bitter or sweet variety) used. Coursey (1973) has indicated that the bitter cassava has higher content of cyanogenic glycoside (the form in which cyanide occurs in *Manihot* roots) than the sweet variety.

A good number of people, particularly the working class and urban dwellers, obtain their *garri* from the local markets. The HCN levels in market-purchased *garri* flour samples ranged from 1.8 to 65.8
µ g/g on dry matter basis. A value of 2-3 mg/100g has been regarded as acceptable level of cyanide in *garri* (11TA, 1989). However, long-term consumption of cassava products containing low levels of HCN produces goiter and neuropathy (Maner and Gomez, 1973; Osuntokun, 1969; 1973) and 50 mg of cyanide per 50 kg body weight could be lethal to man (Nartey, 1973).

Table 2: The HCN Contents of market-purchased *garri* samples

S. No.	Levels of HCN (µg/g dry matter) ±	
	White *garri*	Yellow *garri*
1	21.3±0.5	16.5±0.9
2	27.3±0.5	11.6±1.4
3	15.4±1.9	9.09±0.17
4	36.6±3.1	3.45±0.22
5	15.1±0.4	2.60±0.21
6	9.32±0.41	8.10±0.62
7	12.1±1.7	29.1±0.5
8	65.8±2.3	3.34±0.61
9	6.46±2.1	26.0±0.6
10	22.2±0.9	4.90±0.6
11	27.6±0.3	19.3±0.9
12	48.8±0.1	37.9±3.1
13	7.80±0.8	6.60±0.12
14	31.7±0.2	29.5±1.8
15	46.1±0.2	52.1±0.9
16	4.54±0.82	1.8±0.30
17	3.70±0.5	10.4±0.5
18	18.6±1.9	7.30±0.38
19	50.9±1.4	2.94±0.70
20	12.8±0.7	4.54±0.52

[a]Results are expressed as means of triplicate determinations ± S.E

This implies that an average person of 70 kg body weight will have to consume between about 53 to 1944 kg dry *garri* flour before the lethal effects of cyanide poisoning will set in.

The white *garri* flour, in most cases, had higher levels of residual HCN than the yellow flour (Table 1 and 2). These differences were found to be statistically significant as determined by t-test. Various reasons have been advanced for the reduced HCN level in yellow *garri* flour (Ukhun and Nkwocha, 1989). The time of addition of palm oil to the grated cassava during processing, i.e., prior to fermentation or during roasting had little or no influence on the HCN content of the produced *garri* flour.

Conclusion: The major factor influencing the level residual cyanide in *garri* is the length of fermentation period. Addition of palm oil reduces HCN content of *garri* with the time of addition (whether during roasting or prior to fermentation) having no significant effect.

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