

Microbiological evaluation of street vended *Saccharum officinarum* (sugarcane) sold within Lafia Metropolis, Nasarawa State, Nigeria

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ABSTRACT *Saccharum officinarum* (Sugarcane) is primarily cultivated for its juice from which sugar is processed. This study aimed to evaluate the microbiological state of street vended sugarcane sold within Lafia Metropolis by determining microbial count, coliform count, and identifying the bacterial and fungal pathogens. A total of forty (40) samples, ten (10) from each location were collected from Mararaba Akunza, Lafia Main Town, Bukan Sidi and Ombi 1. All samples were analyzed for bacterial, coliform and fungal using pour plate method and were cultured on Nutrient Agar, MacConkey Agar and Potatoes Dextrose Agar, respectively. The mean total microbial count ranged from $2.51 \times 10^5 \pm 0.31$ cfu/g to $7.63 \times 10^5 \pm 0.75$ cfu/g, $2.24 \times 10^3 \pm 0.36$ cfu/g to $7.38 \times 10^3 \pm 0.90$ cfu/g and $2.00 \times 10^3 \pm 0.24$ cfu/g to $6.60 \times 10^3 \pm 0.45$ cfu/g for total heterotrophic bacterial, total coliform and total heterotrophic fungal count respectively. Bacterial species isolated include *E. coli* (55.00%), *S. aureus* (37.50%), *Shigella* spp (35.00%), *Samonella* spp (32.5%), *Micrococcus* spp (32.50%), *Bacillus* spp (30.00%), *E. faecalis* (27.50%), *S. epidermidis* (27.50%), *Streptococcus* spp (17.5%) and *Pseudomonas* spp (5.00%) while the fungal species include *A. flavus* (10.00%), *A. niger* (10.00%), *A. fumigatus* (10.00%), *Rhizopus* spp (5.00%), *Penicillium* spp (5.00%), *A. clavatus* (2.50%) and *Mucor* spp (2.50%), respectively. There was a significant difference ($P < 0.001$) observed in distribution of bacterial isolated from different locations. It is recommended that Nigerian government and food regulatory agencies should regularly analyze hawked sugarcane for the possibility of pathogenic agents.

KEYWORDS: Sugarcane; Microbiological; Contamination; Street Vended; Lafia Metropolis.

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INTRODUCTION

Saccharum officinarum (Sugarcane) is the world's oldest cash crop, accounting for 80% of global sugar production and it is the largest crop in terms of production volume, accounting for 1.9 billion tonnes in 2016, with Brazil accounting for 41% of the world total (Babalola *et al.*, 2013; Girei & Girohi, 2012; Babalola *et al.*, 2009; Binbol *et al.*, 2006).

The juice from sugarcane is a common man's refreshing drink which is now becoming a popular drink of choice in local social gathering for thirst quenching during summer. It also gives instant energy and still remains cheapest for an average or low-income individual hence, many people prefer it to industrially-produced beverages (Asiegbu *et al.*, 2016; Ima *et al.*, 2016; Oliveiera *et al.*, 2006). Street vended food are valued for their unique taste and convenience, as well as for maintaining the nutritional status. In developing countries where there is high level of unemployment, streets food serves as true source of employment and income generation to many.

Food safety is defined by Ansaril *et al.* (2013) as a condition or measures that are necessary during the manufacturing, processing, storage, distribution and preparation of food to ensure that food is acceptable according to its intended use. Food contamination refers to the process by which

food get spoiled or contains microorganisms such as bacteria, parasites, or toxic substances that makes it unsuitable for human consumption. Microorganisms are mostly transferred to food (sugarcane) by processors from soil, water, dust, gastrointestinal tract, contact with animal hides, and other environmental sources (Kidus & Teka, 2020; Scott & Bloomfield, 2018). No trainings are conducted for street vendors and so most of them have little or no understanding about food safety practices (Rashed *et al.*, 2013; Tembekar *et al.*, 2009). There has been report of foodborne illness associated with consumption of street vended food in Nigeria and other parts of the world. About 15 cases of foodborne disease outbreaks monitored in Zhapo, a coastal resort of Guangdong in China, from 2008 to 2011 and were traced to the negligence of food vendors (Liu *et al.*, 2015).

According to Nigerian Centre for Disease Control (NCDC), the highest occurrence of foodborne diseases is in Asia and sub-Saharan Africa compared to the rest of the world. Foodborne diseases in Nigeria are usually not reported except in cases of outbreaks like in the case of botulism outbreak that was linked to food consumption in Abuja (Okunromade *et al.*, 2020).

Sugarcane preparation can introduce foodborne microorganisms from unwashed hands of vendors through unsanitary handling (Bhasker *et al.*, 2004). Most vendors do not follow safe practices such as sprinkling unsafe water from containers picked on the ground to keep the sugarcane fresh at point of sale (Tulchinsky *et al.*, 2015), leaving the sugarcane open which gives opportunity for flies to flirt on it, dust and airborne particles from busy roads also settled on it as vendors hawked along heavy vehicular traffic (Muinde & Kuria, 2005). The consumption of sugarcane is high in Lafia Metropolis, but no studies have been reported to ascertain its microbial quality. Hence, these might pose a serious health challenge to the populace.

