Detoxication And Artisanal Transformation Of Three Cassava Varieties (Manihot Esculenta Crantz) In Flour

Randrianantenaina Antoni, Razafimahefa, Fenoradosoa Andree Taratra

Food Biochemistry and Valorization of Natural Resources, Faculty of Science, University of Antsiranana, BP 0-Antsiranana (201), Madagascar
Antoni73randria@gmail.com

Biochemistry, Microbiology and Biotechnology Applied, Faculty of Science, Technology and Environment, University of Mahajanga, BP 652-Mahajanga (401), Madagascar
razafimahefa3@gmail.com

Food Biochemistry and Valorization of Natural Resources, Faculty of Science, University of Antsiranana, BP 0-Antsiranana (201), Madagascar
radosoataratra@yahoo.fr

Abstract: After rice, cassava is the second most important source of energy in Madagascar. The artisanal cassava detoxification method reduces the rate of cyanogenic potential by 3.40 ± 0.00 ppm HCN for the Menarevaka variety; 4.51 ± 0.54 ppm HCN for the Mena variety and 2.44 ± 0.86 ppm HCN for the Fotsy variety. This method produces flours production yields of 32.76 % (Menarevaka), 30.99 % (Mena) and 32.00 % (Fotsy). The flours thus obtained are white and unfermented. They can be used to prepare modern foods.

Keywords: Edible, perishable, toxic, Madagascar, linamarine, lotaustraline.

1. Introduction

Cassava (Manihot esculenta Crantz) is a perennial shrub native to Central and South America [1] that produces edible roots. It was cultivated mainly to serve food to the poorest classes of people [2]. But currently, it is an integral part of the diet of more than 800 million people worldwide [3]. In Madagascar, after rice, cassava is the second most important food source. It represents nearly 14 % of Malagasy caloric consumption [4]. The cassava contains two cyanogenetic glycosides, the amount of which varies according to variety, organ, age, soil environment and humidity and temperature [5], such that linamarine has a rate ranging from 93 to 97 % and lotaustraline from 3 to 7 % [6]. These cyanogenic glycosides are responsible for visible symptoms such as goiter, cretinism, ataxic neuropathy, xerophthalmia for consumers [7]. The processing of cassava is essential because of its perishable and toxic nature. The need to detoxify is one of the major concerns of all processing of cassava for human consumption. Among reliable ways to detoxify cassava is to hydrolyze the glycosides, and then to remove hydrocyanic acid, which is soluble in water and can then be volatilized by heat [8]. The general objective of this work is to detoxify cassava roots during processing into flour. This processing method is a traditional method that promotes the elimination of hydrocyanic acid and water. The production yields and cyanogenic potential rates of the finished products are finally determined. The detoxifying flours obtained are intended for use in modern food products.

2. Materials and methods

2.1. Plant material collection

The raw materials used are the roots of three of the most cultivated, consumed, abundant and widely available cassava cultivars in the Region of DIANA (Diégo-Suarez, Ambilobe, Nosy-Be, Ambanja) (Madagascar), such as Menarevaka, Mena and Fotsy. Root harvesting was carried out during the dry season (November 2016). It is during this season that the cassava loses all its leaves and the stem takes its final color and all the nutrients necessary for the development of the stems and leaves (starch, proteins, mineral salts and vitamins) accumulate completely in the roots. These roots were harvested at maturity; that is, after 12 months of planting.

2.2. Detoxification steps and processing of cassava roots into flour

The detoxification and transformation of cassava roots into flour began with root selection, stripping and peeling, washing, grating, spin-drying, drying and finally grinding.

➢ **Root selection**

Root selection is a very important step during processing. Good quality, healthy, ripe, firm and crack-free roots were chosen.

➢ **Stripping and peeling**

These operations begin with trimming, which consists of removing the woody head and tapered tail from the root with a knife. The bark of the remaining part and the central fiber of each root have been removed. The outer bark removed contains more cyanogenic glycosides and fibers [9]. It eliminates 10 to 13 % of the root weight [10]. Without particular care, peeled roots degrade more quickly than those covered with skin and deterioration occurs only a few hours after peeling. In this case, the root changes color, a characteristic sign of the enzymatic oxidation reaction due to the presence of polyphenols [11]. This reaction is possible when the root wall is cut off. In this case, cyanogenic glycosides located in the vacuoles of the cytoplasm react

with the enzyme linamarase located in the cell wall [12]. Linamarase is an enzyme specific for linamarine and lotaustraline [13]. For its various reasons, root transformation must take place immediately after harvesting. It avoids losses that can sometimes reach 50 % of the harvest in wetlands [14].

➢ **Washing**

Washing is a significant step for food products. It has been made with clean water to remove all dirt, such as soil, sand and clods. Storage of roots in water should not be delayed, as it can cause fermentation and softening [11].

➢ **Grating**

The grating was carried out using a simple perforated stainless steel sheet. Root shredding consists in destroying the cell structure that eliminates the water stored in the shredded pulp and increases the contact area between the air and these reduced pulp. This step dissolves cyanogenic glycosides in the fine mash.

➢ **Spin-drying**

The spin-drying was carried out using a low-porosity muslin fabric. It thus makes it possible to eliminate the excess water stored in the fine mash. According to Hongbété et al. [15], runoff water during the pressing of ground cassava eliminates 90 % of the hydrocyanic acid in cassava.

