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Cyanogen content of cassava roots and flour in Indonesia

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Abstract

A survey has been made of the total cyanogen content of cassava roots and products from the cassava growing provinces of Lampung and East, Central and West Java, in Indonesia. Twenty five samples of cassava products were analysed for cyanogens by the acid hydrolysis method and also by the simple picrate kit method. The mean percentage difference between the results was 17%. Thirty samples of cassava starch and other specialised products had a mean cyanogen content of only 5 ppm, whereas 29 samples of cassava flour, chip and gaplek gave a much higher mean cyanogen content of 54 ppm (SD 51). The WHO safe value for cassava flour is 10 ppm and the Indonesian level is 40 ppm. There are four outliers of cyanogen content 140–200 ppm, which would be dangerous to human health. The cyanogen content of starch/chips/gaplek needs to be reduced by using cultivars of lower cyanogen content and by using improved processing methods. Twenty seven samples of cassava roots gave a mean cyanogen content of 19 ppm (SD 14).

1. Introduction

Cassava is the third most important food source in the tropics after rice and maize (corn). Indonesia is a major world producer of cassava of which about 64% is consumed directly as food (fresh root or dried root called ''gaplek''), a large amount is used locally and exported to the European Community as feed and smaller amounts are processed to flour, tapioca, starch and other products (Damardjati, Widowati, & Rachim, 1993). Iodine deficiency diseases (IDD), which include goitre and cretinism and are due to a lack of iodine in the environment, are made worse by intake of cyanogens from cassava consumption (Ermans et al., 1983). In Indonesia, many of the endemic areas of IDD are those regions in which cassava is consumed as a staple food.

The safe level of cyanogens in cassava flour has been set by WHO as 10 ppm (FAO/WHO, 1991) and the acceptable limit in Indonesia is 40 ppm (Damardjati et al., 1993). A recent study in Mozambique of 80 samples of cassava flour gave a mean value of 45 ppm (Cardoso, Ernesto, Cliff, Egan, & Bradbury, 1998). In that study a new simple picrate field method available in kit form was used to determine total cyanogens (Egan, Yeoh, & Bradbury, 1998). Modifications to that method allow determination of the three forms of cyanogens present in flour (1) linamarin, (2) acetone cyanohydrin and (3) HCN/CN^- (Bradbury, Egan, & Bradbury, 1999). In this paper a comparison has been made between the amounts of cyanogens in cassava roots and flour from Indonesia and Mozambique and to check out the simple picrate kit method against an accurate acid hydrolysis method (Bradbury, Egan, & Lynch, 1991).

2. Materials and methods

Cassava flour and other cassava products and cassava roots were collected from three provinces of Java (East Java, Central Java and West Java) and the Lampung province of Sumatra, which are the centres of cassava production in Indonesia. The collections were made during the peak harvest season from August to October 1996. Cassava roots are normally chipped in a manual or powered chipping machine into either circular chips of diameter about 50 mm and thickness of 3–6 mm or irregular longer pieces of 100–150 mm long. These are sun dried and then ground to produce flour (Damardjati et al., 1993). Alternatively the cassava after peeling may be sun dried to produce ''gaplek'', a traditional product produced by farmers. Production of cassava starch

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involves peeling and shredding using a simple machine. The shredded root is covered with a thin cloth and pressed strongly while pouring water over it. The extracted water plus starch is placed in a container and the starch settled for about 3 h. The solution is discarded and the starch dried in the sun. This intermediate starch product produced by the farmer is subsequently ground and packaged for sale. Cassava roots were obtained from Lampung (11 samples) and East, Central and West Java (16 samples). These were covered with wood shavings and stored at room temperature until used for analysis. All cassava samples, were analysed for total cyanogens by the acid hydrolysis method (Bradbury et al., 1991). Twenty-five cassava product samples were also analysed for total cyanogens by the picrate kit method (Egan et al., 1998). Single analyses were made on all samples.

3. Results and discussion

3.1. Comparison of acid hydrolysis and picrate methods of analysis

A comparison of the results of 25 total cyanogen analyses by the acid hydrolysis method (Bradbury et al., 1991) and the picrate method (Egan et al., 1998) are given in Table 1. The 13 samples of flour and chip have much higher cyanogen contents (mean value 42 ppm, SD39) than the starch and other products. The results obtained by the picrate kit method agree satisfactorily with those of the more accurate acid hydrolysis method. If the results below 5 ppm are excluded from the comparison on the grounds that the picrate method loses accuracy at such low levels, the mean percentage difference between the results over 20 samples is 17% ($SD = 17$), which agrees with a value of 20% obtained in an earlier study (Egan et al., 1998).

3.2. Total cyanogen content of cassava products

Fifty-nine samples of cassava products were obtained from factories and farmers in Lampung and Central, West and East Java provinces of Indonesia. The raw data showed no difference between the four different geographic areas. Also cassava chips, flour and gaplek have higher levels of cyanogens than cassava starch and other products. The results have therefore been analysed as two separate groups of data. Twenty-two samples of starch and eight samples of other products had a mean value of cyanogens of 5 ppm (SD 4), and the maximum value was 19 ppm. Clearly, the processes used to produce cassava starch and cassava products are effective in removal of cyanogens. On the other hand, cassava flour (14 samples), chip (nine samples) and gaplek (six samples), had a mean value of cyanogens of 54 ppm (SD 51). The level of cyanogens present in flour, chip and gaplek is thus higher than the mean of 45 ppm for 80 samples of cassava flour obtained in Mozambique (Cardoso et al., 1998). The value of 54 ppm is much higher than the WHO safe level of 10 ppm and higher than the Indonesian level of 40 ppm.

