The effects of processing techniques against cyanogen levels during the production of siger rice from cassava (*Manihot esculenta*)

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Abstract

This study investigated the effects of cassava processing techniques against cyanogen levels to low levels during the production of siger rice from cassava (*Manihot esculenta*). The processing techniques used for step each of siger rice production were vary in details from one processor to the other. They were highly effective in substantially reducing mean cyanogen levels (76,24-88,26 mg/kg) to low levels (0,45-2,72 mg/kg). In spite of the different cassava varieties used for processing, similar mean reduction levels (96.2–99.5%) in cyanogens levels were obtained by the processors 96,92%, 97,50%, 99,41%, and 98,16% for Kasesa, Tailan, Manggu, and Adira, respectively. Siger rice made from cassava variety of Kasesa produces white color, sticky texture, preferably by panelists, containing moisture content (9.81%), ash (0.47%), fat (0.90%), Protein (2.13%), crude fiber (4.79%), carbohydrate (81.90%), and glycemic index 31.

Keywords: cyanogen, *Manihot esculenta*, processing techniques, ubikayu

I. Introduction

Cassava (*Manihot esculenta* Crantz) is a widely grown plant in the tropics and a valuable low-cost source of calories. These plants contain variable levels of cyanogenic glucosides mainly as linamarin and to a lesser extent as lotaustralin that are present in the leaves and roots of the plant. Several cassava processing techniquesare meant to cause desirable biochemical changes that effect significant modifications of the foods so as to improve quality, extend shelf life and reduce marketing cost. Most processing techniques, accompanied with root cellular damage, trigger the enzymatic hydrolysis of linamarin, which is stored in the vacuoles of the cassava cell, by the endogenous enzyme linamarase to the corresponding ketone (acetone cyanohydrin) and glucose. Cyanohydrin has been known to break down nonenzymatically to hydrogen cyanide and acetone at a rate dependent upon pH and temperature, with stability increasing at acidic pH values (Cooke, 1978). Acetone cyanohydrin can also be broken down by an enzyme hydroxynitrile lyase, which has been found mainly in leaves but with little activity in roots (White et al., 1998).

It is widely claimed that there is inter- and intracommunal variability in cassava processing techniques due to a clear lack of standardization (NRI, 1989; Nweke, 1994) that has been reported to produce foods with variable organoleptic properties and different levels of residual cyanohydrin and HCN (Banea et al.,1992). These residual compounds have been incriminated for the toxicity associated with the continued ingestion of insufficiently processed cassava (Mlingi et al., 1992; Tylleska, 1994). Cassava toxicity has been reported to occur when food shortage and social instability induces shortcuts in established processing methods or when high cyanogen varieties are introduced into areas lacking appropriate processing techniques (Bokanga et al., 1994).

Despite the importance of cassava as a staple food, there is limited information on the effectiveness of different processing techniques in reducing total cyanogens contents of a wide range of cassava varieties to low levels. Some studies have partly elucidated the variations in total cyanogens during cassava fermentation and soaking processes used in the production of a few foods while exempting the other stages in the overall production chain (Westby, 1991; O'Brien et al., 1992; Oyewole and Odunfa, 1992; Brauman et al., 1995). The effectiveness of processing techniques is essential if cassava foods are to be produced on a large scale and in case the techniques have to be modified and/or improved without causing adverse effects to health.

The objective of this study was to investigate the effects of processing techniques in reducing cyanogens levels to low levels during the production of of siger rice from cassava.

II. Materials and methods

2.1. Method

This study was conducted in a completely randomized design with 3 replications. The study was conducted using 4 cassava variety obtained from Central Lampung. The data were analyzed with Tuckey and followed by analysis of variance (anova) to obtain prediction error variance and to find out if any differences between treatments. The results from anova were then analyzed using least significant different (LSD) at 5% level.

