Cyanogenic Potential of Roasted Cassava (*Manihot esculenta* Crantz) roots Rale from Inhambane Province, Mozambique

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Abstract: Roasted cassava roots flour is part of a common meal in Africa, it is known as *rale* in Mozambique. Fifty six samples of *rale* were collected from homes and markets in Inhambane Province, Mozambique, for cyanogenic potential (CNp) analyses. The names of cassava varieties used for preparing the *rale* samples could be determined in the home-collected samples, three varieties were recorded. *Xinhembwe* variety gave *rale* samples with 30 ± 8 mg CNp/kg (mean + standard error), *Precoce de angola* with 43 ± 11 mg CNp/kg and *Rungo sabonete* with 58 ± 22 mg CNp/kg dry weight. The mean cyanogenic value for all the 56 samples collected was 41 ± 16 mg CNp/kg. Cyanogenic potentials in all the *rale* samples were above 10 mg HCN/kg, the value regarded by the Codex Alimentarius Commission of the FAO/WHO as safe.

Keywords: *Manihot esculenta*; Rale; cyanogenic potential

INTRODUCTION

Cassava is an important source of food in the tropics. A large proportion of the population in Mozambique eat cassava as a staple food. Cassava tissues contain in varying degree potent toxins, cyanogenic glucosides (Conn 1980).

Cyanogenic gucosides in cassava consist mainly of linamarin and lotaustralin in a ratio 97:7. Cassava tissues also contain the enzyme linamarase. Cyanogenic glucosides are located inside vacuoles and the enzyme linamarase in the apoplast (Conn 1994). Disruption of cassava tissues initiates the hydrolysis of cyanogens, which come into the contact with linamarase, a β-glucosidase, to produce acetone cyanohydrin from linamarin and 2-butanone cyanohydrin from lotaustralin (Conn 1994). These cyanohydrins are unstable and decompose spontaneously to the corresponding ketones and hydrogen cyanide at pH values above 5 and temperatures above 30°C. Cyanohydrin degradation can also be catalysed by α-hydroxynitrile lyase, located in apoplast (White *et al*. 1994). The cyanogenic potential is expressed as HCN equivalent. Cassava cyanogens can be reduced to low levels by several cassava processing methods.

The processing methods used for cassava differ from region to region in Mozambique. In Nampula Province, Northern Mozambique, cassava chips are heap fermented and/or sun-dried and pounded into flour. The flour is then mixed with water and cooked into a thick paste, karakata. In the Southern Province of Inhambane, cassava is grated, fermented and then roasted to produce rale, a ready to eat condiment similar to the West African gari.

The cyanogenic potential values in such ready to eat condiments are important as the product is only reconstituted with hot or cold water before consumption. The aim of this study was therefore to assess the cyanogenic potential values of *rale* samples from rural homes and markets in Inhambane Province, Mozambique.

MATERIALS AND METHOD

Sample collection. Samples of *rale* were collected from 3 different locations in Inhambane Province, namely Inhambane, Inharrime, and Maxixe. Sample collection was carried out in June, 2006. Samples were collected both from the market and homes. The name and the taste of variety used to process the samples were recorded.

Cyanogenic potential analysis. For cyanogenic potential measurement, each sample, rale (4 g) was mixed with 0.1 mol/l orthophosphoric acid (25 ml) and cyanogenic potential was measured using the method described by Essers (1996) with KCN as a standard. All the analyses were carried out in duplicate. The enzyme, linamarase, used in total cyanogens assay was prepared from cassava latex by a previously described method Haque and Bradbury (1999).

Statistical analysis. Statistical analysis of the data collected was carried out using MSTAT Software. ANOVA (analysis of variance) and Student Newman Keuls multiple comparison test were carried out.

RESULTS AND DISCUSSION

Cyanogenic potential was determined in rale, a ready to eat condiment similar to the West African gari.

The names of cassava varieties used to produce rale were only possible to determine for samples collected at homes. Three varieties were recorded, Xinhembwe – a sweet variety, Rungo sabonete and Precoce de angola – both bitter varieties.

