

Food Quality and Chemical Composition

Changes in Cyanide Content of Cassava Tissues as Affected by Plant Age and Variety

Authors: Guillermo Gómez and Mauricio Valdivieso, Utilization Section - Cassava Program, Centro Internacional de Agricultura Tropical, Ap. Aéreo 6713, Cali, Colombia.

ABSTRACT

Two cassava varieties, CMC-40 (low cyanide) and CMC-84 (high cyanide), were studied from the 9th to the 12th month of age of plants. Highest cyanide concentration was in the root and the lowest in the parenchyma; the leaves showed intermediate concentration as compared to the root tissues. Roots of CMC-40 had high levels of cyanide in their peels, especially at 9 months of age; the cyanide in the root peels of both varieties diminished with the age of the plant. Concentration of cyanide in the parenchyma was the most stable parameter and was practically not affected by plant age; the cyanide content of the root parenchyma of variety CMC-84 was approximately three times higher than that of roots of variety CMC-40 (623 ± 25 vs 234 ± 10 ppm, dry matter basis). Changes in cyanide content of leaves of CMC-40 were more pronounced than in variety CMC-84. Ninety percent or more of total cyanide in cassava tissues was present as the cyanogenic glucoside or bound cyanide.

Introduction

Cassava roots, an excellent source of carbohydrates, are used in a wide variety of food products for human consumption. While only the parenchyma is the edible part of the root, the root cortex or peel is used by itself or as a component of whole-root chips for animal feed. Cassava leaves are also used in some countries as food vegetables or as animal feed.

Cassava contains the cyanogenic glucosides linamarin and lotaustralin (Conn, 1969). Medical studies (Ermans et al., 1980) have demonstrated that cassava ingestion, together with iodine deficiency, is a factor in the etiology of endemic goitre and cretinism in Central Africa. It is thought that the goitrogenic factor is thiocyanate produced by the cassava cyanide detoxification processes of the body.

Cassava varieties grown under similar edaphoclimatic conditions differ widely in root cyanide content (Gómez et al., 1980). In addition to varietal differences, other factors appear to affect cyanide content of cassava tissues (Bolhuis, 1954; De Bruijn, 1971). The variety and the age of the plants are normally considered as two important factors affecting both the yield and the quality of cassava roots. Because of limited information on this subject (Cooke and De la Cruz, 1982), one study has been carried out at CIAT to ascertain effects of these

two factors on the cyanide content of cassava tissues. Roots and leaves of two varieties (CMC-40, low-cyanide cultivar, "sweet", and CMC-84, high-cyanide cultivar, "bitter") were evaluated, from 9 to 12 months of age, at monthly intervals.

Materials and Methods

Two cassava varieties, CMC-40 and CMC-84, were planted in adjacent fields in April 1980, at a density of 1x1 m (10,000 plants/ha); a total of 4,400 stakes of each variety was planted. The soil had a pH range of 7.2 to 7.8, a phosphorus level of approximately 40 Bray-11 ppm and in general good characteristics for cassava production previously described (Kawano et al., 1978). Total rainfall during the year of study (April 1980-March 1981) was 740 mm, with two drought periods (July-September and November-January); the overall average ambient temperature was 23.9°C.

At monthly intervals, from January 1981, areas of 560 plants (after borders were discarded) were harvested. From the total sampling area, 20 plants of each variety were selected at random ensuring that each sample plant was bordered all around. Leaves and roots of each plant were weighed in the field and immediately transported to laboratories in paper bags; leaf and root tissue samples were prepared for cyanide analyses within 1 and 3 hours after harvest, respectively.

Leaves of each plant were chopped, mixed and an accurately-weighed ~4 g sample was immersed in orthophosphoric acid, homogenized and filtered (Cooke, 1978). Roots were cleaned with a soft brush or washed if necessary. About an hour after measurement of specific gravity, the peel (root cortex) of each root was removed with a knife and then peel and parenchyma (peeled root) tissues of each sample plant were weighed. Cross transverse slices of peeled roots were cut along the length of the roots of each plant to obtain a representative sample for cyanide analyses. Root parenchyma slices and peels from roots of each sample plant were separately diced and manually mixed before samples were taken for analyses. Parenchyma (~60 g) and peel (~10 g) weighed samples were rapidly transferred (~5 min after the beginning of the milling operation) into orthophosphoric acid and homogenized. Total and free cyanide contents were determined in the leaf and root tissue homogenates using an enzymatic assay (Cooke, 1978). The dry matter (DM) content of leaf samples was determined by drying a 10 g sample of the chopped tissue to constant weight at 60°C in a convection oven whereas DM of parenchyma and peel tissues was determined in a vacuum oven at 90°C. Cyanide concentration in the cassava tissues is expressed on dry matter basis and data was analyzed for statistical significance by analysis of variance using the Statistical Analysis System (1979).