2.2. Siger Rice production

Roots of cassava variety and an improved variety of the Agricultural Faculty, Lampung University. The process of making siger rice from cassava. Ubikayu peeled and washed with water. The cubic acid was then shredded with a solvent machine and then immersed in clean water with a ratio of material and water (1: 3) while stirring using a stirring speed of 100 rpm for 1 hour. Furthermore, cassava is squeezed until obtained filtrate and cassava dregs. Fltrate is allowed to stand in the container for 1 hour to obtain tapioca sludge. Tapioca and cassava dregs obtained were then dried at 60oC oven to dry 8% water content. After drying, each tapioca and cassava dregs are milled and sieved with the size of 60 mesh to become flour. Siger rice production is done by mixing cassava, tapioca, and binder. The composition between the cassava and tapioca dregs flour is (4: 1), and the binder comprises 500 mL / kg of water, 10 mL / kg of palm oil, 6 g / kg glycerol monostearate, CMC 15 g / kg, ascorbic acid 2 g / kg, and 4 g / kg salt. The binder was stirred with a mixer for 2 minutes, then put into a mixture of cassava and tapioca dregs flour. The flour mixture and the binder are then stirred with the mixer for 5 minutes. The dough is then steamed in a steaming pan at 90 ° C for 60 minutes. The dough is then allowed to stand at room temperature for 6 hours. The dough is then inserted into a single screw extruder machine at 40 rpm thread, 60 rpm cutting knife rotation, elliptical hole dies, 6 mm in length and 2 mm center width, and 32 dies holes. Grains of siger rice extruded from the extruder machine are then dried at 60oC oven to dry 8% water content. Processing of siger rice can be seen at figure 1.

