

BACTERIOLOGICAL QUALITY OF KUNU GYADA SOLD IN WUKARI, NIGERIA

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ABSTRACT

This study was carried out to evaluate the bacteriological quality of kunu gyada sold in Wukari, Nigeria. A total of six (6) samples, two from each of the locations (School Gate, Takum Junction, and Tanker Park) in Wukari, were evaluated for bacterial load and the presence of bacteria using standard microbiological techniques. The result shows that the total bacteria load was observed to be highest in School Gate 2 (5.0×10^6 cfu/mL), followed by School Gate 1 (3.0×10^6 cfu/mL), Tanker Park 1 (2.0×10^6 cfu/mL), and Takum Junction 1 (1.0×10^6 cfu/mL). Takum Junction 2 presented no bacteria growth. The total coliform count ranged from no growth to 3.3×10^5 cfu/ml. The bacteria isolated and identified were *Staphylococcus aureus*, *Bacillus* species, *Escherichia coli*, and *Klebsiella* species. The occurrence of these bacteria showed that *Escherichia coli* was the highest 5 (83.3%), followed by *Staphylococcus aureus* 4 (66.7%), *Bacillus* species 2 (33.3%) and *Klebsiella* species was the least 1 (16.7%). The high bacteria load and presence of some pathogenic bacteria indicated that the kunu-gyeda sold in Wukari has been contaminated, which is significant for public health. Hence, kunu-gyeda producers and vendors in Wukari need to practice good manufacturing and hygiene practices during preparation to avoid microbial contamination that may cause an outbreak of foodborne illness.

Keywords: Bacteria load, foodborne illness; public health; Kunun gyada; hygiene.

INTRODUCTION

In most cultures, food habits are based on the available agricultural raw materials. Traditional cereals and grain legume crops play important roles in the diets of many people in Africa and are major sources of proteins, carbohydrates, vitamins, and minerals (Ezekiel *et al.*, 2018). Traditional beverage foods are based on these local staples, namely rice, maize, millet, sorghum groundnuts, and beans (Ndukwe *et al.*, 2023).

Kunun gyada is a traditional beverage that originates from the Hausa people of northern Nigeria. It has deep roots in Hausa culinary heritage and is an integral part of their culture. The Hausa, one of Nigeria's largest ethnic groups, have passed down the recipe for kunun gyada through generations, making it a cherished drink in their traditions (Ezekiel *et al.*, 2018). In the northern states of Nigeria, many traditional foods are prepared mainly from cereals and grain legumes, either singly or in combination. Examples are *ogi* or *akamu*, fermented cereal gruel; *kunun zaki*, a sweet beverage from cereals alone; *mardam*, overcooked cereal porridge; *kunun tsir*, a beverage made of cowpeas; and *kunun gynda*, a beverage based on groundnuts and cereal (Bristone *et al.*, 2018).

Traditional African households consume a significant number of fermented beverages in their meals (Tafere, 2015). Due to their excellent nutritional value and relatively inexpensive production costs, in Nigeria, traditional beverages are widely consumed and are typically preferred to commercial soft drinks by people from low-income environments (Ezekiel *et al.*, 2019). Kunun gyada is known for its nutty taste and creamy texture, one of its defining characteristics achieved through diligent stirring and gradual thickening during the cooking process. As it simmers, the drink gradually transforms into a smooth, slightly viscous liquid, served and enjoyed as a refreshing drink. It's not just delicious but also provides quality nutrients with the groundnuts, a primary component that contributes protein, healthy fats, vitamins, and minerals, enhancing the drink's nutritional value (Tafere, 2015). Rice provides carbohydrates, further boosting its energy-providing properties. Moreover, the presence of these nutritious ingredients renders Kunun Gyada a potential source of essential nutrients, making it a preferred choice not only for its taste but also for its perceived health benefits within the communities where it is consumed (Ezekiel *et al.*, 2018).

Kunun Gyada holds a prominent place in local markets, roadside stalls, and households across northern Nigeria. Its availability spans various outlets, from dedicated vendors to homes where families prepare it for personal consumption or small-scale sales. Vendors often sell Kunun Gyada in markets or street corners, where the beverage is showcased in large containers, attracting people seeking a refreshing and nourishing drink. The sales of Kunun Gyada contribute to local economies while preserving cultural culinary practices within the region (Bristone *et al.*, 2018).

In recent years, Kunun Gyada has gained recognition beyond its place of origin. Its unique taste and nutritional value have captured the interest of not just locals but also individuals exploring diverse culinary experiences globally. As a result, it's not uncommon to find variations or adaptations of kunun gyada in different parts of Nigeria, each with its own twist to suit local tastes and preferences (Nduka *et al.*, 2018).

