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Hazard Analysis Critical Control Points of Cyanogenic Potentials (CNP) in 'Gari' processing system

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Abstract
Cyanogenic potentials *(CNP)* levels and variations in cassava tuber processing into”gari” chain cause several toxicological implications. Hazard Analysis Critical Control Points (HACCPs) which has not been applied in cassava tuber processing into “gari” product was used to identify cyanogenic hazard levels associated with “gari” processing and Control Points (CPs) where control measures could be effective in cassava tuber processing into “gari” chain. Interviews and direct participatory observation were used to determine manufacturing practices, food handling and Critical Control Points (CCPs) for cyanide extraction in cassava tuber processing steps and stages into “gari” from farm-to-table in the studied “gari” processing industry. Laboratory investigation was carried out to analyze and measure cyanide toxic levels and variations to better recommend Critical Control Points (CCPs) of cyanogenic potentials (CNP) in cassava tuber processing into “gari” steps from farm-to-table. The mean cyanide level and variation (mg HCN Average/100 mg) in “gari” processing steps and CCPs measures were established at: unpeeled cassava 3.68 – CCP; peeled cassava 9.35 – CCP; peeled and washed cassava 10.16 – CCP; pressed mash 7.48 – CCP; hold and sell 2.09 – CCP. Adherence to Good Manufacturing Practices (GMP) and handling, and effective control at appropriate CCPs for CNP control in cassava tuber processing into “gari” chain is essential measure to avoid toxic effect in the “gari” product.

Keywords: Cassava, toxic, Food, Processing, HACCP, Manufacturing practices

Introduction
Cassava, one of the over 3000 types of plants that produce cyanogenic compounds (Kakes 1990, Poulton 1990, McMahon et al 1995, Vetter 2000) releases hydrogen cyanide (HCN) upon hydrolysis (Conn 1980, McMahon et al 1995, Vetter 2000). This process of HCN production is known as cyanogenesis and makes cassava a potential toxic food to humans (Kakes 1990, McMahon. Preventive quality assurance (Hazard Analysis Critical Control Points) of cassava tuber processing into “gari” product is therefore extremely needed for “gari” quality control. Quality is what makes a product suitable for its intended use (Akunyili, 2001). Thus food safety and food quality are two vital parameters in food control system. Good quality, safe and wholesome food is required for consumption by the populace and for promoting adequate and proper nutrition (Agbede,2001) but poor manufacturing practices and handling in cassava tuber processing into “gari” chain from farm-to-table can increase cyanogenic potential (CNP) in “cassava processed products and finished product (“gari”) to unsafe level.

As 'gari', one of the cassava food products is the most widely consumed and traded of all cassava foods in Nigeria (Cock 1985, Almazon 1992, Westby et al 1992, Okafor et al 1998) and many other countries in West Africa (Oduro et al 2000), it is critical to understanding manufacturing practices and handling affecting toxic level trends in each processing step and Critical Control Points (CCPs) for effective control measures. Hazard Analysis Critical Control Points (HACCPs) concept is a more desirable alternative to more traditional control options for food manufacturing and handling in developing countries. In an effective HACCPs plan, precautions from farm-to-table should be stressed. HACCP is a novel tool for food quality assurance and yet it has not been applied in “gari” processing industries. This study conducted in the informal sector “gari” processing industry, seeks to address the food control system in cassava tuber processing into “gari” chain, which is lacking in the informal sector “gari” he processing industries. To assess relative risk and identify the points where Critical Control Points (CCPs) could be effected in the "gari" processing chain, direct participatory observation, collaborative information from key informants and in-depth interview were carried out, result from laboratory analysis of samples collected from observed steps in the "gari" processing chain from farm-to-table were used to establish Critical Control Points in the "gari" processing chain.

Materials and Method

Onipepeye-Oremeji-Agugu "gari processing" industry is the biggest and oldest "gari" processing industry in Ibadan, Nigeria, the largest indigenous city in black Africa, Ssuth of the Sahara (UNICEF – FMoH, 1989).It is located near the forest/grassland boundary of Western Nigeria with a population of 1,438,659 people (NPC 2008) and it is 145km from Lagos. "Gari" food product from the industry is consumed in Ibadan and other parts of Nigeria, while some are exported. But the "gari" product for export is not distributed legally in the importing countries, because it does not undergo an effective food control system in the exporting country as required by the World Trade Organization (WTO), which this study is addressing. Information on sources of cassava tubers used in the "gari" processing industry, the transaction and human interactions with cassava tubers from farm-to-table, cassava industry market, sales, procurement of cassava tubers, reasons for procedures and manufacturing practices applied in the "gari"processing industry, commercialization of 'gari' product and circulation, carefully discussed on individual basis with each 3 key informants and in-depth interview corroborated each other. Direct participatory observation was used for design of "gari" production flow chart in the 'gari' processing chain, Fig 1. 3 stages and 7 steps in the cassava processing into 'gari' chain were identified for sample collection.

