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SAFETY OF SMALL-SCALE FOOD FERMENTATIONS IN DEVELOPING COUNTRIES

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Abstract : Food safety is a global issue of increasing concern for governments, food producers and food handlers, as well as consumers. Safe and wholesome food supplies play a key role in ensuring the health of populations worldwide. Fermented foods play very important roles especially in the socio-economic and health promoting aspects of people in developing countries. Generally, traditional fermented foods are manufactured under unhygienic conditions which results in contamination and eventually a low quality final product that may be microbiologically unsafe for consumption. However, food safety is achieved by improving the knowledge of the causative agents of food-borne illnesses, providing information on how to control these agents and ultimately, reducing the occurrence of possible sources of food contamination. This could be achieved by deploying and/or incorporating the Hazard Analysis and Critical Control Point (HACCP) concept to small-scale fermented food production in developing countries. This present study focuses on the application of the HACCP concept in ensuring the production of a microbiologically safe Kunun zaki, a fermented sorghum drink.

Key words: *Fermentation, Contamination, Food safety, Kunun zaki.*

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Introduction

Fermentation have been used for several thousand years as an effective tool and low cost means to preserve the quality and safety of foods (Parveen and Hafiz, 2003). It is a means of conserving food, requiring very limited capital outlay, energy and packing materials. It is an inexpensive and manageable food preservation technique (FAO, 1998); hence its extended use may therefore hold much promise for alleviating the problem of world hunger (Hamid, 1993) especially in developing countries. The fermentation techniques are often characterized by the use of simple, non−sterile equipment, chance or natural inoculum, unregulated conditions, sensory fluctuations, poor durability, and unattractive packaging of the processed products (Latunde-Dada, 1997).

Fermented grains and starchy roots form the most important part of diets of people in parts of Africa, especially West Africa. However, several factors are responsible for their continued popularity which includes; inaccessibility to commercially processed foods, inconsistency in electricity supply to encourage refrigeration and ultimately the fact that, very high populations of the consumers are low income earners. As such, their reliance upon fermentation to provide a variety of diets consisting of grains is inevitable.

Lately, fermentation processes have caught the attention of Food Scientists and Food Microbiologists due to the subtle changes that occur in the food as a result of the growth of microorganisms in it. These changes may be beneficial or otherwise. The beneficial properties documented are; enhancement of the nutrient content of foods through the biosynthesis of vitamins, essential amino acids and proteins; improvement of protein and fiber digestibility; enhancement of micronutrient bioavailability; degradation of various antinutritional factors such as cyanogenic compounds present in cassava; enhancement of food safety by reducing toxic compounds such as aflatoxins and production of antimicrobial compounds like lactic acid, bacteriocins, carbon dioxide, hydrogen peroxide and

ethanol which facilitates the inhibition or elimination of foodborne pathogens (FAO, 1998). In addition to its nutritive, safety and preservative effects, fermentation is known to improve the shelf-life of foods, adding value to agricultural raw materials thus providing income and generating employment (FAO, 1998).

Kunun zaki is a sweetened cereal-based, non-alcoholic beverage in Nigeria (Gaffa, *et.al*, 2002a), prepared traditionally using millet, sorghum, maize or in a composite form as millet and sorghum grains usually in a mixing ratio 1:2 (w/w) sorghum/millet (Gaffa and Ayo, 2002). The production and consumption of Kunun zaki is high particularly in Northern Nigeria (Gaffa *et.al*, 2002a). The production process is very crude involving the use of household utensils and is still largely done in homes. Also, the method of production varies from different localities owing to preferences in consumer taste, texture or appearance.

As a final product, Kunun zaki is sold/hawked in bottles or small polythene bags and also served as refreshing drinks in occasions. It is very cheap to produce compared to other common conventional drinks produced on a large scale in industries. This is microbiologically unsafe for consumption by the larger population due to possible contamination by pathogenic microorganisms during production. This could result to food-borne illness, food-borne diseases outbreak and possibly death.

This present study aims at incorporating the International Food Standard measure, Hazard Analysis and Critical Control Point (HACCP), to the traditional processing method of an indigenous traditional fermented food in order to improve its safety and wholesomeness and ultimately encourage its consumption as it has been proven *in-vitro* to contain microorganisms capable of inhibiting the growth of the pathogenic ones (Olotu , 2007).