Kunun gyada is a fermented beverage made with millet, groundnuts, water, and spices. Its taste and preservation are enhanced by natural microorganisms, typically lactobacilli bacteria, which convert sugars into acids and alcohols. Fermentation helps break down complex compounds, making nutrients more accessible (Ndukwe *et al.*, 2023). In developing nations like Nigeria, it has not been possible to have control over the processing of hawked foods because most of the vendors lack adequate knowledge of food processing and handling practices. A large number of lactic acid bacteria, coliforms, *E. coli*, molds, and yeast have been reportedly implicated in food spoilage as they use the carbohydrate content of the foods for undesirable fermentation processes (Nduka *et al.*, 2018).

Kunu gyada can pose health risks if not prepared or stored properly. Contamination, especially in millet and groundnuts, can lead to foodborne illnesses. Allergic reactions can be severe, and improper cleaning of preparation areas or utensils can cause food poisoning. Additionally, improper storage can lead to the development of mycotoxins. According to Orutugu (2015), the production of Kunu is mostly carried out in environments where quality control is lacking, just like in most fermented foods in Nigeria. Some of the microorganisms involved in the fermentation of food include *Lactobacillus*, *Lactococcus*, *Enterococcus*, and *Streptococcus*. The production of Kunu in an environment with poor sanitary conditions could predispose consumers of the drink to pathogens of medical or public health importance. Furthermore, the drink has a

short shelf life. It is prone to bacterial spoilage if not adequately stored and could act as an important medium for the transmission of pathogenic microorganisms. Nwiyi & Elechi (2022) isolated *Bacillus*, *Enterobacter*, *Lactobacillus*, *Micrococcus*, *Salmonella*, *Staphylococcus*, *Streptococcus*, *Escherichia coli*, *Klebsiella*, *Lactobacillus*, and *Pseudomonas* from Kunu zaki, zobo, Fura de Nono, Kunu Aya, and Kunu Gyada. Therefore, the aim of this study is to evaluate the bacteriological quality of Kunun kyeda sold in Wukari.

MATERIALS AND METHODS

Collection of Samples

A total of six (6) freshly prepared samples of kunun-gyada was purchased from three (3) locations in Wukari metropolis (School gate, Takun junction and Tanker Park). Two samples were collected from each of these locations. The samples were collected in sterile plastic containers with cap and labeled appropriately and were immediately transported to the Biology Laboratory of Federal University Wukari for bacteriological analysis.

Determination of Bacteria Load and Isolation of bacteria from Kunu-gyada

The bacteria load of the kunu-gyada samples was determined following the method of Rashed *et al.*, (2013) as described by Ogodo *et al.*, (2018) with slight modifications. Each container of kunu-gyada sample was properly mixed by gentle inversion several times and was serially diluted with sterile peptone water using a ten-fold dilution technique. Exactly 1mL of the fifth dilution (10^{-5}) for each sample was evenly spread on nutrient agar (NA) and MacConkey agar (Mac) for total bacteria count and total coliform count respectively and then incubated at 37°C for 24 h for bacterial growth. At the end of incubation, colonies were counted to obtain the total bacteria count and total coliform count and expressed as colony forming unit per milliliter (CFU/mL).

To obtain pure bacterial cultures, distinct colonies were sub-cultured on nutrient agar from countable plates using the four-quadrant streak technique. The isolated bacteria pure cultures were kept individually in nutrient agar slants and refrigerated at 4°C for further analysis as described by Aruwa and Ogundare's (2017). The pure cultures were identified using the methods described by Fawole and Oso (1988) and Cowan and Steel (1975) with reference to Holt *et al.* (1994).

RESULTS AND DISCUSSION

Results

Table 1 presented the bacteria load on the various kunun-gyeda samples. The result shows that the total bacteria load was observed to be highest in School gate 2 (5.0×10^6 cfu/mL), followed by School gate 1 (3.0×10^6 cfu/mL), Tanker park 1 (2.0×10^6 cfu/mL), Tanker park 1 and Takum junction 1 (1.0×10^6 cfu/mL) each. Takum junction 2 presented no bacteria growth. The total coliform count ranged from no growth to 3.3×10^5 cfu/mL.

Table 2 presents bacteria isolated and their occurrences. The result showed that *Escherichia coli* was the most common 5 (83.3%), followed by *Staphylococcus aureus* 4 (66.7%) and *Bacillus* Species 2 (33.3%) while *Klebsiella* species was the least 1 (16.7%).