Procedure for "Gari" Processing

A "gari" processing chain identified for this study was followed through twice (in 2 visits) from raw tuber to ready - to - eat "gari". The study made use of the same cassava tubers normally purchased by the processors in the industry, and their processing method for the study, using HACCP concept. The processing steps were identified for sample collection. These spanned through: unpeeled cassava tuber, peeled cassava tuber, peeled and washed cassava tuber, grated mash, packed grated mash into bags and left on the platform for 3-5 days for fermentation and dewatered before sieving. After fermentation, and dewatering by press, the paste was sieved into flour using handmade sieve to remove fibres and ungrated lumps. The "gari" frying pot was placed on an open fire for garifying the fermented sieved flour. The final product was sieved to obtain "gari" of different sizes.

Samples were collected from selected points in the flow chart of "gari" processing chain (Fig 1). Based on direct participatory observation and frequent visits to "gari" processing

Cassava tuber processing into "gari" experiment was conducted using cyanide level indicator. The cassava tubers used in the study were those brought into the industry market within the industry premises by cassava farmers or traders and purchased by the processors. A multi-stage sampling technique was used to select one processor's cassava tuber processing into "gari" chain, out of the 20 processors' "gari" processing chains screened. Hazard Analysis of Critical Control Points (HACCPs) novel tool was used for cyanide toxic level of trends. The gari processor's processing chain identified for this study was followed through "gari" processing chain twice (in 2 visits for 2 set of samples) from unpeeled cassava tuber to ready-to-eat "gari" product. The study made use of the industry's "gari" processing procedures and the identified steps for sample collection, using the industry market cassava tubers without reference to variety. A total of 14 samples were collected from the studied processor's cassava tuber processing into "gari" chain in 2 visits, for verification of point(s) of poor manufacturing practices and handling, for determination of cyanide toxic levels (Esser et al.1993) and trends, Control Points (CPs) and where Critical Control Points (CCPs) could be established.