Materials and Methods

Traditional Kunun zaki production process

Sorghum (*Sorghum bicolor*), dry or fresh sweet potato chips (*Ipomea batatas*), ginger (*Zinigiber officinale*) and other locally sourced spices like clove, red or black pepper, are major ingredients required for the production of Kunun zaki. The first stage in the production involves steeping (warm or cold) of the sorghum in local household utensils such as buckets, drums, calabashes or earthenware vessels. The steeping process usually takes between 24-72 hours, though it depends on individual satisfaction or consumer acceptability of the taste or appearance of the final product. The steeped grains are washed along with the spices, wet-milled into a slurry/paste and halved into two portions. The first portion is subjected to heat with constant stirring to homogenize till is becomes gelatinized. The heating process is terminated and the other portion added and stirred to homogenize. The mixture is then allowed to cool, filtered and left overnight to allow fermentation (chance inoculation). The final product can then be sweetened with sugar, bottled or sealed in small polythene bags for sale. This traditional process followed is implemented in Kano and Niger states of Nigeria. The flow chart is shown in Figure 1.

Production process for a microbiologically safe Kunun zaki

The ingredients required for this process were as applicable in the traditional process and the improved production process in Figure 2. However, for the purpose of the present study, the focal points of contamination were identified in Figure 1 and the respective controls implemented in Figure 3.

Results & Discussion

In a study (Gaffa and Ayo, 2002), the traditional and improved production processes of Kunun zaki were compared and slight differences in their nutrient contents was observed. This is an indication that identifying the focal points of contamination and applying the HACCP concept will not hinder the organoleptic properties of Kunun zaki. It will also reduce/eliminate any form of sensory fluctuations giving rise to almost the same product as in the traditional fermented Kunun zaki. In the same study, a low pH value of 4.92 was observed for the traditional production process of Kunun zaki. This occurred as a result of the role lactic acid bacteria play in the production process. They create an unfavourable environment for pathogenic microorganisms especially the bacillaceae and enterobacteriaceae (Latunde-Dada, 1997). Although the pH value increased to 5.3 in the improved process, it is important to note that starter culture must be developed in order to sustain this property.

Cereal grains are important in many parts of the world as food sources especially for their high starch content. Millet and sorghum are very important cereal crops grown in Nigeria and they are dominant cereals after maize, utilized in the preparation of many traditional fermented foods in homes (Oke, 1980). This high starch content serves as a substrate for the growth and sustenance of the natural inoculums in Kunun zaki. This enables the lactic acid bacteria create an acidic environment unsuitable for the growth of contaminants. The physicochemical properties and molecular structures of starches from millet and sorghum are well documented (Gaffa *et.al*, 2004).

As a cereal food, the nutrient content of Kunun zaki is deficient, to a large extent, in protein (Inatimi *et.al*, 1987). However, the instantization with soybean seed in Kunun zaki beverage production is well documented

(Gaffa *et.al*, 2002) raising the crude protein and fat content to 44% and 17% respectively. Also, the total soluble solid of soybean enriched Kunun zaki revealed the presence of β and α-amylases which hydrolyses the starches at the reducing ends of carbon chains to produce maltose, glucose and dextrins (Mikami and Morita, 1988).

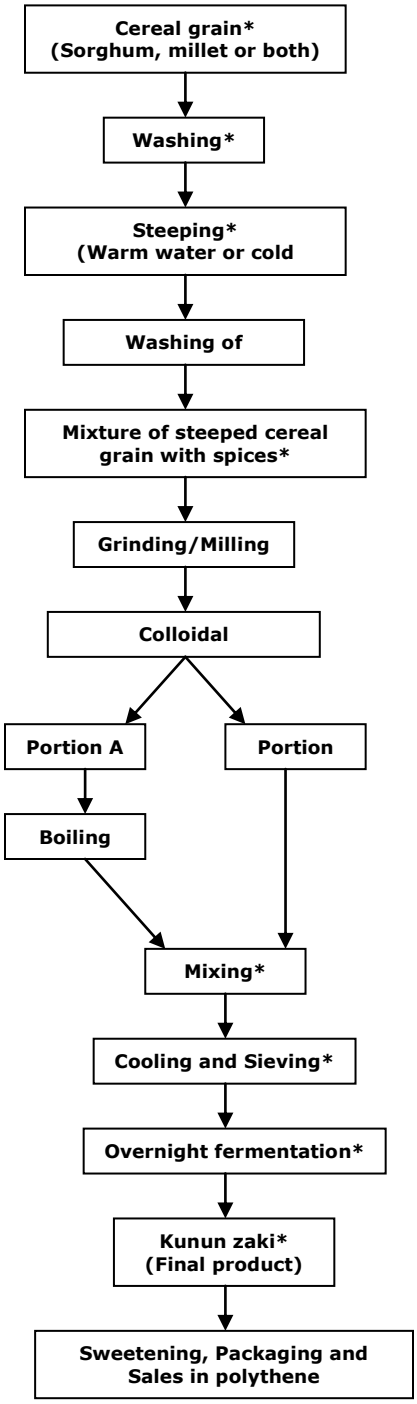

Figure 1: Flow diagram of the traditional Kunun zaki production process in Niger and Kano States of Nigeria.
**Possible focal points of contamination*

