A REVIEW ON THE SAFETY AND QUALITY ISSUES ASSOCIATED WITH TRADITIONAL BEVERAGES

Sirajo **Mohammed** Funtua[1,] Balen **Dlawar Mirza Agha**[2]
[1]Department of Food Science & Technology, Federal Polytechnic, PMB 1012, KauraNamoda, Zamfara State, Nigeria, and Faculty of Engineering, [2]Koya University, University Park, Daniel Mitterand Boulevard, Koya KOY45 Kurdistan Region, Iraq,
Email:balen.dlawar@koyauniversity.org, smfuntua@gmail.com

Abstract
The purpose of this review to provide an updated review on the safety and quality issues related to traditional beverages (TBs) namely Kunu zaki (KZ) and Zobo (Sorrel) drink (ZD). Recent findings have shown that Ochratoxin A has been detected in KZ, and Bacillus species were detected in ZD. However, Addition of Daniellin™ to KZ can reduce Ochratoxin A to a minimum level, and boiling and subsequent chilling at 4-5 °C of ZD can eliminate the Bacillus species. Hence safety and quality of beverages are the public health importance and have a profound impact on the economy of the society. TBs, such as KZ and ZD, are gaining acceptance in Nigeria and in many parts of the globe due to their affordability. Most people consume the TBs for nourishment, quenching thirst, especially in homes, restaurants, schools, tertiary institutions and joints where all sorts of soft drinks are sold. Therefore, the safety and quality of these home-based beverages is the great importance to the public health because the majority of the populace has direct access to them, but their production is not directly monitored by the government agency controlling the production and distribution of foods. This review aims to detail past, current and future studies and assessments for ascertaining the safety and quality of TBs, including processing, microbial and chemical methods and examinations. Production method standardization should lead to better production of safe and quality TBs to ensure the safety of public health.

Key words: Safety, Quality, traditional beverages.

Submitted: 25.04.2016 Reviewed: 07.06.2016 Accepted: 30.06.2016

1. INTRODUCTION

1.1 What are traditional beverages (TBs)?

TBs are local drinks produced using local methods. Primary raw materials used for production include cereal-grains, herbs, calyces, fruits, water and sugar. Examples of TBs include; Kunun zaki (KZ), and Zobo drink (ZD) (Muhammad and Umar, 2007; Sengev *et al*. *2010*; Mohammed 2013). Housewives are into the business of the production of TBs to generate income for the family. TBs are gaining acceptance due to affordability. Most people consume TBs for nourishment, quenching thirst, especially in homes, restaurants, primary schools, secondary schools, tertiary institutions and joints where soft drinks are sold (Muhammad and Umar, 2007; Mohammed and Okereke, 2008; Sengev *et al. 2010*). TBs are also consumed to grace occasions such as 'Ideil Fitr' (i.e. Muslim's festival after the completion of the fasting period) and 'Ideil kabir' (i.e. Muslim's festival after two months, ten days after the fasting period). Also, TBs are nutritious and are good sources of energy and other essential nutrients (Onuorah, 2011; Akoma *et al*. 2002).

1.2 Names of some selected TBs in Nigeria

TBs are produced and sold among the northerners. TBs are usually served chilled for thirst quenching and satisfaction.

The asterisked varieties of "kunun zaki" indicates the primary raw material used in its production, or a combination of two primary raw materials. However, the commonest cereal-grains used among West Africans, such as northern Nigeria, in the production of "kunu" family is the Pearl millet (*Pennisetum typhoides)* and Sorghum (*Sorghum bicolor*) (Asiedu, 1989; Onuorah, 2011).

Table 2 presents the demonstrations of primary raw materials and unit operations in the production of the two selected TBs.