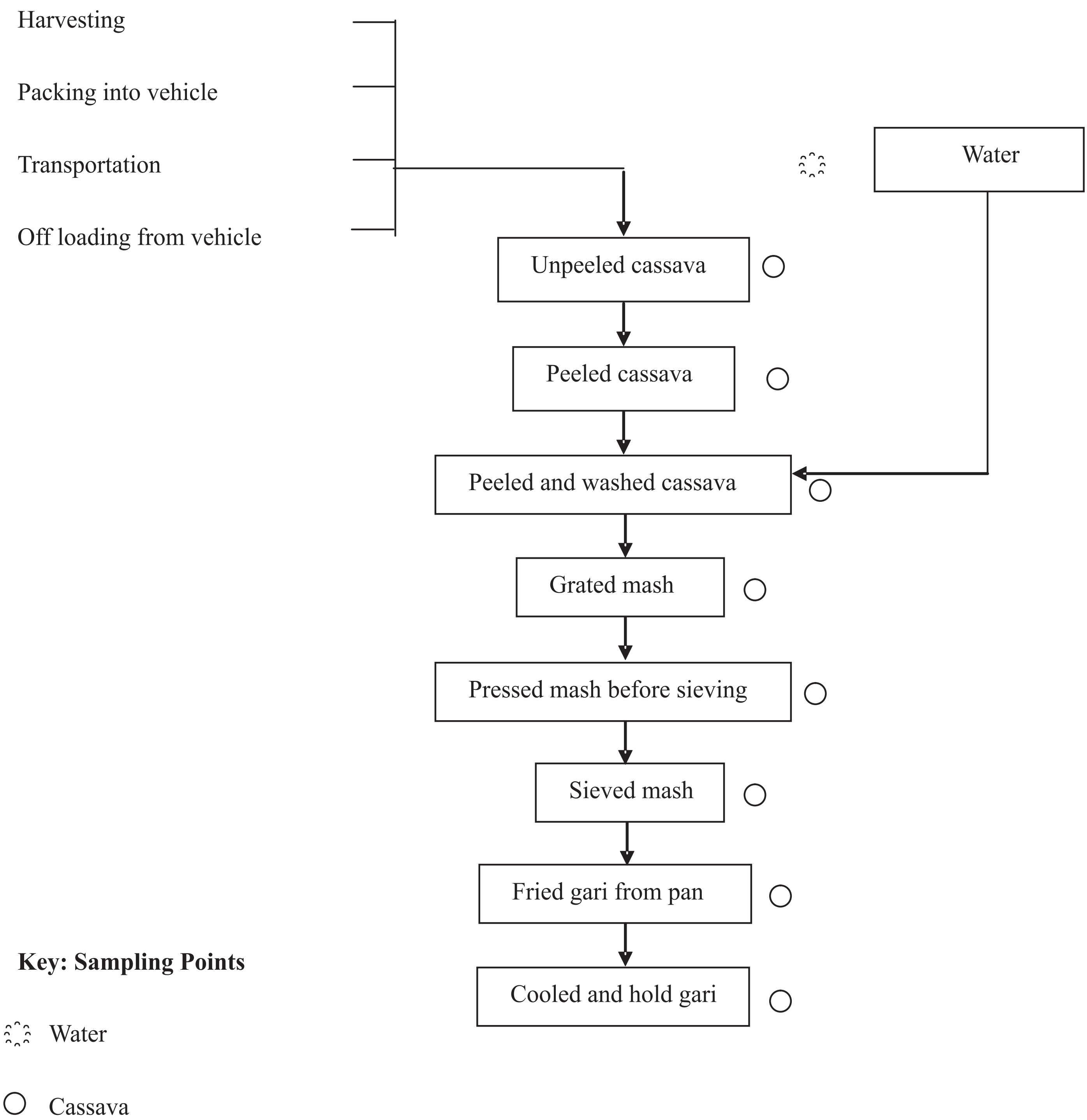
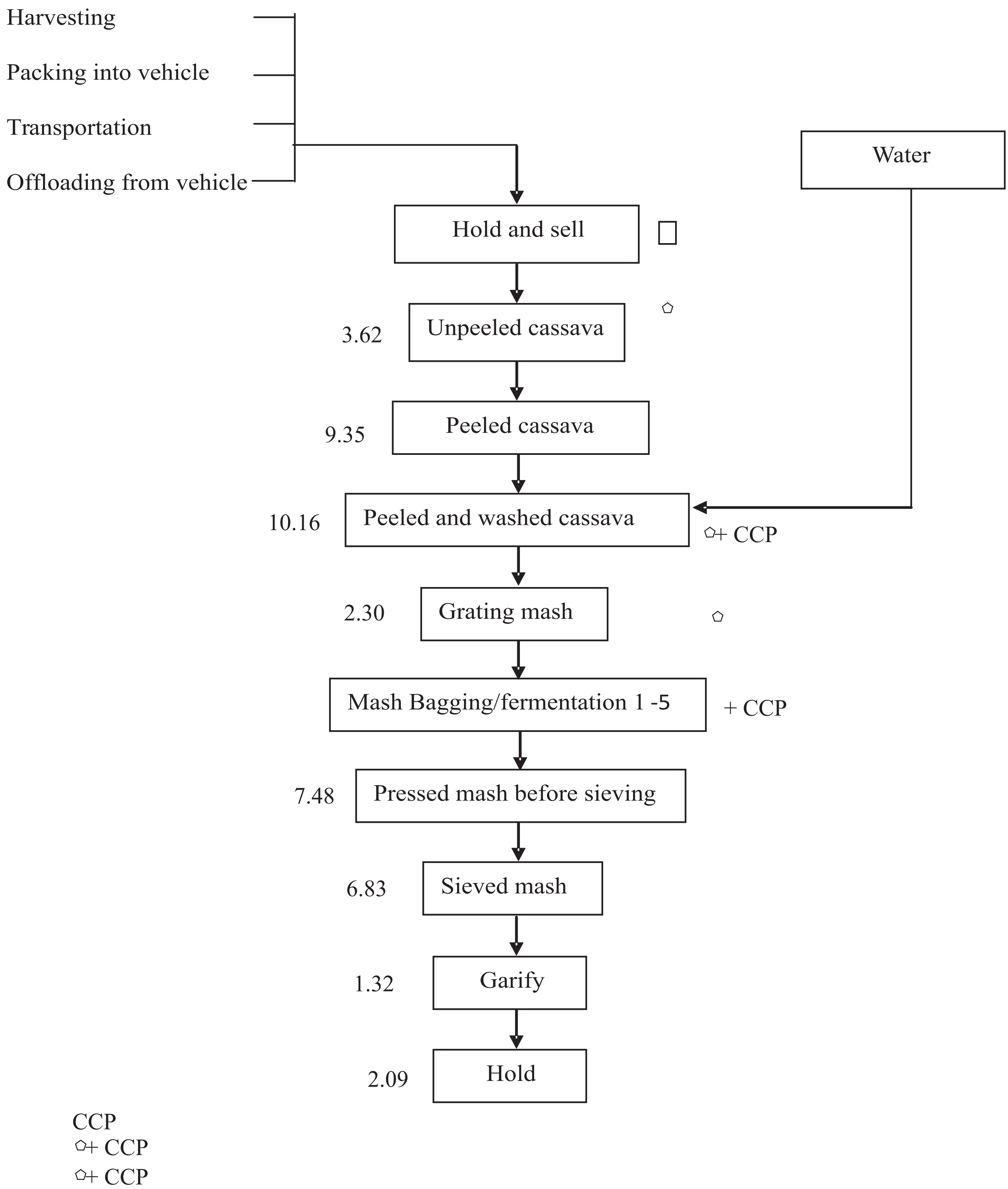