Table 1: Bacterial load of kunun-gyeda samples

Sample Tag	Total bacteria load (cfu/mL)	Coliform count (cfu/mL)
School gate 1	3.0×10^6	1.0×10^5
School gate 2	5.0×10^6	3.3×10^5

Tanker park 1	2.0×10^6	1.0×10^5
Tanker park 2	1.0×10^6	2.0×10^5
Takum junction 1	1.0×10^6	3.0×10^5
Takum junction 2	No growth	No growth

Key: cfu/mL = Colony forming unit per millilitre

Table 3: Percentage occurrence of the isolated bacteria on the samples

Isolates	Number Examined	Frequency	Percentage (%)
<i>Staphylococcus aureus</i>	6	4	66.7
<i>Bacillus</i> Species	6	2	33.3
<i>Escherichia coli</i>	6	5	83.3
<i>Klebsiella</i> species	6	1	16.7

Discussion

The present study revealed that most of the samples analyzed contain high bacteria count ranging from no growth to 5.0×10^6 cfu/mL. Similar high bacteria count was reported by Ogodo *et al.*, (2018) bacteria count ranging from 3.0×10^3 cfu/mL to 2.2×10^7 cfu/mL in kunun-aya. Attah *et*

al. (2019) in their findings reported a total average bacteria count in kunnu to range from 3.5×10^4 cfu/mL to 9.9×10^4 cfu/mL. Anumudu and Anumudu, (2019) also in his findings reported the total bacteria count to range from 1.4×10^3 to 4.5×10^4 cfu/mL in Kunu-zaki sample.

The total coliform count in the present study ranged from no growth to 3.3×10^5 cfu/mL. This is in agreement with the findings of Anumudu and Anumudu, (2019) who reported the coliform count to range from 1.2×10^3 – 3.8×10^4 cfu/mL in kunun-zaki. Similarly, Umar *et al.*, (2014) in his findings reported the total coliform counts to range from 8.2×10^2 to 6.1×10^4 cfu/mL in kunu-aya.

The high bacteria load observed in this study could be attributed to various factors related to production, processing, and storage. These include contamination during production, poor hygiene practices during production, inadequate heat treatment, and use of contaminated raw materials, environmental factors, and cross-contamination. Environmental factors like air and water quality can also influence bacterial contamination. Cross-contamination during post-production handling and serving can also increase microbial load as observed by Olufade, (2019).

The high coliform count is indicative of contamination with fecal matter or poor sanitation practices during production and handling of the kunu gyeda. Coliform bacteria are found in warm-blooded animals and can be present in food or beverages (Some *et al.*, 2021). Possible reasons include the use of fecal matter contaminated water, poor hygiene practices, contaminated equipment, poor personal hygiene of workers and vendors, and raw material contamination.

The bacteria isolated in this study are *Staphylococcus aureus*, *Bacillus* Species, *Escherichia coli* and *Klebsiella pneumonia*. This is in agreement with the findings of Nduka *et al.*, (2018) who reported the same bacteria in kunu-zaki samples. Ogoto *et al.*, (2018) isolated similar bacteria from kun-aya samples. The presence of these organisms is not surprising because they thrive in fermentable mediums rich in sugars, leading to the souring of taste of kunun-gyeda if not consumed within six hours of production (Nduka *et al.*, 2018). The spores of *Bacillus* can survive high processing temperatures, ensuring survival at pasteurization temperatures. This is why *Bacillus* species are present in kunun-gyeda samples subjected to heat treatment during processing (Wen *et al.*, 2022). Some of these associated microbes have been implicated in food poisoning due to their presence in certain food materials. The presence of some of these potential pathogenic organisms in this study could be a matter of serious public health concern. Bintsis (2017) reported *Staphylococcus aureus*, *Bacillus* Species and *Escherichia coli* foodborne pathogens causing a great number of diseases with significant effects on human health and economy.

The present study shows that *Escherichia coli* was the highest prevalent bacteria isolate 5(83.3%), followed by *Staphylococcus aureus* 4(66.7%), *Bacillus* Species 2(33.3%) and *Klebsiella pneumonia* was the least 1(16.7%). This is in agreement with the findings of Opeyemi and Obuneme, (2020) who reported *E. coli* (76%) to have the highest percentage occurrence followed by *Klebsiella* spp. (36%), *Proteus* spp. (20%), while *Salmonella* spp. (36%) and *Staphylococcus aureus* (25%) in tiger nut milk (kunu-aya). The high occurrence of *Escherichia coli* 5(83.3%) and *Staphylococcus aureus* 4(66.7%) is of public health concern. Pathogenic variants of *E. coli* (pathovars or pathotypes) cause much morbidity and mortality worldwide; many of these pathotypes are a major public health concern as they have low infectious doses

and are transmitted through ubiquitous mediums, including food and water (Croxen *et al.*, 2013; Lorenzo *et al.*, 2018). The high occurrence of *Staphylococcus aureus* in food may be considered a public health hazard because of its ability to produce enterotoxin and the risk of subsequent food poisoning (Kadariya *et al.*, 2014; Hernández-Cortez *et al.*, 2017).

CONCLUSION

The present study has indicated that kunu-gyeda samples sold in Wukari had substantial bacteria load. Additionally, it has demonstrated that the majority of the samples contained potentially harmful microorganisms, which are significant for public health. Therefore, there is need for hygienic practices during processing, production, handling and storage of Kunun gyeda to ensure that the product is not contaminated to avoid outbreak of diseases associated with the organisms isolated in this study.

CONFLICT OF INTEREST

The authors declared that there is no conflict of interest

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