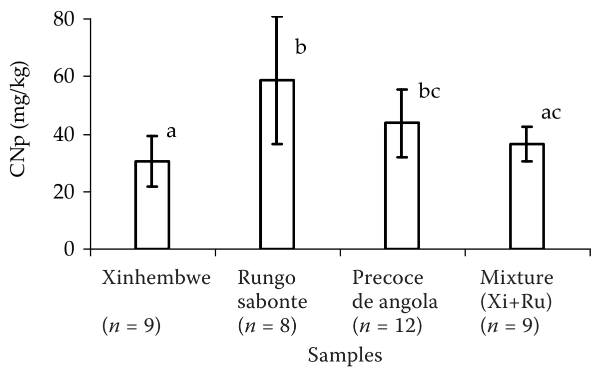

Figure 1. Cyanogenic potential of rale from different varieties where Xi = Xinhembwe, Ru = Rungo sabonte, *n* = number of samples. Same letter mean no significant difference (α = 0.05) and different letter show significant difference. Error bars represent standard deviation

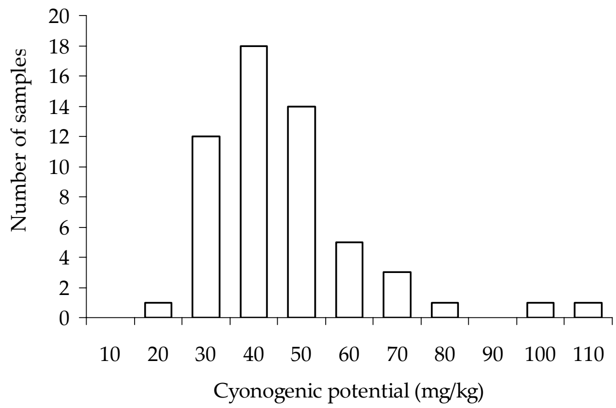

Figure 2. Distribution of the cyanogenic potentials of all the sample of rale from Inhambane Province

The bitterness or sweetness is reference to the taste of fresh roots and this partly correlates with cyanogen concentrations. Bitter varieties are associated with high concentrations of cyanogenic glucosides (Sundaresan *et al.* 1987).

Figure 1 shows values of cyanogens of *rale* by variety Rale produced from Xinhembwe variety had significantly (α = 0.05) lower cyanogenic potential value than the other two varieties. Rale reported as made from a mixture of Rungo sabonete and Xinhembwe had a significantly (α = 0.05) lower cyanogenic potential than that from Rungo sabonete alone. The proportions of the varieties in the mixture could not be determined but the intermediate values of cyanogenic potential in the mixtures suggests lowering of cyanogenic potential of the variety Rungo sabonete by diluting.

Table 1 shows the mean of cyanogenic potential values for the different rale samples by geographical area. The mean cyanogenic value for all the 56 samples of rale collected in the Inhambane Province is higher than the mean value of 25 mg CNp/kg of the 30 samples of gari obtained in Port Harcourt, Nigeria (Adindu *et al.* 2003) and the mean value of 34 mg CNp/kg of the 71 samples of sun-dried heap fermented cassava flour from Nampula, Mozambique (Zvauya *et al.* 2002), but is lower than the mean value of 54 mg CNp/kg of the 29 of sun dried cassava samples obtained in Indonesia (Djazuli & Bradbury 1999) and mean value of 64 mg CNp/kg of the 37 samples of sun dried cassava flour from Nampula, Mozambique (Zvauya *et al.* 2002). Previous results of cyanogenic potential related to Inhambane Province were in the range of 4 to 20 mg CNp/kg, but the mean value was not given (Cardoso *et al.* 1999).

Table 1. Mean of cyanogenic potential values (mg CNp/kg) of *rale* classified according to collection points. Uncertainties are shown as standard deviations

Points of collection	Maxixe	Inhambane	Inharrime	Total
Total Homes and markets	39.1 + 8.3	31.1 + 9.9	50.1 + 21.5	41.3 ± 16.2
Number of samples	24	12	20	56
Homes	40.0 + 9.2	29.5 + 12.2	48.6 + 20.1	42.0 + 16.1
Number of samples	18	5	15	38
Markets	36.2 + 3.5	32.2 + 8.8	54.7 + 25.7	39.8 + 16.7
Number of samples	6	7	5	18