➢ **Drying**

Drying is the oldest method of food preservation practiced by man. This process improves food stability by significantly reducing water and microbial activity, thus limiting physical and chemical changes during storage [16]. The mash thus wrung out were carefully spread and crumbled in a scattered manner on a well stretched polystyrene tablecloth and fixed on a rectangular frame of 150 cm x 70 cm, arranged on a gentle slope, in full sunlight. The two ends of the frame were placed above the raised racks 1 to 1.10 m above the ground. The inclination of this gently sloping frame easily allows the water contained in these rasps to flow out. They were then covered with a very fine net to protect them from flies, birds and dust. The protective net was securely attached and stretched over the frame to facilitate the penetration of light into the rasps. Drying was carried out in two days to obtain a standard necessary for the moisture content, i.e. between 10 and 12 %, as Djilemo [17] indicated. It eliminates 10 to 30 % of the cyanogenic carbohydrates contained in products [18], [19].

➢ **Grinding**

The grinding of the dried cassava mash was carried out using an electric mill. This reduces the large granules to small particles of uniform size.

2.3. Determination of flour production yields

After the cassava detoxification steps, the flour processing yields were calculated according to the following formula (1):

$$\% R = \frac{M_2}{M_1} \times 100 \qquad (1)$$

With: M_1, the mass (g) of the processed roots and M_2, the mass (g) of the flour produced.

2.4. Determination of cyanogenic potential

In this study, we will determine the cyanogenic potential by an automatic method developed by Rao and Hahn [20] with some modifications on the reagents used. The latter are those used by Essers [21] and Essers et al.[22]. The cyanogenic potential (P_{CN}) of each cassava flour sample (dry matter based) is determined using the formula (2):

$$P_{CN}\ (\text{ppm HCN}) = \frac{100(ah + b) \times V \times FC \times FD}{\%\ MS \times M} \qquad (2)$$

With: a, the slope of the calibration curve (of the form C = a h + b); h, the height (cm) of the peak on the map (on t he abscissa axis); b, the intersection of the calibration curve with the axis of concentrations (C) in cyanide ions (ordinate axis); V, the volume (ml) of the solvent used to extract the cyanated compounds (250 ml); FC, the conversion factor of the standard used to produce hydrocyanic acid (0.1093 in the case of linamarine); FD, the dilution factor of the test extract; M, the mass, in g, of the fresh flour sample used; and % MS, the dry matter content of the test flour sample.

3. Results

After the steps of processing cassava roots into flours, the processing yields and cyanogenic potential contents of the flours of these three cassava cultivars studied are summarized in the table.

Table: *Cyanogenic yields and potentials of flours of three cassava cultivars Menarevaka, Mena and Fotsy*

Parameters	Menarevaka variety	Mena variety	Fotsy variety
Yield (in %)	32.76	30.99	32.00
Cyanogenic potential (ppm of HCN) *	3.40 ± 0.00	4.51 ± 0.54	2.44 ± 0.86

*The results represent the Mean Standard Deviation (n = 3 independent determinations), the difference between the means is significant ($p \leq 0.05$).

The cyanogenic potential levels of cassava flours are related to the way in which cassava roots are processed into flour. Indeed, Delange and Ahluwalia[18] found a huge loss during root transport and storage due to contact of the enzyme linamarase with substrates (Linamarine and lotaustraline) due in particular to "injuries" on its roots. And those Diallo et al. [23] have been informed that hydrocyanic acid is soluble in water and volatilizes into air when the temperature is above 28 °C. Dependent, according to IITA [24], on operations such as soaking and sun drying, a large amount of cyanide in the product is removed. Indeed, peeling removes 10 to 13 % of cyanogenetic carbohydrates from roots [10] and drying degrades 10 to 30 % of cyanide [18], [19]. Researchers such as Hongbété et al. [15] have also shown that runoff water during grated cassava spin drying removes 90 % of hydrocyanic acid. As a result, the levels of cyanogenic potentials are reduced during the steps of processing these roots into flour.

4. Discussion

The yields of cassava root meal production are lower than those obtained by Yao et al. [25], which are 42.50 ± 1.10 % (Zoglo cassava cultivar), 42.00 ± 1.10 % (Bonoua cassava cultivar) and 38.70 ± 1.05 % (Yacé cassava cultivar) respectively. These differences can be explained by the size of the woody head, the tail of the root and the amount of fibrous material that is removed during processing and the method of processing cassava into flour. The levels of cyanogenic potentials in the flours of these three varieties of cassava chosen in this study are lower than those of the three cassava-based attiéké, attoukpou and placali dishes, which are 15.20 ± 0.01 ppm HCN ; 19.10 ± 0.12 ppm HCN and 11.40 ± 0.12 ppm HCN respectively [26]. They are significantly lower than the cyanogenic potentials of three cassava cultivars Akaman, Zoklo, Yace, which are 54.33 ± 7.03; 20.00 ± 6.54 and 106.00 ± 12.13 ppm HCN respectively [27]. The cyanogenic potential of these three flours of the cassava varieties Menarevaka, Mena and Fotsy is below the threshold of no more than 10 ppm HCN of product [28], [29]. The differences can be explained by the varietal difference, the processing method, the harvesting season, the environmental condition of the lees and the age of the cassava to be processed.

5. Conclusion

In Madagascar, cassava, an edible root plant available all year round and throughout the country, is the second most important source of calories after rice. This processing process makes cassava root products more stable, increases their shelf life and reduces their cyanogen content by large amounts. The products obtained by this method can be used to prepare modern foods.

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