Table 1: List of selected traditional non-alcoholic beverages produced and sold in Nigeria

Local name	English name	Region of production	Consumers	Serving condition
Kunun-zaki	*Millet beverage *Sorghum beverage *Millet-Maize beverage *Millet-sorghum beverage	North, South-West	Most Nigerians	Cold
Zobo or Soborodo	Sorrel drink	North, South-West	Most Nigerians	Cold

Sources: (Alobo *et al.* 2009; Mohammed and Okereke, 2008; Onuorah, 2011; Ibegbulem and Chikezie, 2013; Mohammed 2013)

Table 2: Raw materials and methods for production of TBs

Raw materials	Production method	Description	Product
Millet/Sugar/Water	Fermentation: Extraction, boiling and sweetening	Whitish beverage	Kunu zaki
Sorrel calyces/Sugar/ Water	Extraction: Steeping/boiling, sweetening	Reddish/purplish beverage	Zobo drink

Sources: (Akoma *et al.* 2002; Mohammed, 2005; Sengev *et al. 2010*; Mohammed 2013).

1.3 Schematics of the technological processes involved in the production of selected traditional beverages (TBs) in Nigeria

Table 2 presents the processing steps employed in the production of TBs including wet-cleaning, steeping, milling, cooking (in the case of 'Kunun zaki'), extracting (in the case of 'Zobo' drink), sieving, sweetening and chilling at 5°C (Mohammed,1997; Akoma *et al*. 2002; Mohammed, 2005; Onuorah, 2011; Mohammed 2013). Although, if KZ is produced from Sorghum it is regarded as a sweet Sorghum beverage; also if it is produced from Maize kernel it is called sweet Maize beverage; and if it is produced from Millet it could be referred to as sweet Millet beverage; while a combination of any of the two grains is only called KZ meaning 'sweet beverage' in 'Hausa' language (Sengev *et. al 2010*; Onuorah, 2011). These sweet beverages are produced and serve chilled to consumers (Muhammad and Umar, 2007; Alobo *et al*. 2009; Onuorah, 2011). This is the reason during the winter period sell and consumption of TBs drastically drops; although, some consumers still patronize TBs during the Harmattan (i.e. winter season) (Alobo *et al*. 2009).

1.4 Nutritional and social values of TBs

The nutritional value of TBs depends on the initial food value of the raw materials and ingredients used for production and the fermentation process the food materials are subjected to (Asiedu, 1989; Akoma *et al.* 2002; Oboh and Elusiyan, 2004; Mohammed and Okereke, 2008). Traditional beverages contain carbohydrates, proteins, fats, vitamins and minerals (Asiedu, 1989; Akoma *et al.* 2002; Oboh and Elusiyan, 2004). For example, Zobo drink is an excellent source for Vitamin C, Lycopene, βeta carotene, and iron (Mohammed and Okereke, 2008; Al-Baghdadi, 2011; Olayemi *et al.* 2011). And KZ is an excellent source of sugars (sucrose), calcium, phosphorus, protein and iron (Akoma *et al.* 2002).

2. SAFETY AND QUALITY ISSUE ASSOCIATED WITH TRADITIONAL BEVERAGES (TBs)

2.1 Safety and quality issues associated with TBs

One of the major quality problems associated with the TBs is that they are produced under poor sanitary conditions; poor handling of raw materials and ingredients resulting in short shelf life (Akoma *et al.* 2002; Adegoke *et al.* 2007; Ojo, 2011). This could be attributed to poor Good Manufacturing Practice (GMP) and Good Hygiene Practice (GHP) during processing of TBs (Roberts, 2007). One of the safety issues that require attention and addressing is the use of already used

polyethylene teraphthalate (PET) packages in packaging sweet beverages in Nigeria. Home-based producers of TBs use old PET bottles to package and sold KZ and ZD. Sometimes plastic bottles and/or Polyethylene-based packages are used for packaging and presenting TBs to consumers. Research work has shown the risks associated with plastic polymers produced from synthetic materials (Lither *et al.* 2011). These plastics are used repeatedly by producers to sell their products without knowing the implications of their action. The consumers continue to buy and consume TBs packaged in old PET containers due to illiteracy coupled with poverty (Mohammed, 2012).

