Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 3 (4): 589-593
 (ISSN: 2141-7016)
jeteas.scholarlinkresearch.org

A study of starch and Cyanide Contents in Etche Manufactured Garri

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Abstract
This work considered a comparative determination of starch and hydrogen cyanide (HCN) content from a locally manufactured garri. The manual and mechanical method of dewatering (pressing) was used. The percentage of starch released from both methods decreased with time. At 30 minutes, the percentage of starch for manual pressing was 5.45% while that from mechanical pressing was 7.70%. At 150 minutes, the amount of starch from manually pressed garri was 2.30% and that from mechanically pressed garri was 1.75%. Mechanical presser removed more HCN than manual presser at all time intervals. At 30 minutes and 150 minutes, the percentage of HCN from mechanical and manual pressing were 0.064, 0.046 and 0.053,0.031% respectively. The temperature of curing for both methods was approximately 90^0C, at 25 minutes. The significant of this research is to investigate a better method of processing garri with less amount of HCN. Hydrogen cyanide is injurious to human health because it is carcinogenic. This study revealed that mechanical pressing brought a significant reduction of HCN than manual pressing.

Keywords: Starch, cyanides, garri, fermentation, dewatering, cure/vulcanized, frying.

INTRODUCTION

The tropical root crop cassava (Manihot escilanta crantz) constitutes one of the major stable foods for an estimated 300 million people in the tropical world (Akinrele, 1964). The major processed forms of the cassava tuber include, instant cassava flour and garri. Garri is the most popular form in which cassava is consumed in West Africa. The unprocessed tuber contains small but significant amounts of Cyanogenic Glucose (Onwumere, 1975). Cassava is a highly productive crop in terms of food calories produced per unit land area per unit of time, significantly higher than other staple crops. Cassava can produce food calories at rates exceeding 250,000 cal/hectare/day compared with 176,000 for rice, 110,000 for wheat, and 200,000 for maize (corn). Cassava, like other foods, also has anti-nutritional and toxic factors. Of particular concern are the cyanogenic glucosides of cassava, which are linamarin and lotaustralin. These, on hydrolysis, release hydrocyanic acid (HCN). The presence of cyanide in cassava is of concern for human and for animal consumption. The concentration of these antinutritional and unsafe glycosides varies considerably between varieties and also with climatic and cultural conditions. Selection of cassava species to be grown, therefore, is quite important. Once harvested, cassava must be treated and prepared properly prior to human or animal consumption. Cassava roots and leaves should not be consumed raw because of the presece of cyanogenic glucosides, linamarin and lotaustralin. These are decomposed by linamarase, a naturally-occurring enzyme in cassava, liberating hydrogen cyanide (Cereda and Mattos, 1996). Cassava varieties are often categorized as either sweet or bitter, signifying the absence or presence of toxic levels of cyanogenic glucosides, respectively. The so-called sweet (actually not bitter) cultivars can produce as little as 20 milligrams of cyanide (CN) per kilogram of fresh roots, whereas bitter ones may produce more than 50 times as much (1 g/kg). Cassavas grown during drought are especially high in these toxins. (White, et al., 1998; Bhatia, 2002). It has also been linked to tropical calcific pancreatitis in human, leading to chronic pancreatitis. People who traditionally eat cassava generally understand that some processing such as soaking, cooking, fermentation, etc are necessary to avoid getting sick(FAO, 1990)

Symptoms of acute cyanide intoxication appear four or more hours after ingesting raw or poorly processed cassava such as vertigo, vomiting, and collapse. In some cases, death may result within one or two hours. It can be treated easily with an injection of thiosulfate, which makes sulfur available for the patient's body to detoxify by converting the poisonous cyanide into thiocyanate (FAO, 1990).
Chronic, low-level cyanide exposure is associated with the development of goitre and with tropical ataxic neuropathy, a nerve-damaging disorder that renders a person unsteady and uncoordinated. Severe cyanide poisoning, particularly during famines, is associated with outbreaks of a debilitating,

irreversible paralytic disorder called konzo and, in some cases, death. The incidence of konzo and tropical ataxic neuropathy can be as high as 3% in some areas according to Wagner (2010). In FAO, 2011 report, brief soaking (four hours) of cassava is not sufficient, but soaking for 18–24 hours can remove up to half the level of cyanide and that drying may not be sufficient, either.

For some smaller-rooted, sweet varieties, cooking is sufficient to eliminate all toxicity. The cyanide is carried away in the processing water (Cereda and Mattos, 1996). The larger-rooted, bitter varieties used for production of flour or starch must be processed to remove the cyanogenic glucosides. and then ground into flour, which is then soaked in water, squeezed dry several times, and toasted . The Industrial production of cassava flour, even at the cottage level, may generate enough cyanide and cyanogenic glycosides in the effluents to have a severe environmental impact was reported by Cereda and Mattos, (1996).