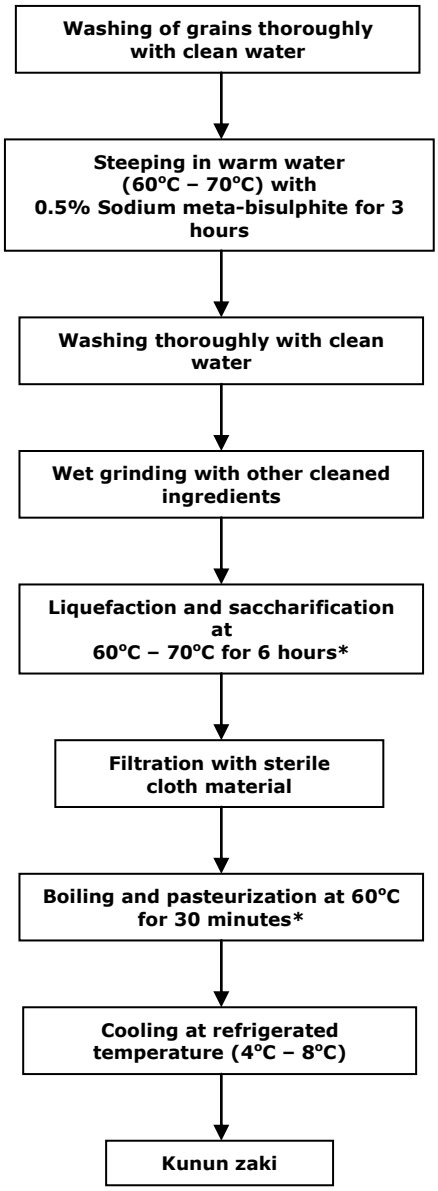

Figure 2: Improved Kunun zaki production process (Gaffa and Ayo, 2002).
** High temperatures would result into destruction of natural fermenting inoculums and deactivation of enzymes.*