Results and Discussion

Figure 1 shows changes in total cyanide content in peel and parenchyma of the roots as well as in leaves of plants of the two varieties studied. Highest concentration of cyanide was in the peel and lowest in the parenchyma; the leaves showed intermediate cyanide contents, when compared with the root tissues. Roots of variety CMC-40, considered a low-cyanide cultivar, had high levels of cyanide in their peels, especially at 9 and 10 months of age; cyanide in root peels of both varieties diminished with age of the plant and this decrease was more pronounced in roots of variety CMC-40.

Concentration of cyanide in the parenchyma was the most stable parameter and was practically not affected by plant age; cyanide content of the parenchyma in

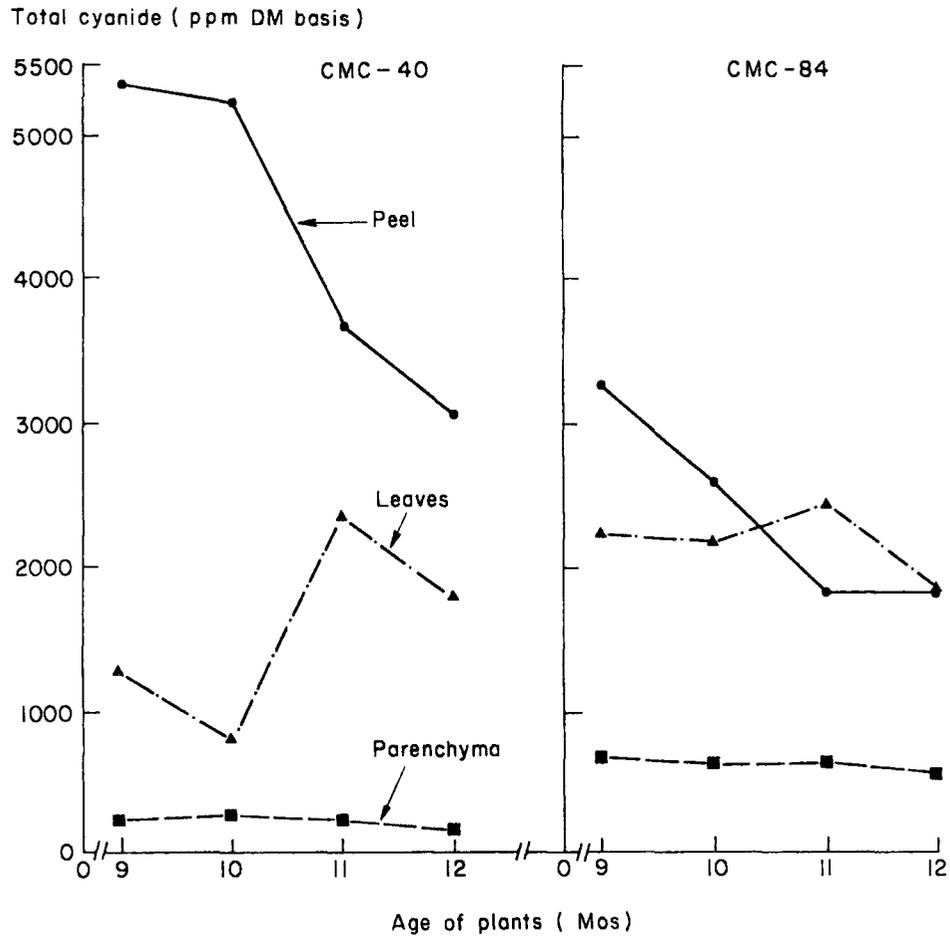


Figure 1. Effect of age of plant on total cyanide content in cassava leaves and roots (peel and parenchyma).

roots of variety CMC-84 was approximately three times higher ($P < .05$) than that in roots of variety CMC-40 (623 ± 25 vs 234 ± 10 ppm on DM basis).

Cyanide content in leaves did not follow a definite trend and changes observed throughout the experimental period differed between the two varieties; changes in cyanide content of leaves of variety CMC-40 were more pronounced than those of variety CMC-84.