A safe processing method used by the pre-Columbian indigenous people of the Americas is to mix the cassava flour with water into a thick paste and then let it stand in the shade for five hours in a thin layer spread over a basket. During which about 5/6 of the cyanogenic glycosides are broken down by the linamarase; the resulting hydrogen cyanide escapes to the atmosphere, making the flour safe for consumption same day (http://info.anu.edu.au/mac/Media/Media_Releases/,2007). The traditional method used in West Africa is to peel the roots and put them into water for three days to ferment. The roots then are dried or cooked. In Nigeria and several other west African countries, including Ghana, Benin, Togo, Ivory Coast, and Burkina Faso, they are usually grated and lightly fried in palm oil to preserve them. The fermentation process also reduces the level of ant nutrients, making the cassava a more nutritious food (Oboh and Oladunmoye, 2007). The reliance on cassava as a food source and the resulting exposure to the goitrogenic effects of thiocyanate has been responsible for the endemic goitre seen in the Akoko area of southwestern Nigeria(Akindahunsi, et al., 1998)

Starch, which is present in cassava as a polymer, that is, one in which the molecules are built up by the chemical union of hundreds or thousands of molecules of a simpler substance. In starch, this simpler substance, or building block, is D-glucose, or dextrose, which combines with itself chemically through a dehydration reaction to make the starch molecule and it can be broken down again to dextrose by acid hydrolysis or by enzyme action (Coursey, 1973).It has been reported that in cassava starch the aliphatic cyanogenic glucoside, linamarin and lotaustralin often referred to as a bound cyanide, while the non-glycosidic cyanide is free (Cooke and Maduagwu, 1978). The cyanogenic glucoside produce hydrocyanic acid (HCN) when the action of an endogenous enzyme, linamarase is initiated by crushing or otherwise damaging the cellular structure of the plant. The utilization of cassava roots for both human and animal nutrition appears to be limited by the presence of these cyanogenic glycoside. The concentration of HCN in cassava tubers ranges from 10 – 490 mg/kg tuber (Conn, 1969).The hydrocyanic acid (HCN) is lethal if more than 0.1g of it is contained in the food eaten by an individual at any one time (Owueme, 1978). When the peeled tuber coain less that 50 milligrams of HCN per kilogram of the freshly grated c.assava, the cassava can be taken as harmless to the consumer. A concentration of between 50 and 80 milligrams may be slightly poisonous, 80 to 100 milligrams is toxic, while concentrations above 100 milligrams per kilogram of grated cassava are fatal (Oyenuga and Arnazigo, 1957). Owing to the presence of the cyanogenic glycoside in cassava, various processing methods are employed to bring about a reduction in the toxicity of the roots. Studies on a wide variety of traditional cassava processing methods which include maceration, soaking, boiling, roasting, fermentation, drying of cassava tubers, or combination of these processes indicate that there is partial removal of cyanogenic glycosides during processing, but residual quantities are left which is responsible for the chronic toxicity associated with continued ingestion of cassava products (Sundresan, 1988). In more recent time, considerable mechanization has been introduced into garri manufacture, and several integrated factories for garri manufacture have sprung up (Wadhwa, 1973).

The purpose of this research include a comparative determination of starch and hydrogen cyanide present in processed garri having by a machine and that processed manually because of the adverse effect of cyanide. And also to know the method of production that give rise to lower amount of HCN with good starch content and to deduce a temperature at which a preferable garri is vulcanized with an acceptable taste.

Methods of Garri Processing

The processes involved in producing garri traditionally are basically the same in the sub-region and involves the following unit operations: peeling, washing, grating, fermenting and dewatering (i.e. pressing), pulverizing, sieving and frying. Peeling was done manually with kitchen knives. After, the cassava tubers has been peeled, they were washed and made ready for grating. Grating was done on a metal sheet (Aluminum or galvanized iron) with holes punched with nail, making one surface rough and the other smooth. Grating was done on the rough surface by pressing the tuber on it and by a forward and backward movement. The grated cassava is collected in a basin.