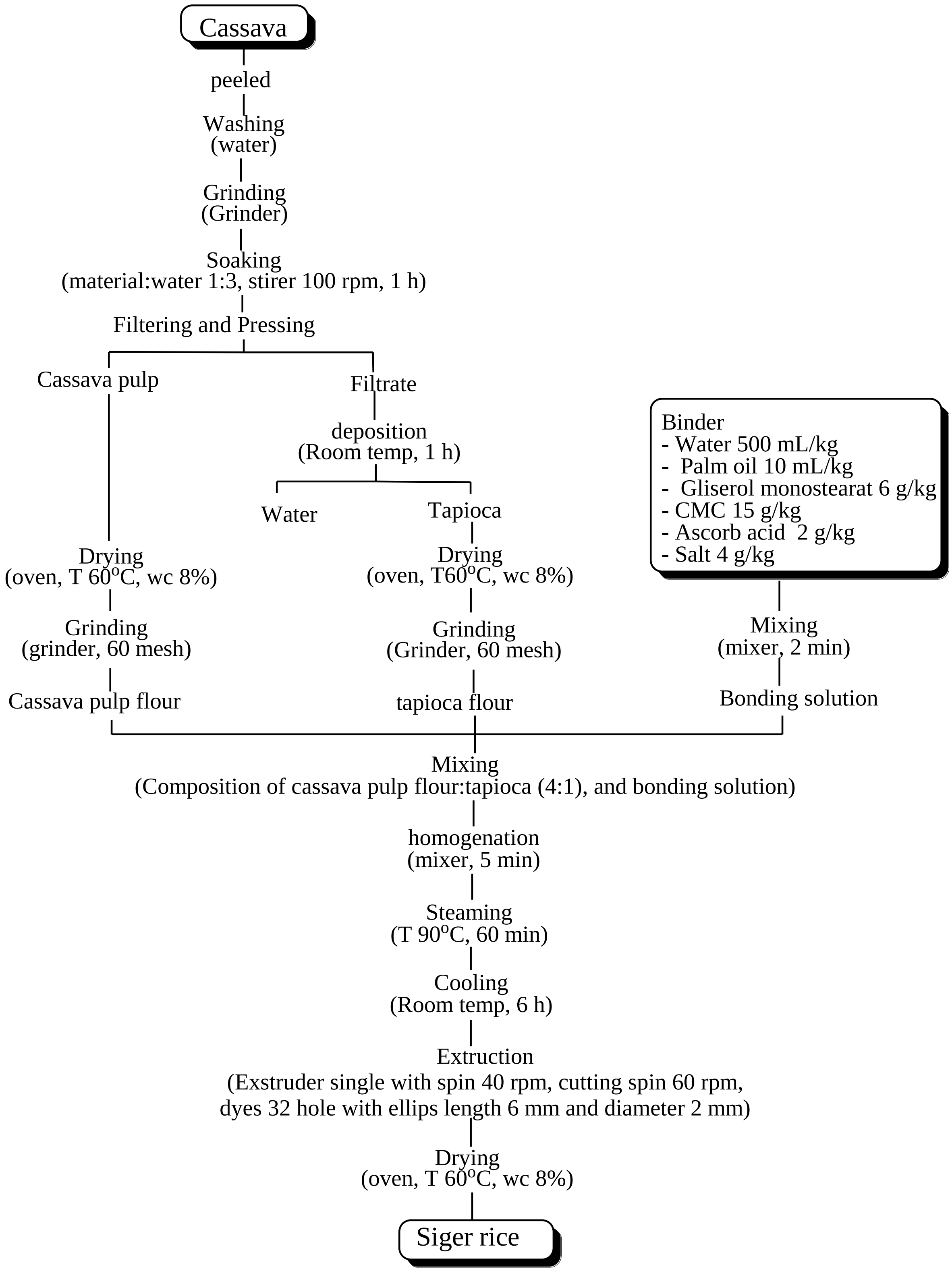

Figure 1. Processing of siger rice from cassava

2.3. Chemical analyses

Each of the process batches was analysed in quadruplicate. Moisture content was determined by the AOAC (1990) method while pH values were measured using a combination electrode on a sample (10 g) homogenized with distilled water (100 ml). Extraction and assay of cyanogens (linamarin, cyanohydrin and HCN) was by the Cooke (1978, 1979) method as modified by O'Brien et al. (1991).

III. Results and discussion

3.1. Initial cyanogen contents

The mean total cyanogen contents of the cassava roots, expressed on a dry weight basis, ranged from 197.3 mg HCN equivalent/kg in adira to 951.5 mg HCN equivalent/kg in var. of tailan (Table 1). Virtually, the major cyanogen found in the roots was in the form of linamarin and a certain amount of enzymic hydrolysis had occurred during the rapid preparation of samples for chemical analyses, which resulted in small quantities of cyanohydrin and free HCN. Throughout this study, it was observed that HCN represented only a small proportion of total cyanogens.

3.2. Effects of processing techniques

The variations in cyanogen levels during processing for the production of the cassava foods are shown in Tables 1. These processing techniques were highly effective in substantially reducing the total cyanogens to low levels (1.1–27.5 mg HCN equivalent/kg), irrespective of their initial contents. In spite of the different cassava varieties used for the production of each of the foods studied, similar mean reduction levels (97.1–99.8%) in total cyanogens were obtained by each of the processors. The mean overall reductions in total cyanogens were 98.8% (range 98.6–98.8%), 97.1% (range 97.0–97.2%) and 99.7% (range 99.5–99.8%) for Tailan, kasesa, and adira, respectively. The mean reduction in total cyanogens levels, obtained in this study, corroborate those from other studies that unmodified processing techniques are capable of effective reduction in total cyanogens even of cassava varieties containing high initial linamarin contents (Vasconcelos et al., 1990; O'Brien et al., 1992).

Table 1. Variations in cyanogens levels during cassava processing for the production of siger rice

