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

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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.
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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

<table>
<thead>
<tr>
<th>Local name</th>
<th>English name</th>
<th>Region of production</th>
<th>Consumers</th>
<th>Serving condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kunun-zaki</td>
<td>*Millet beverage</td>
<td>North, South-West</td>
<td>Most Nigerians</td>
<td>Cold</td>
</tr>
<tr>
<td></td>
<td>*Sorghum beverage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Millet-Maize beverage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Millet-sorghum beverage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zobo or Soborodo</td>
<td>Sorrel drink</td>
<td>North, South-West</td>
<td>Most Nigerians</td>
<td>Cold</td>
</tr>
</tbody>
</table>

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

Table 2: Raw materials and methods for production of TBs

<table>
<thead>
<tr>
<th>Raw materials</th>
<th>Production method</th>
<th>Description</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet/Sugar/Water</td>
<td>Fermentation: Extraction, boiling and sweetening</td>
<td>Whitish beverage</td>
<td>Kunu zaki</td>
</tr>
<tr>
<td>Sorrel calyces/Sugar/Water</td>
<td>Extraction: Steeping/boiling, sweetening</td>
<td>Reddish/purplish beverage</td>
<td>Zobo drink</td>
</tr>
</tbody>
</table>

Sources: (Akoma et al. 2002; Mohammed, 2005; Sengve 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 (Sengve 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, ßeta 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 sell 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 (mycotoxicosis) 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 contamination from the sorrel calyces, and it was noted that Fuminosins (Douglas et al. 2001) have been identified in the beverage (Zobo drink) (Aboaba et al. 2007).
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°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 plantarum and Streptococcus 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 moniliforme and Aspergillus ochraceus. Aflatoxin B₁ is the most potent carcinogens known to man; Fumonisins B₁ 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 B₁ 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 < 10² cfu ml⁻¹) and PBSC (< 10³ 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 (10⁵ to 10⁸ 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 (10³ cfu g⁻¹); but high levels (≤ 10⁵ 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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