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Proposed Hazard Analysis and Critical Control Point (HACCP) Plan for Production of Ready-to-Drink *Fura-Da-Nono*- A Review

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Abstract

The article intended to provide a concise and affluent proposal for the development of HACCP plan in the production of ready-to-drink *Fura-da-Nono* using information from reputable literature and guidelines recommend by food regulatory bodies. Poor personal hygiene, low quality raw materials and the rudimentary operations involved in the traditional processing of ready-to-drink *Fura-da-Nono* accounts for inconsistent quality, shorter shelf-life, poor hygiene and unacceptable qualities. During processing, materials are exposed to filthy processing environment, contaminated water, unclean processing equipment and contaminated packaging and storage containers. Application of HACCP guidelines in the production of ready-to-drink *Fura-da-Nono* will significantly improve its safety by assuring acceptance of only good quality raw materials and ensuring adequate processing along the production chain. These will not only guarantee the safety of the finished product, but will also ensure better nutritional qualities and acceptable organoleptic properties.

Keywords: HACCP; Traditional food; *Fura*; *Fura-da-Nono;*

INTRODUCTION

Hazard Analysis and Critical Control Point (HACCP) is a global acceptable program for ensuring food safety. It is used as baseline for development of food safety standards by food regulatory organisation and its implementation by food business operators is mandatory in many nations (Musaj *et al.*, 2012). The HACCP system basically is applied to food processing to identify specific hazards and control measures in order to ensure the safety of foods (Rai *et al.*, 2014). Food safety systems such as HACCP have been applied to prevent contamination of the food (Kim *et al.*, 2020), and its application in traditional foods processing caused significant improvement in their safety(Amoa-Awua *et al.*, 2007). HACCP system has been recognised as an effective and rational means of ensuring food safety from primary production to final consumption, using a “farm to table” methodology (El-Hofi *et al.*, 2010).

There are obvious food safety challenges across West-African sub-region and reported cases of foodborne diseases and outbreaks (Oguntoyinbo, 2014). The unhygienic conditions under which local production occurs include unclean processing environment, use of contaminated water and equipment, contamination from producer and poor storage. These account for poor microbiological quality in many traditional foods and pose grave risks to consumers (Omemu and Adeosun, 2010). Lack of economic resources, purchasing power, more complex food-handling practices, lack of technical expertise and limited personnel have all been cited as possible barriers to HACCP implementation in retail and catering sectors (Karaman *et al.*, 2012). The seven HACCP principles are (1) Conduct a hazard analyses (2) Identify the critical control points (CCPs) (3) Establish critical limits for preventive measures associated with each identified CCP (4) Establish CCP monitoring requirements (5) Establish corrective actions to be taken when monitoring indicates then a deviation from an established critical limit (6) Establish verification procedures and (7) Establish record-keeping and documentation procedures(Abd El-Razik *et al.*, 2016).

Safety Aspects of *Fura-da-Nono*

Fura is a cereal dumpling produced from pearl millet (*Pennisetum glaucum*) flour blends with spices, it is a traditional staple food in many West African countries including Nigeria, Ghana, Niger, Cameroun and Burkina-Faso (Jideani *et al*., 2002; Owusu-Kwarteng *et al*., 2012). It is a good source of minerals and energy (Durojaiye *et al*., 2010).*Fura* is consumed with fermented whole milk (*kindirmo*) or fermented skimmed milk (*Nono*) (Jideani *et al*., 2002), and can be consumed alone or mashed in water to form porridge-like drink (Filli *et al*., 2012). The production process of *Fura* is still very crude, involves the use of rudimentary equipment and techniques, this accounts for the inconsistent quality, shorter shelf-life, poor hygiene and unacceptable qualities (Filli *et al*., 2015). The manual work involved in the local production of *Fura*, particularly hand-moulding, which is the final operation, can serve as a source of contamination to the finished *Fura*. Post-process contamination is also very possible by the nature of the handling it received after processing (Anyanwu, 2019). Contamination can also happen during milling which is commonly done in community milling centres (Owusu-Kwarteng *et al*., 2012).Grinding parts are made using scrap metals whose origin and composition are unknown, this results in heavy metal contamination in foods milled in commercial milling centres (Sinayobye, 2011). The moisture content of *Fura* is about three times more than that of millet, this makes *Fura* to be less stable and can provide optimum moisture requirement for the growth of both spoilage and pathogenic microorganisms (Durojaiye *et al*., 2010).