Results of cyanide analyses have also confirmed (Nartley, 1978; Gómez et al., 1980) that 90% or more of the total cyanide in cassava tissues is present as cyanogenic glucoside (linamarin) or bound cyanide and only a small proportion (3% to 10%) is found as free cyanide (Figure 2). Proportions of free and bound cyanide in tissues of variety CMC-84 appeared to be less affected by age of plant than in the samples of variety CMC-40; these proportions in the parenchyma tissue were also less variable than those of the root peel and leaves (Figure 2).

Linear correlation coefficients were computed (Table 1) between cyanide levels of tissues analyzed for each variety and sampling date. Some significant correlations, notably with the variety CMC-84, were found between cyanide levels of leaves/root peel and peel/parenchyma, but practically no relationship between those of leaves and parenchyma. These results explain the lack of success of attempts made to obtain a close correlation between cyanide content of leaves and roots so as to predict cyanide level of the latter (root parenchyma) without the need for harvesting the plants.

Table 1. Linear correlations of total cyanide contents in leaves and roots (peel and parenchyma) of the varieties CMC-40 and CMC-84.

Variety and age of plants	n	Peel parenchyma	Peel leaves	Leaves parenchyma
Linear correlation coefficients (r)				
<u>CMC-40</u>				
9	20	0.45	0.11	0.13
10	20	0.35	0.18	0.00
11	18	0.60**	0.25	0.30
12	20	0.66**	0.15	0.35
<u>CMC-84</u>				
9	19	0.63**	0.40	0.06
10	20	0.56*	0.57**	0.57**
11	15	0.77**	0.58*	0.10
12	20	0.62**	0.66**	0.37

* = $P < 0.05$; ** = $P < 0.01$.

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Free cyanide (% of total, DM basis)

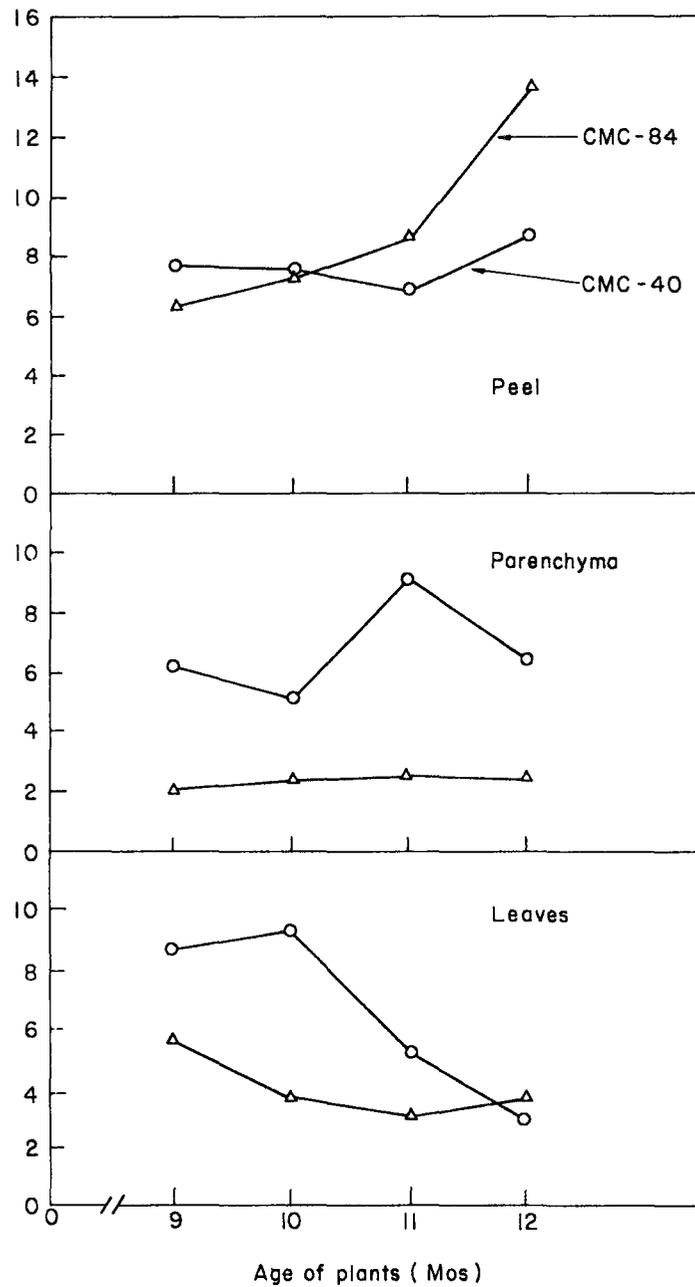


Figure 2. Free cyanide (% of total) in cassava tissues as affected by age of plants of two varieties.

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