The grater or milled cassava pulp which is mash form was then put into a white cotton bag, tied and put under heavy compressive force by using hydraulic machine, and manually, respectively, pressing for dewatering. This is achieved by placing the bag of pulp between two flat wooden surfaces, and thereby, compressing the pulp bag for dewatering (drying). It was left for 2 – 4 days during which time fermentation of the pulp took place. This fermentation is very necessary to reduce the cyanide content of the product (Chuzel, 1987). After the pulp has been dewatered and fermented, it becomes lumpy and with a characteristic fermented odour. The weight of grated cassava before and after dewatering was determined to ascertain moisture content. The lumps were broken with hand and then sifted in a sieve locally made from palm frond ribs or wire mesh. The product is granular and with about 50 – 60% moisture content (wet basis). The final stage of frying is done in a locally constructed oven or using a big circular metalic frying pan. The process of garri frying, normally referred to as garification, involves simultaneous cooking and dehydration. The final product when cured is crispy.

EXPERIMENTATION

Determination of Starch Contents for Manually and Mechanically Pressed Cassava

The starch content of the pressant was determined by gravimetric method. A known volume of the pressant (20 ml) was measured with tared porcelain dish. This was allowed to stand undisturbed for one hour. The supernatant was decanted and the sedimented starch was allowed to stand on boiling in a water bath until they were well dried. The porcelain containing the dry starch was dried in the oven at 85^0C, until a constant weight was obtained.

Determination of Hydrocyanide Contents for Manually and Mechanically Pressed Cassava

The contributions of the various unit operations to HCN reduction in the various methods of garri manufacturing were determined using Alkaline titrating method. 100 ml of samples grated was placed in a – neck 1 litre quick fit flask. 200 ml of distilled H_2O was added and allowed to stand for 2 – 4 hours while connected to a steam distiller for the distillation of the HCN. It was then distilled and 100 ml distillate was obtained and collected in 20ml of 25% NaOH solution. The distillate was diluted to 150ml in a volumetric flask. To 50ml of the diluted distillate was added 8ml of 6 N NH_4OH and 3ml of 5% KI solution indicator. This was titrated against 0.02N $AgNO_3$. The end point was indicated by a faint permanent turbidity appearance.

Determination of the Temperature of Cured Garri for Manually and Mechanically Pressed

The temperature of the garri at roasting or frying was taken at different time intervals ranging from 5 – 25 min with a thermometer during frying. The final temperature was recorded when the garri is cured or vulcanized

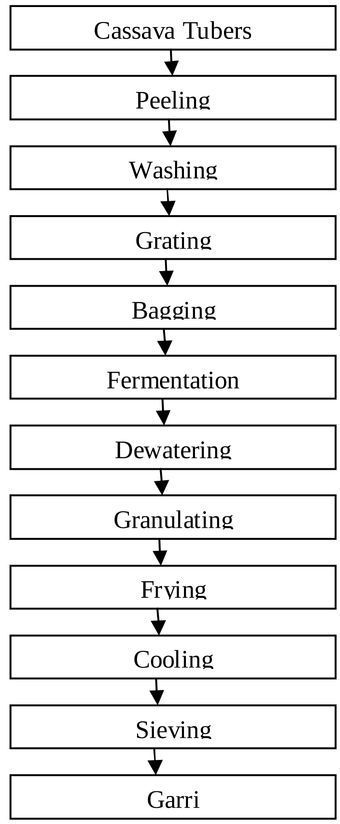


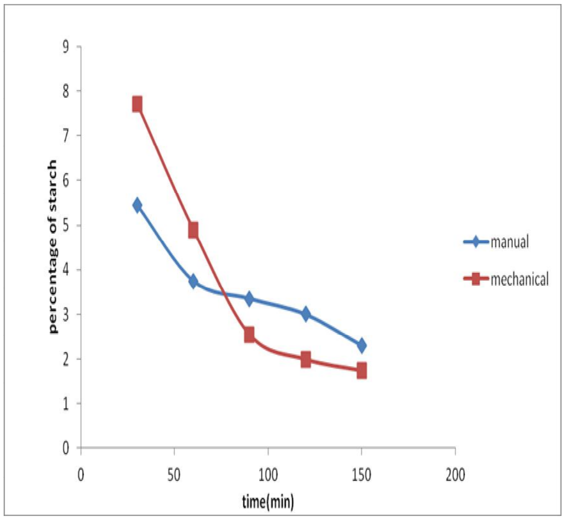
Figure 1: Flow chart for garri processing

RESULTS

The results of the amount of starch produced with time from manually and mechanically pressed garri is represented in Table 1 and Figure 2. Similarly, the hydrogen cyanide for manually and mechanical methods are shown in Table 2 and Figure 3 respectively. Represented in Table 3 and Figure 4 is the temperature of curing with time and finally Figure 5 showed the relationship between percentage starch and HCN obtained for both method considered in this work.

Table 1: Percentage of starch from manually and mechanically pressed garri

Time (min)	Wt% of starch manually	Wt% of starch mechanically
30	5.45	7.70
60	3.75	4.90
90	3.35	2.55
120	3.00	2.00
150	2.30	1.75



Firgure 2: Percentage starch produced from manually and mechanically pressed garri.