Nono is traditionally fermented milk which is very similar to yoghurt. Traditional methods of fermenting milk involve the use of indigenous microorganisms, leading to the production of a variety of tastes in fermented milk products (Karenzi *et al*., 2013). Production of *Nono* is by back-slopping, a technique that involves the use of the residue from previous fermented batch to inoculate a new batch. The processes also involves the repeated use of fermentation vessels and containers to facilitate the inoculation (Oguntoyinbo, 2014). Dairy products are important food commodities but they are potentially hazardous products when processed under unhygienic conditions. In addition, dairy products are also potential carriers of veterinary drugs, chemical pollutants and microbial toxins (Karaman *et al*., 2012). Dairy products have been long associated with the transmission of food-borne diseases (Anyanwu, 2019). Interestingly, the application of HACCP program in dairy processing significantly improve the microbial quality and safety of the finished products (Musaj *et al*., 2012). Critical control points (CCP) in fermented milk processing are raw milk, after pasteurisation, mixing with other ingredients, fermentation, packaging and storage (Musaj *et al*., 2012; Siddig and Barka, 2015).

Fura is a two in one product supply body with the two important nutrients (protein and carbohydrate) (Anyanwu, 2019). In the production of ready-to-drink *Fura-da-Nono*, *Fura* is mashed into *Nono* and sugar may be added to taste. The mixture of *Fura* and locally fermented milk (*Nono*) is called "*Fura-da-Nono*" and also shortened as *Fura* by many. *Fura-da-Nono* is used as a staple food for adults and as a weaning food in some parts of West Africa (Owusu-Kwarteng *et al*., 2012).

Fura can be considered to be of two different types; the traditional *Fura* which produced completely by local processing, both the *Fura* and the *Nono* were produced traditionally, and modern *Fura* which can be referred as "*Fura* da yoghurt" which can be considered to be more hygienic. This brand of *Fura* is produced by yoghurt companies by mashing traditionally produced *Fura* in yoghurt with the addition of preservative and low-temperature storage to extend the shelf-life (Anyanwu, 2019). Traditional *Fura-da-Nono* is normally sold in calabash covered with mat and usually consume using ladle made from a calabash. *Fura* is mix with *Nono* in a bowl, usually, one bowl is used in mixing for many customers without washing (Abdulkadir and Mugadi, 2012). Commercial samples of the both types obtained from Abuja (Nigeria) were found to be unsafe for human consumption due to poor microbiological qualities (Anyanwu, 2019).

Pathogenic bacteria found in *Fura* include *Pseudomonas aeruginosa, Serratia mercesens, Bacillus pumillus, Staphylococcus aureus, Salmonella* spp and *Bacillus alvies* (Abdulkadir and Mugadi, 2012). Infectious diseases commonly found in dairy products are *Tuberculosis, Brucellosis, Salmonellosis, Staphylococcus mastitis, Listeriosis* (Benyagoub and Ayat, 2014), and organisms include *Escherichia coli* and *Staphylococcus aureus* (Samet-Bali *et al*., 2016).

Proposed HACCP Plan for Production of Ready-To-Drink *Fura*-and-*Nono*

HACCP Plan

Codex (2009) guidelines for establishing a HACCP plan were used in proposing HACCP plan for the ready-to-drink *Fura-da-Nono*. The plan is designed to identify hazards that can adversely affect the quality and safety of ready-to-drink *Fura* and apply procedures that will either prevent the occurrence of the hazards or can adequately control them. The plan identifies different steps along the production chains of both *Fura* and *Nono* before and after combining them. The plan is basically developed based on the following questions.

1. Is there any hazard associated with ready-to-drink *Fura*?
2. What are the precise points along the production line that are suspected to be the source(s) of hazard?
3. At what point can control be precisely applied to curtail the hazard?
4. What are the monitoring procedures for ensuring the effectiveness of the control?

Hazard Analysis of the Proposed Control Measures

Each of the two major ingredients (millet and milk) used in the production of *Fura-da-Nono* and processing operations were studied. Possible hazards and control measures in the raw materials and processing operations were identified and listed in Table 1.

Identification of Critical Control Points during Processing

Critical control points are points along the processing chain where control can be applied to prevent, eliminate or reduce hazard to acceptable levels. Critical control points were identified using Codex (2009) decision tree. Critical limits for microbiological criteria of raw materials, intermediate and fished products were chosen based on the recommendations of International Commission on Microbiological Specifications for Foods (ICMSF, 2011). ICMSF guidelines are used in evaluating process control and product acceptance during food processing. Critical limits for chemical contaminants were chosen based on general standard for contaminants and toxins in food and feed (CODEX STAN 193-1995) published by Codex Alimentarius Commission (Codex, 2014).

A total of 10 CCPs were identified (Figure 1), six CCPs were identified in the production of *Fura*, two in the production of *Nono*, and two in the combined *Fura-da-Nono*.

Critical Limit and Corrective Actions

Critical limit is a criterion that separate acceptability from unacceptability, it is used as a safety boundary to control identified hazard. Critical limits for each of the identified CCP were established (Table 2). This includes critical limits for biological, chemical and physical hazards. Also, corrective actions for each of the identified CCP was established (Table 2), this includes rejection of poor quality raw materials, ingredients and packaging materials, modification of processing conditions and good manufacturing practices.