Figure 1: Flow Diagram Showing Points of Sample Collection for Cyanide Analysis in Gari Processing

Results

Fig 2 shows the flow diagram of the studied cassava tuber processing into "gari" chain from raw cassava tuber stage to finished product stage with points of cyanide extraction and levels. Critical Control Points (CCPs) were also established for cyanide levels reduction in the "gari" processing chain.



KEY

□ Contamination of raw material

⌂ + Potential growth of Cyanide level on initial contamination

⌂ Reduction in Cyanide toxicity due to mechanical breakdown of Cyanogenic compounds and rise in temperature.

+⌂ Growth in Cyanide level CCP Critical Control Point for reduction of cyanide levels

Figure 2: Flow Diagram Showing Cyanide Extraction, Levels and Critical Control Points in the Processing of "gari" from Raw Cassava Tuber

Discussion

HACCPs strategy identifies hazards associated with different types of food processing and handling, assesses the relative risks and identifies points where control measures would be effective (Bryan 1988a, Ehiri *et al*. 2001).

The CNP of 3.62 mg HCN eq. Average/100g in the first step of unpeeled cassava in the "gari" processing chain increase to CNP 9.35 mg HCN eq. Average and 10.16 mg HCN eq. Average/100g at steps of peeled cassava, and peeled and washed cassava respectively. Grating the cassava tubers reduced the CNP level to 2.30 mg HCN eq. Average/100g. The pressed fermented mash recorded an increased CNP level to 7.48 mg HCN eq. Average/100g. Sieved mash had a CNP of 6.83 mg HCN eq. Average/100g, while fried "gari" from pan recorded 1.32 mg HCN eq. Average/100g CNP level. An increase slightly to 2.09 mg HCN eq. Average/100g CNP level was recorded in the "gari" that had been left to cool, hold and ready – to - sell. Critical Control Points would therefore be established at steps of peeled cassava, and peeled and washed cassava, pressed mash before sieving and hold cooled "gari" ready-to-sell.

The long storage hours of cassava tubers (Bokanga 1991) between peeled, and peeled and washed cassava tuber for grating attributed to the rise in CNP to 7.48 mg HCN eq. Average/100g at steps of peeled and washed cassava tuber which is the practice in the industry, hence CCPs at these steps. Critical Control Points is also established at point of pressed mash before sieving with a CNP of 7.48 mg HCN eq. Average/100g. There is a wide variation in the level of linamarase activity in cassava tubers. Further, the low pH (around 4.0) rapidly achieved during fermentation is inhibitory to linamarase activity and stabilizes cyanohydrins, thus slowing down linamarin hydrolysis and cyanohydrin breakdown. At point of cooled/or hold was established a CCP to check the rise in CNP to 2.09 mg HCN eq. Average/100g from 1.32 mg HCN eq. Average/100g which might be due to the resettling of evaporated cyanogens on the moist surface of the cooled "gari" as it is readily soluble in water.

Conclusion

Toxic effects of cassava are still a limited problem in relation to the frequency of other public health problems in tropical countries and the wide use of cassava. Adherence to an appropriate processing method and effective control at appropriate Critical Control Points for cassava roots and processing chain is essential measure to avoid toxic effects. Cassava promotion in form of short-term mass campaigns focusing only on introducing new varieties and processing methods without regard to the traditional processing methods and effective control point strategies in the processing chain may induce toxic effects. The study showed that HACCPs was a useful research tool for determining the steps in the processing stages of cassava tuber processing into "gari" where Critical Control Points (CCPs) could be established for the control of CNP, based on known handling and manufacturing practices for the control of chemical hazards (cyanide) during cassava processing. The technique could also be applied in other known food processing industries for the control of chemical hazards (cyanide) for food safety.

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