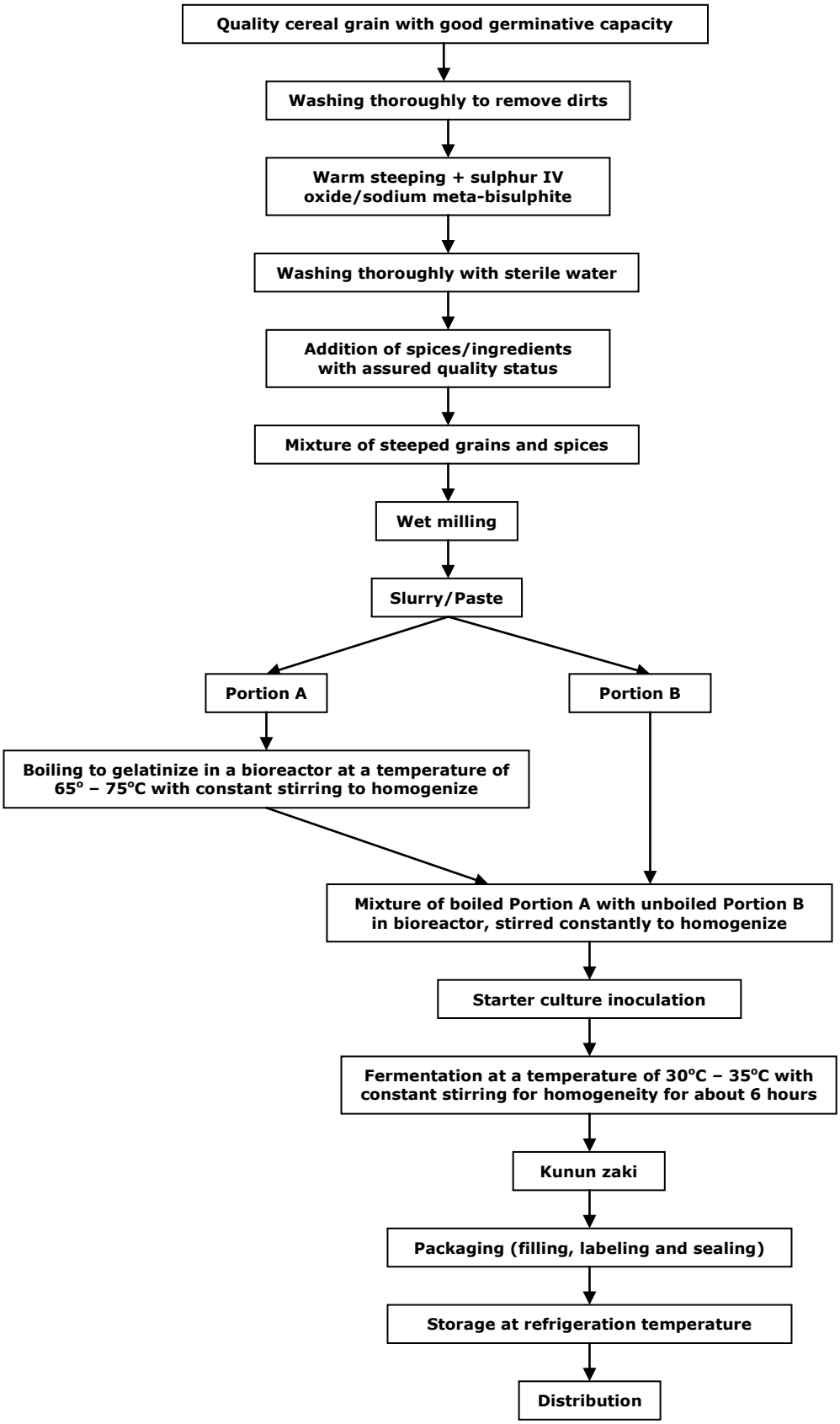

Figure 3: Flow diagram of the production process of a microbiologically safe and wholesome Kunun zaki.

STAGE		PROCESS ACTIVITY	CONTROL POINTS
Raw material	Growth and harvest	• Selection of good quality cultivars that will greatly yield amylose; • Good pasting property of cultivar to enhance gelatinization during boiling within the shortest period of time (Gaffa *et.al*, 2004)	Specification of cultivar required.
	Transportation	Transport in jute bags to processing unit.	Transport vehicles must be covered properly to prevent during rainy seasons.
	Inspection	Germinative capacity of cereal grain must be determined and recorded. Grains must be properly dried before accepting for storage.	Inspection of stored grain to ensure moisture content retains the set standard to prevent growth of fungi.
Processing	Washing	Washing is done to remove accumulated dust from farms and storehouse.	Thoroughness in washing must be ensured to prevent contamination with chemicals used in storage which could result into poisoning.
	Steeping	Warm steeping to soften endosperm within the shortest period of time.	Sulphur IV oxide or Sodium meta-bisulphite will remove any sign of contaminating microorganisms.
	Washing	Sterile water must be used and must be thorough.	This will remove preservatives used in killing microorganisms and any other signs of chemicals.
	Milling	Type of milling machine is very important. Factors like type of cereal being milled, degree of fineness of slurry, power consumption, required throughput, available capital and expertise, availability of spare parts and maintenance/repair facilities must be put into consideration.	Cleaning-in-place process like visual inspection of machine, swabbing, rinse sampling and testing of batches before and after milling is done. New techniques to further ensure effectiveness are evolving. Such as microbiological methods, chemical methods. ATP measurement and polymerase chain reaction (PCR).
	Boiling and mixing	Minimum temperature of boiling must be 65^{o}C for proper gelatinization.	Bioreactors used to prevent further contamination.
	Fermentation	Minimum temperature must be 30^{o}C to enhance optimum microbial activity within the shortest period of time.	Purity of selected strain of starter must be ensured. Fermentation should be completed within the shortest period of time to avoid sensory fluctuations.
Packaging	Filling, labeling and sealing	Vaccum packaging in a sterile and oxygen free environment. Manufacturing date, expiry date, batch number must be properly labeled.	Sterility of packaging materials must be ensured to prevent opportunistic contaminants.
Storage and distribution		Storage at refrigerating temperature to slow down microbial activity.	Distribution trucks must be careful during transportation of finished product.

Table 1: Critical control measures taken to ensure safety and wholesomeness of Kunun zaki.

Conclusion

Sorghum grains, millet grains and soybean seeds are readily available in Nigeria and are cheaply sourced.

In the advent of this unprecedented development coupled with the recent approach to improving traditional foods through starter culture development, raw material development and development of fermentation processes, attention should be given to promoting Kunun zaki consumption and other fermented food products. For instance, if the organisms responsible for traditional fermentation processes were carefully isolated, purified and characterized, they could probably be used to genetically engineer starter microorganisms which may enable the release of larger quantities of nutrients such as amino acids and vitamins in the fermented foods, helping to improve the nutritional value of the food for the rural people and other prospective consumers.

Dairy and dairy products such as yoghurts, for so long in the developed countries, have served as the only delivery vehicle for conveying probiotic microorganisms to the human gastrointestinal tract. If improved upon, Kunun zaki will serve effectively the same purpose and may possibly serve as a prebiotic, owing to its high starch content. Presently, *in-vivo* studies to determine the possible therapeutic and/or prophylactic properties of Kunun zaki is in progress.

However, this study is serving as a challenge to food processing industries that are of reputable standards to rise up and harness these results. The Federal Institute of Industrial Research Oshodi (FIIRO) Lagos State in Nigeria has successfully preserved Kunun zaki for 90 days with the use of chemical preservatives.

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