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Full Length Research Paper

Application of HACCP to post-harvest processing of African breadfruit *Treculia africana* Decne in Nigeria

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African breadfruit *Treculia africana* Decne 'ukwa' in Igbo is an important food crop in Southern Nigeria. The seed has less fat (4 to 7%) than some other nuts and contains 19% protein similar to most pulses. The dehulled seeds are in the form in which the seeds are consumed as main dish or roasted as snack. The spongy pulp (deseeded flesh) is used as fodder while the seed hulls are used as feedstuff. Most of the women processors of African breadfruit seeds seem to be ignorant of the importance of good processing practices in value addition to their products. Poor quality products which attract low prices or outright rejection by consumers is a problem for the processors. Processing of the seeds need the application of Hazard Analysis Critical Control Point (HACCP) system for production of high quality and safe products along the value chain for the processors and consumers either manually or mechanically. This study determined the processing stages of African breadfruit seeds from June to November, 2009 and identified the hazards and critical control points in these stages. The results will be useful in recommendations to the processors concerning the need for high quality and safe products.

Key words: Hazard analysis critical control point (HACCP), processing, African breadfruit, Nigeria.

INTRODUCTION

African breadfruit, *Treculia africana* Decne Igbo: 'ukwa', Efik: 'ediang', Ibibio: 'afon', Senegal: 'brebretim'; Tanzania: 'ezeya', Uganda: 'muzinda' is a vegetable crop and medicinal plant belonging to the family Moraceae and order *Urticales*. It is widely grown and the nutritional tree fruit used as a vegetable in humid South Eastern ecological zone of Nigeria and humid rain forest of Southwest Cameroon. It is widely distributed in tropical Africa (Metuno et al., 2007.) *T. africana* fruits are yellow, spongy in texture, up to 18 inches in diameter, containing about 900 seeds scattered between the spongy pulps. The edible seeds are a valuable food among the Igbos in particular (Okonkwo and Ubani, 2007) and the Efiks, Kalabaris, Edos and the Ika Igbos in Delta of the Southern part of Nigeria in general.

The defatted seed contains 19% protein, which is higher than that for cereals and similar to most pulses; and is particularly, high in aromatic amino acids, which makes it a potential source of good quality protein (Makinde et al., 1985). The raw seed contains 40 to 50% carbohydrate as well as, minerals and vitamins (Oyetayo and Omenwa, 2006). The seed contains less fat than some other nuts and about 4 to 7% total lipid content (Nwaokorie, 1983). Breadfruit seeds are potential sources of protein to help meet inadequate consumption of protein foods in Nigeria especially, at the rural settings where there is availability of the raw materials and the application in food processing (Ejidike and Ajileye, 2007). The spongy pulp (deseeded flesh) is used as fodder (Ogunleye and Parakoyi, 1992) while the seed hulls are used in several feed stuffs for livestock (Ademosun and Imevbore, 1988).

African breadfruit processing is mainly women's occupation. Women processors need sensitization in improvement of skills required for processing breadfruit by indigenous methods. This is to enable them have full benefits of value addition to breadfruit. The seed flour has been found to have bread making properties (Giami and

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Amasisi, 2005), and could be used for pastries, weaning foods, breakfast cereals and beverages (Sunday et al., 2000).

African breadfruit is consumed by Igbos in diaspora especially, in North America and Europe. Processed breadfruit seeds need to meet the required standards for food safety and quality in both national and international markets.

The application of Hazard Analysis and Critical Control Points (HACCP) system to the indigenous processing methods of African breadfruit seeds will enhance food safety and quality in addition to increasing the effective use of resources by the processors. This system has the capacity to accommodate changes such as advances in equipment design, processing procedures and technological development, and as such, will contribute to meeting the UN MDGs as well. The present work is an attempt to identify specific hazards and measures for their control to ensure food safety and quality in African breadfruit seed processing at Nnewi in Anambra state of Nigeria.

MATERIALS AND METHODS

Various stages of postharvest processing of breadfruit were analyzed for hazards and critical control points identified for reduction or elimination of these hazards by appropriate techniques. Table 1 shows the unit operations of postharvest processing of breadfruit and hazard analysis chart indicating process step, hazard source and control measures.

RESULTS AND DISCUSSION

The indigenous methods in processing of African breadfruit seeds for commercial purposes were studied in Nnewi, Anambra state, Nigeria. The hazards in the processing methods and the measures to control these hazards at critical points were identified. Table 1 is a summary of the Hazard Analysis and Critical Control Points (HACCP) for African breadfruit processing by women processors in Nnewi, Anambra state. The hazard analysis was applied from the level of harvest of the fruits to the consumer level of the processed products. The major hazard sources identified include microbial infection of the whole fruit due to dropping on the soil from the tree when ripe; rusty and dirty containers used for parboiling and de-hulling of the seeds; unhygienic environments for drying and storage of de-hulled seeds. The parboiling of the seeds for de-hulling was a critical point that needed proper control and adequate addition of catalyst (palm oil) to aid in the de-hulling process. Other points identified in the production process that needed to be controlled were the de-hulling stage, using a mechanical milling machine. The de-hulling component of the machine was set appropriately to avoid seed breaking that will be a source of microbial contaminant. This is in agreement with the study of Nwabueze (2009), who reported that parboiling and de-hulling are two critical points preceding *T. africana* seed extraction for utilization in any food form. He observed that using second-order central composite design and response surface analysis resulted in optimum combination of process variables and thereby, achieved maximum kernel yield and machine efficiency. It was observed that the time interval between de-hulling and winnowing of seeds was a critical point to control. The container used in conveying the unwinnowed seeds may constitute a hazard resulting to microbial contamination.