2.2 Safety and quality issues associated with 'Kunu zaki' (KZ)

KZ is a viscous and whitish beverage; and it is a product of lactic acid fermentation (Nkama *et al.* 2010). Hence, this traditional beverage has poor keeping quality due to unguided processing methods and poor storage (Osuntogun and Aboaba, 2004). It is also known to be prone to microbial contamination (Adegoke *et al.* 2007). There are several microbial contaminants associated with KZ including *Aspergillus* and *Penicillium* species (Osuntogun and Aboaba, 2004). They are both toxigenic fungi including the *Fusarium* specie (Creppy, 2002). Fusarium is commonly isolated from cereals, and it is the most prevalent toxin-producing fungi (Creppy, 2002). In developing nations such as Nigeria, it has been noted that Fuminosins and Aflotoxins are likely to be of significance, and they are produced by three species of *Aspergillus* namely *A. flavus*, *A. parasiticus* and *A. nomius* (Douglas *et al.* 2001; Creppy, 2002). Aflotoxins are group of mycotoxins of most concern because they are having both hepatotoxins and carcinogens (Creppy, 2002). Also, Ochratoxin A (OTA) has been reported in foodstuffs especially the cereals and their products; for example OTA (50 mg/kg) has been identified in the cereal (millet) used for the production of KZ (Adegoke *et al.* 2007). Therefore, the important foodborne mycotoxins (FMT) include Aflotoxins, Ochratoxins and Fuminosins (Douglas *et al.* 2001; Creppy, 2002).

2.3 What is the implication of Mycotoxins to public health?

Mycotoxins are secondary metabolites of moulds that exert toxic effects (mycotixicosis) on humans, the severity of which depends on the toxicity of the Mycotoxins, the extent of exposure, age and nutritional status of the individual and the synergistic effects of other chemicals to which the individual was exposed to (Peraica, 1999). Mycotoxins are low molecular weight chemicals, and they are heat stable (Douglas *et al.* 2001). The adverse effects of FMT on the public health include carcinogenicity, genotoxicity, immunotoxicity, mutagenicity and teratogenicity (International Agency for Research on Cancer, 1997). Also, FMT causes Ergotism, known as St. Anthony's Fire; it is a 'plague' in the Middle Ages that caused tens of thousands of deaths and loss of limbs due to gangrene (Nagler and Coker, 2012).

2.4 Safety and quality issues associated with 'Zobo drink' (ZD)

ZD is a traditional soft drink produced by either steeping or boiling the calyx of the sorrel plant (*Hibiscus sabdariffa* variety *sabdariffa*) in potable water and usually sweetened with sugar and served chilled to consumers (Muhammad and Umar, 2007; Alobo *et al.* 2009). ZD is a sparkling red-purple colour juice prepared from either the red or purple calyces of sorrel, and it tastes like Cranberry (Mohammed 2013). It is consumed by many people for its ability to quench thirst, stimulating effect and nutritional value (Doughari *et al.* 2007; Alobo *et al.* 2009; Olayemi *et al.* 2011). Unfortunately, ZD deteriorates quickly if prepared and not consumed immediately, due to varieties of factors such as processing method, contamination from the sorrel calyces, ingredients and poor quality water used for production, and lack of personal hygiene from the home producers resulting to microbial

activities and growth (Doughari *et al*. 2007; Braide *et al*. 2009; Ojo, 2011).

Studies reported that the shelf-life of unpreserved ZD falls between 24 to 72 h depending on the preparation method employed in its production, its packaging and storage condition (Doughari *et al*. 2007; Nwafor, and Ikenebomeh, 2009). Also, it has been reported that ZD produced by heat processing, preserved with lime juice, chemical preservatives (benzoic acid and sodium benzoate, 2 ml volume by volume concentration) and packaged in bottles has a shelf-life of about 4 to 14 days without refrigeration (Mohammed, 1997; Nwachukwu *et al.* 2007; Braide *et al*. 2009).