Processing techniques	Cyanogen level (mg HCN equivalent/kg)			
	Linamarin	Cyanohydrin	Free HCN	Total
Kasesa				
Peeled roots	421.5+10.1	17.0+2.2	10.1+0.2	448.6
washing	353,6+9,3	27.9+7.9	10.6+0.3	392.0
Sun drying	25.6+1,3	75.3+2.6	11.7+0.7	112.6
steaming	8.1+0.8	25.3+2.9	8.1+0.8	41.5
ekstruder	6.0+0.4	9.0+0.3	4.1+0.5	19.1
Oven drying	4.8+0.1	6.2+0.9	2.1+0.3	13.0
Tailan				
Peeled roots	633.7+11.1	23.1+1.2	9.9+0.2	666.6
washing	531.5+9.8	40.7+2.3	10.4+0.8	582.5
Sun drying	38.5+7.1	117.4+11.6	11.4+1.3	167.3
steaming	12.2+2.1	41.5+3.7	7.9+0.5	61.6
ekstruder	9.0+0.7	15.4+1.1	4.1+0.4	28.4
Oven drying	7.2+0.3	10.1+0.8	2.0+0.3	19.3
Manggu				
Peeled roots	910.9+15.5	26.9+1.2	13.6+1.2	951.5
washing	764.1+17.5	53.1+1.8	14.3+0.7	831.5
Sun drying	52,3+11.6	167.7+9.4	15.8+1.6	238.8
steaming	17.6+9.5	59.4+5.8	10.9+1.2	87.9
ekstruder	12.9+2.2	22.0+1.4	5.6+0.7	40.5
Oven drying	10.3+1.4	14.4+1.2	2.8+0.5	27.5
Adira				
Peeled roots	620.8+14.1	28.1+1.3	6.2+0.2	655.1
washing	520.8+11.0	45.3+2.7	6.5+0.8	572.5
Sun drying	37.7+2.1	119.6+4.3	7.2+1.1	164.4
steaming	12.0+1.5	43.6+1.9	5.0+0.9	60.5
ekstruder	8.8+0.7	16.6+1.6	2.5+0.4	27.9
Oven drying	7.0+0.9	10.7+2.3	1.3+0.3	18.9

3.3. Effects of root size reduction and soaking

The initial grating, cutting into chunks and soaking of the cassava roots caused appreciable decreases in both linamarin and pH levels that coincided with a significant increase in cyanohydrin. Linamarin decreases were considerably greater than the corresponding increases in cyanohydrin. These changes occurred during the initial 1st and 2nd day of root soaking, respectively, for siger rice production. They were marginally more evident for siger rice production than for the other foods. This could be due to the smaller root sizes obtained after grating during siger rice production as compared to chunks (1–4 cm) and (5–9 cm) soaked in water, respectively, for the production of siger rice production. With regard to the greatest reduction in cyanogens, the most important techniques used in the production of the foods studied were those that maximise cassava root tissue disintegration. Grating, cutting and soaking in water cause tissue cellular disruption that results in comparatively greater susceptibility to the actions of bacteria, as indicated by the fall in pH values, and the enzymes *a*-amylase and endogenous linamarase (Cooke, 1979).

Root softening during soaking has been ascribed to an increase in the activity of cell-wall degrading enzymes (Okolie and Ugochukwu, 1998; Ampe et al., 1995). It has been reported that the rate of acidification increased with decreasing cassava root sizes (id. *o*15 mm) during the first 48 h of fermentation for the production of siger rice which also affected product organoleptic qualities. The reduction in cyanogen levels has been found to be strongly correlated to the degree of root size reduction, which is also directly related to the rate of softening and acidification (O'Brien et al., 1992; Ampe et al., 1994; Westby and Choo, 1994). From this study, it could be deduced that the efficacy of root size reduction and the level of endogenous linamarase activity are important factors in the effectiveness of linamarin elimination.

IV. Conclusion

The processing techniques used for step each of siger rice production were vary in details from one processor to the other. They were highly effective in substantially reducing mean cyanogen levels (76,24-88,26 mg/kg) to low levels (0,45-2,72 mg/kg). In spite of the different cassava varieties used for processing, similar mean reduction levels (96.2–99.5%) in cyanogens levels were obtained by the processors 96,92%, 97,50%, 99,41%, and 98,16% for Kasesa, Tailan, Manggu, and Adira, respectively. Siger rice made from cassava variety of Kasesa produces white color, sticky texture, preferably by panelists, containing moisture content (9.81%), ash (0.47%), fat (0.90%), Protein (2.13%), crude fiber (4.79%), carbohydrate (81.90%), and glycemic index 31.

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