Verification and Record-Keeping

Verification for raw materials and ingredients will include supplier's guarantee, visual inspection and laboratory tests. While visual inspection, laboratory test and adjustment of processing conditions will be used for verification of intermediate and finished products. Records to be kept will include supplier's guarantee, reports for visual observations, results of laboratory analyses (microbial, chemical and physical) and processing conditions such as time, temperature, pH, etc.

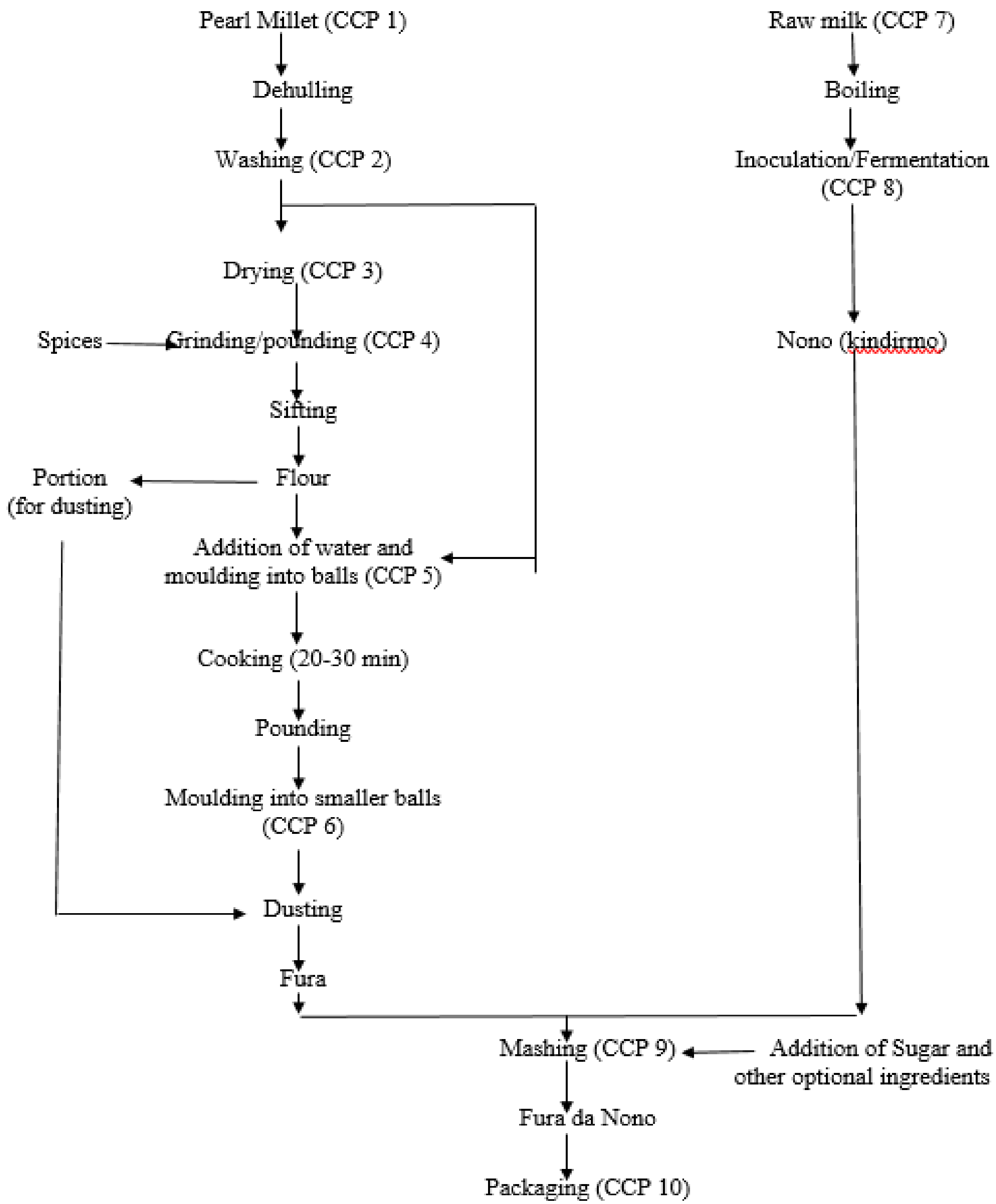

Figure 1: Critical Control Points in the Production of Ready-to-Drink *Fura-da-Nono*