Furthermore, several works have reported that ZD harbours organisms such as, *Staphylococcus aureus*, *Lactobacillus acidophilus*, and *Saccharomyces cerevisiae*. This is not surprising because they are secondary micro-flora of fermentable food products, which could be one of the reasons why ZD undergoes fermentation within a short time (24-48 h) after production if kept at room temperature of between 40-45^{o}C (Omemu *et al.* 2006; Doughari *et al*. 2007; Nwafor, and Ikenebomeh, 2009). Also, studies have shown that spoilage of ZD within a short time can be attributed to the presence of *Staphylococcus aureus*, *Pseudomonas, Klebsiella species* and some *Bacillus species* causing both food spoilage and food poisoning (Dogan and Boor, 2003; Durak *et al.* 2006; Forsythe, 2010). ZD has low pH of about 2.7 to 3.5, but survival of bacteria in the drink is worrisome (Nwafor, and Ikenebomeh, 2009).

In addition, other research findings confirmed the presence of several other microscopic organisms in the calyces and ZD including fungi (*Aspergillus flavus, Fusarium oxysporum* and *Penicillium citrinum*); yeasts (*Saccharomyces cerevisiae*) and lactic acid bacteria (LAB) namely *Lactobacillus planetarium and Stretococcus lactis* (Akoma *et al.* 2002; Doughari *et al*. 2007; Nwachukwu *et al.* 2007; Braide *et al*. 2009; Nwafor, and Ikenebomeh, 2009). Available studies reported the possibility of using hurdle technique (heating and spicing ZD with the juices of ginger and African black pepper) to inhibit fungi growth (Nwachukwu *et al.* 2007; Ilondu and Iloh, 2007). And a recent study has reported that the high number of yeasts detected in ZD reflects a good adaptation to a substrate rich in proteins, lipids, sugars and organic acids leading to the production of alcohol and carbon-dioxide resulting to ZD fermenting and subsequently deteriorating in quality (Nwafor, and Ikenebomeh, 2009). The spoilage characteristic of ZD could be described as bitty cream and production of bitter taste perhaps due to excessive production of gaseous substance (carbon-dioxide), ethanol and lactic acid (Marth and Steel, 2001; Mohammed 2013). And lactic acid bacteria found in ZD is considered as candidates for probiotics and antibiotics that are used in the food and drug systems to improve the health of people with hypertension and other chronic diseases (Noreen *et al.* 2011; Tian *et al.* 2012).

Furthermore, recent studies have shown that *Bacillus cereus* and *Bacillus subtilis* were detected in ZD and this could signify a source of food poisoning for consumers because they are known to be potential pathogenic organisms (Braide *et al.* 2009; Nwafor, and Ikenebomeh, 2009; Fernandez-No *et al.* 2013; Mohammed, 2013).

2.5 Discussion

KZ quality problems are microbial contamination from the raw materials and handlers during processing. While the major safety problem of KZ is the production of Mycotoxins such as Aflatoxins, Fumonisins and OTA by the respective mould namely *Aspergillus parasiticus, Aspergillus, Fusarium moniloforme* and *Aspergillus ocraceous*. Aflatoxin B_1 is the most potent carcinogens known to man; Fumonisin B_1 and OTA cause immune suppression and cancer. Many Mycotoxins are non-toxic prior to metabolism, but after ingestion, they are metabolized to both toxic and non-toxic compounds, such as Cytochrome P450. Aflatoxins can affect the liver, OTA can affect the kidney and

Fumonisin B_1 can affect the lungs (Nagler and Coker, 2012). Research study reports that Daniellin™ has been used to control OTA in KZ. This is because it has the ability to decrease OTA from 50 mg/kg to less than 1.5 mg/kg by incorporating Daniellin™ of 2.0% and 2.5% to KZ (Adegoke *et al.* 2007). Also, use of quality raw materials and application of Good Manufacturing Practice in the production of KZ would improve and ensure the safety and quality of home-based beverages, such as KZ and ZD (Adegoke *et al.* 2007; Mohammed 2013). Daniellin™ is a product of *Afromomum danielli* (AD). AD is a local spice belonging to the family *zingiberaceae*; it possesses natural anti-oxidant properties and has the ability to suppress microbial growth (Fasoyiro *et al.* 2007).