The milling machine used for de-hulling of breadfruit seed was not of food grade stainless steel materials. Cast iron or other materials were sources of contamination with metal parts and paints. Seeds conveyed in airtight containers to the winnowing environment tended to have heat build-up that impacted greenish discoloration to the products. This was a sign of microbial infection of the seeds. There is need to air the de-hulled seeds in ventilated containers during transportation for winnowing.

Winnowing and sorting of hull and de-hulled seeds need to be carried out using stainless steel or appropriate plastic materials. Wholesome and unwholesome seeds should not be mixed in the final product bulk. To avoid contamination of the final product, the hulls need to be disposed off appropriately. Contamination with filth, sand, metal and pests were eliminated by seed drying in a clean environment with clean and suitable spreading materials. Hull seeds were stored in hermetic containers in a cool dry environment for 24 months, while the de-hulled seeds stored for 9 months. The shelf-life of the de-hulled seeds was shorter than that of the whole seeds.

Conclusion

High quality product starts from the choice of the raw material. The mature ripe breadfruit must first be deseeded fresh. Retting of the fruits gives low quality end product. Application of the HACCP plan in the processing of African breadfruit *T. africana* seeds by the women processors will result in high quality and safe products which will attract higher prices for local and export markets. The processors need to be trained to benefit from their occupation by effective use of resources to include improved nutrition and increased income.

There is need for stakeholders in African breadfruit processing to set up processing centres for women processors. This will enhance uniform product quality and food safety. These centers will equally server for capacity building demonstration sites.

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Table 1. Hazard analysis chart. Product: Commercial breadfruit seeds. Date: June to November, 2009.

S/N	Process step	Hazard and source		Control measure
1.	Whole fruit ripening on tree.	Nil	Nil	Tree surrounding searched regularly for dropped ripe fruits.
2.	Whole fruit dropping from tree.	Point of microbial infection and insect infestation of fruit.	Soil where fruit dropped and left for days.	Dropped fresh fruit removed immediately from the ground.
3.	'Retting' /fermentation of whole fruits.	Insect infestation of fruits and microbial infection.	Heaped fruits resulted in cross infestation of fruits.	Fresh fruits were deseeded immediately.
4.	Washing and Draining seeds.	Contamination with fine sand particles.	Sand was used as abrasive to wash seeds. Only wholesome seeds were picked.	Sharp river bed sand used for abrasion in washing the seeds. Sand particles were thoroughly separated from the seeds after washing.
5.	Sorting of hull seeds.	Low quality seeds.	Improper sorting and mixing of wrinkled, aborted and deformed seeds with wholesome seeds.	Removal of unwholesome seeds from the wholesome ones.
6.	Drying of hull seeds.	Heaped in dirty raffia basket.	Improper drying.	Spread out on clean material on raised platform for free air flow.
7.	Parboiling of hull seed	Difficulty in dehulling of parboiled seeds. Contamination with rusty containers.	Addition of excess palm oil to seeds during parboiling. Ineffective stirring of parboiling seeds. Exceeding parboiling time. Rusty containers used in parboiling hull seeds.	Parboiled hull seeds within the recommended time. Added the required measure of palm oil for parboiling seeds. Stirred seeds intermittently during parboiling. Used rust free containers for parboiling.
8.	Draining of parboiled hull seeds.	Contamination of seeds with dirt and particles.	Dirty and over used raffia baskets for draining seeds.	Used clean and rust free sieve for draining parboiled seeds. Cold water sprinkled on time for cooling parboiled seeds.
9.	Removal of hulls from seeds/dehulling of whole seeds on concrete slab (for domestic use/consumption).	Contamination with sand, soil, dirt.	Seeds dehulled on dirty rough concrete slab using wooden roller or bottle.	Specialized skill applied. Dehulled on clean rough concrete floor.
10.	De-hulling of whole seeds in milling machine.	Seeds broken during milling. Point of microbial infection.	Milling machine rusty. Improper teeth plate adjustment	Seeds milled in food grade quality stainless steel milling machine. Adjusted teeth plate to appropriate size.
11.	Transportation of de-hulled seeds	Heating up of seeds.	Seeds transported in woven polypropylene sack tainted greenish colour.	Dehulled put in plastic bucket slightly covered to allow free air flow.
12.	Pre-drying of wet de-hulled seeds.	Microbial infection of seeds as a result of heaping.	Dirty and rusty tray used. Allow free air flow.	Used stainless steel trays for pre-winnowing.
13.	Winnowing of de-hulled seeds and sorting.	Low quality seeds.	Improper sorting and mixing of seeds of all grades.	Removed unwholesome seeds from the wholesome ones.
14.	Sun drying of de-hulled seeds.	Contamination of seeds with dirt, sand and particles.	De-hulled seeds spread on overused mats directly on ground.	De-hulled seeds spread thinly on clean mats /woven polypropylene sheets on raised platform.

Table 1. Contd.

15.	Air drying of de-hulled seeds.	Microbial infection	Improper drying of de-hulled seeds in enclosed environment.	Dried de-hulled seeds in cross ventilated area for proper free air flow. Dried seeds at safe moisture content.
16.	Drying of seed hulls for feed.	Insect infestation and microbial infection.	Improper disposal of seed hulls.	Seed hulls dried properly and package for feedstuff.
17.	Packaging of dried seeds.	Insect infestation and microbial infection of seeds.	Used and dirty woven polypropylene sacks, containers without lids, and thin gauge polyethylene bags.	Packaged seeds in clean woven polypropylene sacks/ transparent or opaque polyethylene bags of appropriate gauge.
18.	Storage.	Exposure to direct sunlight. Microbial infection.	Stored in the kitchen where heat is produced and on the floor.	Kept inside hessian bags/plastic containers. Store in cool environment on raised platform. Avoid direct sunlight.

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