Table 1: Suspected Hazards and their Control Measures

Processing step	Hazard			Control Measure
Millet	**Biological**	**chemical**	**Physical**	
Raw millet (CCP 1)	Microorganisms	Mycotoxins, pesticides residue, heavy metals	Impurities and foreign matter	Awareness and use of good quality raw materials from certified suppliers
Dehulling	Non	Non	Non	
Washing (CCP 2)	Spoilage and pathogenic microorganisms			Use of potable water
Draying (CCP 3)	Spore forming bacteria, mould and yeast		Impurities and dust	Mechanical drying
Grinding/pounding and addition of spices (CCP 4)	Cross-contamination		Impurities and foreign matter	Good manufacturing practice and use of good quality spices
Sifting				
Addition of water/moulding (CCP 5)	Spoilage and pathogenic microorganisms (including Human)			Use of potable water, use of hand gloves
Cooking	Nil	Nil	Nil	
Pounding	Non	Non	Non	
Moulding (CCP 6)	Spoilage and pathogenic microorganisms (including Human)			Use of hand gloves and use of anti-microbes during dusting
Nono				
Raw milk (CCP 7)	Pathogenic and spoilage organisms			Good quality (pasteurised) milk from certified suppliers
Boiling				
Inoculation (back slope)/ Fermentation (CCP 8)	Spoilage and pathogenic microorganisms			Use of starter culture
Fura-da-Nono				
Addition of ingredients (CCP 9)	Spoilage/Pathogenic microorganisms			Use of good quality ingredients
Packaging (CCP 10)	Cross-contamination and human pathogens			Maintaining GMP

Table 2: Critical Limits and Corrective Action of the CCPs

Processing step	Proposed Critical Limit			Proposed corrective action
Millet	**Microbiological**	**Chemical**	**Physical**	
Raw millet (CCP 1)	[1]APC <10^5cfu/g	[2]Aflatoxin (total) ≤15 µg/kg Pesticide residue and heavy metals <5 ppm	< 2 % of physical contaminant	Reject raw material with higher microbial counts and higher chemical(s). Re-clean grains with impurities
Dehulling				
Washing (CCP 2)	Coliform and *E. coli* = Not to be detected in 25 g [1]APC < 10^3cfu/ml			Reject processing water with faecal contamination and/or higher APC
Draying (CCP 3)			At 70 °C for 6 hrs with even air circulation	Adjust processing condition to optimum
Grinding/pounding and addition of spices (CCP 4)	*Coliform* and *E. coli* = Not to be detected in 25 g [1]APC < 10^5cfu/ml			Reject intermediate product and sanitise the processing equipment
Sifting				
Addition of water/moulding (CCP 5)	*Coliform* and *E. coli* = Not to be detected in 25 g [1]APC < 10^5cfu/ml			Reject processing water with faecal contamination and/or higher APC
Cooking				
Pounding				
Moulding (CCP 6)	*Coliform* and *E. coli* = Not to be detected in 25 g [1]APC < 10^3cfu/ml			Reject intermediate product in case of faecal contamination. Re-cook product with high APC
Nono				
Raw milk (CCP 7)	*Coliform* and *E. coli* = 0 [1]APC < 10^5cfu/ml	< 5 ppb		Reject any doubtful raw materials
Boiling				
Inoculation (back slope)/ Fermentation (CCP 8)			At 30 -35 °C	Adjust processing condition and inoculate with starter culture
Fura-da-Nono				
Addition of ingredients (CCP 9)	[1]*Coliform* and *E. coli* = Not to be detected in 25 g [1]APC < 10^3cfu/ml			Reject any doubtful ingredient
Packaging (CCP 10)	*Coliform* and *E. coli* = Not to be detected in 25 g [1]APC < 10^3cfu/ml			Reject any doubtful package and observe good manufacturing practices

1- ICMSF (2011)
2- Codex(2014)
APC; Aerobic Plate Count

CONCLUSION

Unhygienic processing and handling, as well as post-processing contamination potentially, constitute microbial hazards of *Fura-da-Nono*. HACCP as a global acceptable program for ensuring food safety can guarantee the safety of *Fura* when properly applied through the identification of potential hazards along the production chain and application of appropriate corrective actions where ever there is deviation. Lack of formal education, poor economic resources, poor purchasing power, lack of awareness on the danger associated with poor food hygiene and lack of technical expertise are the possible barriers to HACCP application in the traditional production of *Fura*. An effective HACCP program will improve the safety of *Fura* and extend its shelf-life.

RECOMMENDATIONS

1. *Fura* should always be produced from high quality raw materials with no physical, chemical or biological hazard.
2. Good manufacturing practices should be observed throughout the production processes of *Fura*.
3. Environmental and personal hygiene should always be observed by producers and retailers.
4. Utensils and equipment used in the production should be clean.
5. Awareness on the danger of poor food quality should be created among *Fura* producers and retailers.
6. Appropriate packaging system should be designed to prevent post-process contamination

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