Also, the major problems of ZD are microbial contamination from the raw materials and handlers during processing and presence of *Bacillus species*. Also, harsh conditions, such as boiling and refrigeration temperatures, can initiate and support the production of spores by *Bacillus* species (Moeller *et al.* 2008). Recent study presumptively confirms the presence of species of *Bacillus* associated with the sorrel calyces and ZD as reported by several studies (Omemu *et al.* 2006; Doughari *et al*. 2007; Braide *et al.* 2009; Mohammed, 2013). Also, several studies have shown that *Bacillus cereus* and *Bacillus subtilis* were detected in ZD and this could signify a source of food poisoning for consumers because they are known as potential pathogenic organisms (Omemu *et al.* 2006; Nwachukwu *et al.* 2007; Nwafor, and Ikenebomeh, 2009; Braide *et al.* 2012; Fernandez-No *et al.* 2013). Furthermore, it has been established that *Bacillus cereus* and *Bacillus subtilis* produce spores and both are potential food poisoning agents causing emetic and diarrhoeal infection (Lawley *et al.* 2012; Marsden *et al.* 2012; Fernandez-No *et al.* 2013).

A recent study suggests that boiling can be employed to produce safe ZD for human consumption because the levels of aerobic plate count (APC) and presumptive *Bacillus species* count (PBSC) in the samples of boiled ZD are within the limits of APC (10 to $< 10^2$ cfu ml^{-1}) and PBSC ($< 10^3$ cfu ml^{-1}) for ready-to-drink soft drink (Mohammed 2013; Food and Drug Administration Philippines, 2013). Toxin production is not going to be an issue due to low pH of ZD because *Bacillus* species cannot produce enterotoxins at low pH values (2 to 4.3) (Lawley *et al.* 2012). Also, an intoxication dose of 8µg Kg^{-1} body weight of spores of *Bacillus* species has been suggested (Paananen *et al.* 2002). But large doses (10^5 to 10^8 cfu g^{-1}) of viable cells of *Bacillus spp*. (*Bacillus cereus* and *Bacillus subtilis*) are required before toxin (cereulide) becomes detectable in the food (Health Protection Agency, 2009). Also, an emetic toxin in foods was implicated in an outbreak in Japan ranged from 0.01 to 1.28 µg g^{-1} (Agata *et al.* 2002). Although, it has been opined that *Bacillus cereus* can cause food poisoning at low dosage (10^3 cfu g^{-1}); but high levels ($\leq 10^5$ cfu g^{-1}) are necessary to produce enough toxin to cause illness (McIntyre *et al.* 2008; Lawley *et al.* 2012; Food and Drug Administration Philippines, 2013).

3. CONCLUSION

Recent research on ZD indicates that boiling method will be a better preparation approach for the production of safe ZD over the steeping method because results for presumptive *Bacillus species* count were less than the samples from steeping methods. Therefore, production of ZD that is safe for consumption is possible by boiling sorrel calyx in potable water and chilling before consumption because microbial growth of cells of microorganisms was not observed in the samples of ZD produced at 100°C for 10 to 20 min. boiling times and refrigerated at 4°C for 30 min. (Mohammed, 2013). Also, if ZD is produced and consumed on the same day this will give little or no chance for microbial growth, such as *Bacillus species*, that might cause foodborne problems (Mohammed, 2013). Furthermore, ZD produced by the steeping method is as well safe provided it is prepared and consumed straightaway (Mohammed, 2013). As for KZ, its quality and safety can be enhanced by

incorporating Daniellin™ during KZ production and/or producing instant KZ powder (Adegoke et al. 2007; Nkama *et al.* 2010)

In conclusion, the developed standardized methods of production, quality and safety evaluations for TBs should lead to a better assessment of safety and quality issues associated with TBs, which should contribute to the formulation of safety and quality regulations of these home-based beverages.

Contributors

Balen Dlawar Mirza Agha and Sirajo Mohammed Funtua wrote the first draft of this manuscript after detailed discussion with each other during their MSc programme in the United Kingdom. Both authors contributed to draft revisions and approved the final version of this reviewed paper. Also, both the authors do not have any conflicts of interest associated with writing this review.

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