Figure 2 shows the distribution pattern of the values obtained from all samples. None of the sample has cyanogenic potential lower than the value recommended as safe by FAO/WHO (1991), 10 mg CNp/kg . Using as reference the Indonesian standard safe level of 40 mg CNp/kg (Cardoso *et al.* 2005); about 55% of samples can be consider as safe. There is only one sample with cyanogen contents above 100 mg CNp/kg. According to Bourdoux *et al.* (1982) cassava roots with more than 100 mg CNp/kg are considered poisonous if eaten without processing. In the 38 samples where it was possible to know the name of the varieties used to produce the rale, about 55% were from bitter varieties. Bitter varieties in Mozambique range from 400 to 800 mg CNp/kg of cyanogenic potential in dry weight basis (Enersto *et al.* 2000). The method used for processing cassava to *rale* removes greatly the cyanogenic potential, but the performance of the method depends on many factors such as initial level of cyanogenic potential in the fresh roots, time of fermentation and variation of pH during fermentation. The decrease of pH for value below 5 during fermentation showed high retention of cyanohydrin in gari (Onabolou *et al.* 2002). During processing however, some linamarin is hydrolysed to acetone cyanohydrin which then decomposes to HCN gas, and this reduces the cyanogen content. The method used in preparing the *rale* reduces the cyanogen levels but there is still need for improvements to lower the levels to the value recommended by FAO/WHO (1991) of 10 mg CNp/kg.

The total cyanogenic values for all the locations were above 30 ppm with Inhambane city having the lowest value (Table 1). Inharrime village had the significant highest mean cyanogenic potential as compared to the means for the other villages. For each village, there was no significant difference between samples collected from homes and those from markets (Table 1).

Comparing the distribution of value of cyanogenic potential by location (Figures 3) in Maxixe village 42% of samples had more than 40 mg CNp/kg and about 38% of rale samples were from bitter varieties. In Inhambane village only 17% of the

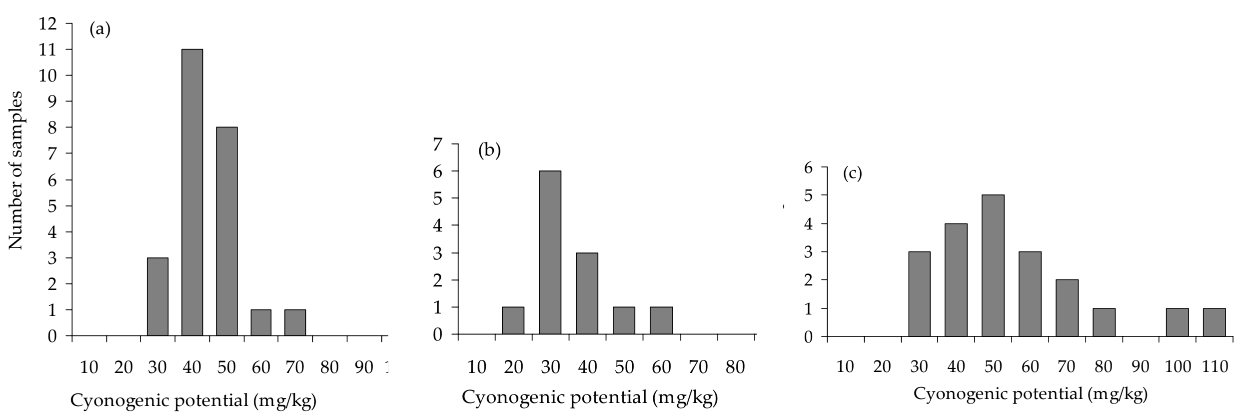

Figure 3. Distribuition of the cyanogenic potentials of the samples of rale for the 3 locations (a) Maxixe, (b) Inhambane and (c) Inharrime

samples had more than 40 mg CNp/kg, and two bitter varieties were recorded out of 12 samples. In Inharrime village about 65% of samples had cyanogenic potential exceeding 40 mg CNp/kg and in this village about 50% of samples were processed from bitter varieties. From this results can be concluded that the use of the bitter variety Makeshas represents a major contribution to the mean value of cyanogenic content in each location. The reason for the samples having the highest values in Inharrime District could be also the bulk and quick preparation of the rale for marketing. Inharrime District is the major producer and commercialisation point of cassava in the Inhambane Province.

CONCLUSION

The varieties of cassava used and the processing method to produce rale in Inhambane Province does not guarantee safe levels of cyanogenic potential as recommended by FAO/WHO. Therefore, there is a need to improve the process to further reduce the content of cyanide.

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