Table 2: Percentage of hydrogen cyanide in manually and mechanically pressed garri

Time (min)	Wt% of starch manually	Wt% of starch mechanically
30	0.053	0.064
60	0.049	0.059
90	0.044	0.057
120	0.038	0.053
150	0.031	0.046

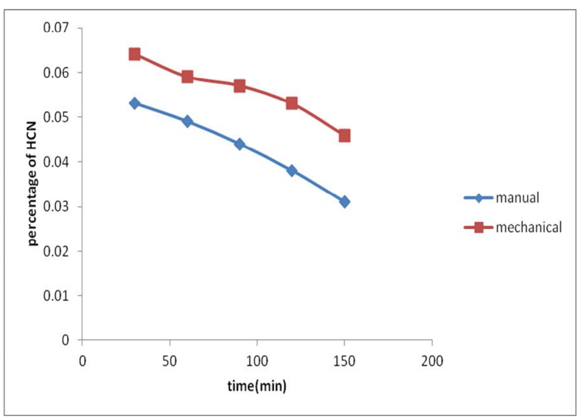


Figure 3: Percentage of HCN produced from manually and mechanically pressed garri with time.

Table 3: Curing temperature with time (manually pressed and mechanically pressed)

Time (min)	Wt% of starch manually	Wt% of starch mechanically
5	59	62
10	66	78
15	78	86
20	85	89
25	90	91

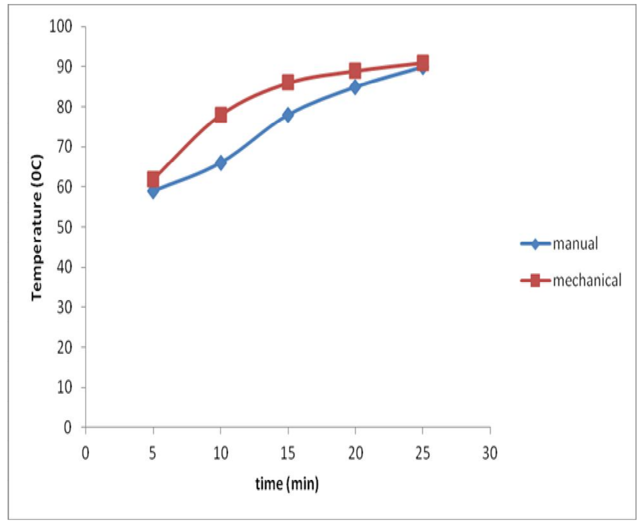


Figure 4:Temperature of manually and mechanically cured with time.

DISCUSSION

The percentage starch released from both manually and mechanically pressed garri decreased with time. At the outset, the total starch released from mechanically pressed was greater than the starch released from manually pressed. Also, starch released at the beginning was faster and the rate decreased rapidly in the mechanically pressed than in the manually pressed. As time progressed, more starch was present from the manually pressed. The percentage of starch decreased more slowly after 60 minutes for manually pressed garri, due to longer period and slows dewatering as shown in Figure 2.

In Figure 3, the percentage of hydrogen cyanide released in the mechanically pressed garri is also higher than that released in the manually pressed garri due to more pressure that was applied by the hydraulic jack (Ikediobi, 1980). The rate of hydrogen cyanide removal tends to decrease steadily with time.

The temperature of the mechanically cured garri was always higher than that of the manually cured, until at 25 minutes of continuous application of heat. At this time, the temperature approached the same value approximately, since the garri must be cured at the same temperature as the study revealed(Figure 4).The temperature of curing for both methods followed the same trend. There is a direct proportion between the amount of starch released and that of hydrogen cyanide for both manually and mechanically pressed garri. The total amount of hydrogen cyanide removed was higher with mechanical presser.

CONCLUSION

In this study mechanical presser removed more starch at a shorter time than manual presser from garri. But at prolong time manual pressing removed slightly higher amount of starch. For the reduction of hydrogen cyanide which is carcinogenic, mechanical pressing should be used. For manually press garri, if the number of days for fermentation be increased; further reduction in the amount of HCN may occur. The research showed that a temperature of 90^0C was adequate for curing both garri that was mechanically and manually pressed. The study has identified the ways of producing garri with reduced hydrogen cyanide and starch for consumption. However, the hydrogen cyanide remaining in the processed garri should be analyzed to ascertain whether it is within allowable limit for human consumption. This aspect was not considered in this present work. For further reduction of HCN, the fermentation period can be increase beyond that reported in this work for manual pressing and HCN left in processed garri should be analyzed.

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