Table 1
Total cyanogen content of cassava products determined by the acid hydrolysis and simple picrate methods

Sample number	Type of product	Total cyanogen ppm (mg HCN equivalents/kg product)	
		Acid hydrolysis	Simple picrate method
1	Flour	149	143
2	Flour	27	27
3	Flour	17	18
4	Flour	84	60
5	Flour	36	36
6	Flour	83	92
7	Chip	42	41
8	Chip	4	9
9	Chip	48	55
10	Chip	6	8
11	Chip	21	14
12	Chip	17	22
13	Chip	26	19
14	Starch	1	5
15	Starch	7	7
16	Starch	11	16
17	Starch	12	12
18	Starch	7	10
19	Starch	2	2
20	Starch	4	11
21	Starch	5	5
22	Starch	2	7
23	Gaplek[a]	7	6
24	Oyek[a]	1	4
25	Onggok[a]	9	7

[a] Gaplek is peeled, dried cassava tuber; oyek is processed gaplek and onggok is a waste cassava product in the preparation of tapioka starch.

The distribution curve of these flour/chip/gaplek samples shown in Fig. 1 is similar to that of the 80 flour samples from Mozambique (Cardoso et al., 1998).

There are seven samples (one chip, one gaplek and five flour, all from Java) with cyanogen contents of >81 ppm. Of particular concern are the three flour and one gaplek sample of cyanogen content 140–200 ppm. These four outliers represent 13% of the total samples, more than twice the percentage of outliers obtained in the Mozambique study.

3.3. Total cyanogen content of cassava roots and flour

Twenty-seven samples of cassava roots gave a mean cyanogen content of 19 ppm (SD 14). This is much lower than the values obtained for 21 cassava root samples in Mozambique (Ernesto, Cardoso, Cliff, Rosling, & Bradbury, 1999). It is also much lower than the

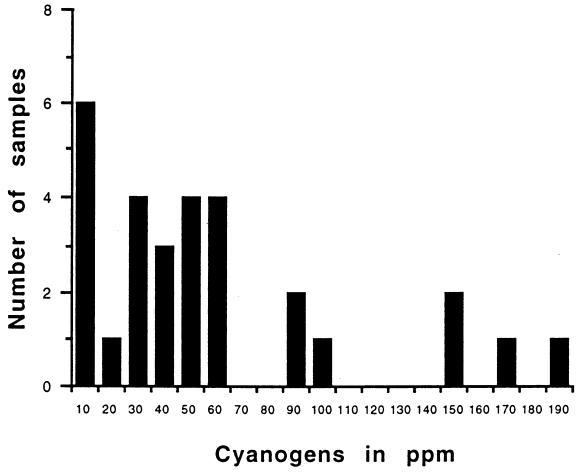

Fig. 1. The distribution curve of total cyanogens (0–10, 11–20, 21–30, ...181–190 ppm) in 29 samples of cassava chips, flour and gaplek obtained from Lampung province in Sumatra and Central, West and East Java provinces of Indonesia.

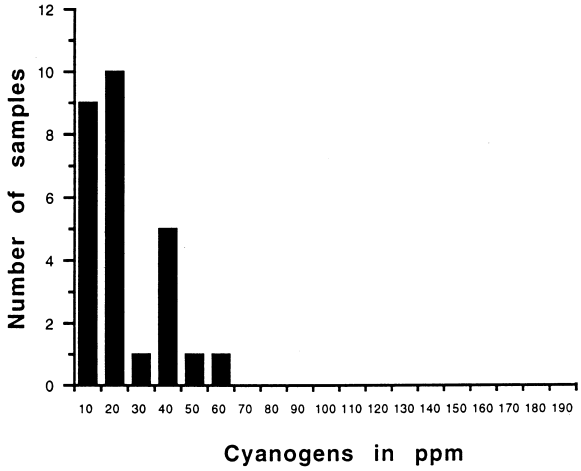

Fig. 2. The distribution of total cyanogens (0–10, 11–20, 21–30, ...181–190 ppm) of 27 samples of cassava roots from Lampung and Central, West and East Java provinces of Indonesia.

mean cyanogen content of 54 ppm of cassava flour, chip and gaplek. The differences are shown clearly by comparing Fig. 2, which shows no outliers, with Fig. 1.

The moisture content of cassava roots averages about 63% (Bradbury & Holloway, 1988) and the moisture content of cassava flour is about 12% (Damardjati et al., 1993), hence on processing of root to flour, if there was no loss of cyanogen, we would expect an increase of 2.4 times in the cyanogen content. However, during processing, some linamarin is hydrolysed to acetone cyanohydrin (catalysed by endogenous linamarase) which decomposes to HCN gas, thus reducing the cyanogen content. The distribution curve of Fig. 2 could conceivably produce a chip/flour /gaplek product with a distribution curve like the low cyanogen end of Fig. 1, but could not produce the four outliers containing >140 ppm of cyanogen. It is likely that these dangerous outliers, occur from high cyanogen cassava roots, in which the cyanogen content may be further increased by conditions of stress in the plant such as drought or disease (Bokanga, Ekanayake, Dixon, & Porto, 1994). There is a need to reduce the cyanogen content of starch/chip/gaplek by using improved cultivars of cassava of lower cyanogen content and also by using processing methods that are more effective in removal of cyanogens.

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