This study aimed to evaluate the microbiological state of street vended sugarcane sold within Lafia Metropolis by determining the total heterotrophic bacterial count (THBC), total coliform count (TCC), total heterotrophic fungal count (THFC), bacterial and fungal pathogens.

MATERIALS AND METHODS

Study Area

This research was carried out in Lafia Metropolis which is the State capital of Nasarawa State and has a population of 330,712 inhabitants according to 2006 census results, 290 meters elevation above sea level and a land mass of 27,117 km². Nasarawa State and its environs are located in the middle belt (North central part) of Nigeria with an average temperature of 31°C and average humidity of 64%. The state is made up of three (3) senatorial districts - North, South and West, with thirteen (13) local government areas. The state shares boundary with five states, to the North-east with Kaduna state, North-west with Plateau, South with Abuja, South-west with Benue State and Kogi state then South-east with Taraba State.

Sample Collection

A total of forty (40) freshly peeled sugarcane samples were purchased from street vendors at four different areas within Lafia Metropolis namely Mararaba Akunza, Lafia Main Town, Bukan Sidi and Ombi 1. The samples were randomly collected from ten (10) different points of sales within the area in sterile polythene bags under aseptic conditions. The samples were taken to Microbiology laboratory, Federal University of Lafia within 6 hrs for analysis.

Sample Analysis

Sugarcane sample was chopped into smaller pieces with a sterile knife. Ten grammes of each chopped sample was weighed and transferred into 90mls of distilled water and was allowed to stand for 30 minutes then it was mixed thoroughly to get the stock sample of 10^{-1} dilution. Ten (10) fold serial dilution was carried out for each sample to a maximum of 10^{-5} . The diluted samples were pour-plated into Nutrient agar, MacConkey agar and Potatoes Dextrose agar following the standard procedure by Cheesbrough, 2004.

Determination of Total Heterotrophic Bacterial Count (THBC), Total Coliform Count (TCC) and Total Heterotrophic Fungal Count (THFC).

THBC, TCC and THFC were determined using the standard procedure by Cheesbrough (2004) after which colonies were counted using colony counter and was expressed in CFU/g.

Isolation and Characterization of Isolates.

Pure isolates were characterized according to the procedures by Wiley *et al.* (2008) and Cheesbrough (2004).

Statistical Analysis

Data generated were analyzed using Statistical Product for Service Solution (SPSS) software version 26. Chi-square test was used to determine the significance difference between qualitative variables. Confidence level was set at $P < 0.05$.

RESULTS AND DISCUSSION

The Mean total heterotrophic bacterial count (THBC) ranged from $2.51 \times 10^5 \pm 0.31$ cfu/g to $7.63 \times 10^5 \pm 0.75$ cfu/g, total coliform count (TCC) ranged from $2.24 \times 10^3 \pm 0.36$ cfu/g to $7.38 \times 10^3 \pm 0.09$ cfu/g and total heterotrophic fungal count (THFC) ranged from $2.00 \times 10^3 \pm 0.24$ cfu/g to $6.60 \times 10^3 \pm 0.45$ cfu/g. There was significant difference ($P < 0.001$) from the total counts across the various locations (Table 1). This result is similar with the studies on microbiological assessment on sugarcane by Doherty *et al.* (2017) where he had THBC and THFC counts of 2.0×10^3 cfu/g to 7.0×10^3 cfu/g and 3.0×10^3 cfu/g to 8.0×10^3 cfu/g respectively.

Table 1. Mean Total heterotrophic bacterial counts, total coliform counts and total heterotrophic fungal counts in sugarcane samples from various locations.

| Location | THBC (CFU/g \pm SD) | TCC (CFU/g \pm SD) | THFC (CFU/g \pm SD) |
|-----------------|-----------------------------|-----------------------------|-----------------------------|
| Mararaba Akunza | $7.63 \times 10^5 \pm 0.75$ | $7.38 \times 10^3 \pm 0.90$ | $6.60 \times 10^3 \pm 0.45$ |
| Bukan Sidi | $2.90 \times 10^5 \pm 0.51$ | $2.65 \times 10^3 \pm 0.69$ | $2.44 \times 10^3 \pm 0.56$ |
| Lafia Main Town | $6.94 \times 10^5 \pm 0.94$ | $6.83 \times 10^3 \pm 0.90$ | $5.93 \times 10^3 \pm 0.64$ |
| Ombi 1 | $2.51 \times 10^5 \pm 0.31$ | $2.24 \times 10^3 \pm 0.36$ | $2.00 \times 10^3 \pm 0.24$ |
| F-value | 157.38 | 131.80 | 225.83 |
| | P<0.001 | P<0.001 | P <0.001 |

THBC=Total heterotrophic bacterial count; TCC=Total coliform count; THFC=Total heterotrophic fungal count.

Ten (10) bacterial species were isolated from the vended sugarcane (Table 2). *E. coli* has the highest frequency and the least occurrence is *Pseudomonas* spp. No significance difference was observed as $P=0.983$. This study agrees with researches conducted by Reena *et al.* (2012), Rahman *et al.* (2011), Nicolas *et al.* (2007) and Oliveira *et al.* (2006). They isolated various pathogenic bacteria from street vended foods. Some species of *E. coli* can cause serious enteric diseases such as diarrhea while others can cause urinary tract infections, pyogenic infections and septicemia. Its presence in sugarcane not only indicates poor hygienic quality but also places consumers at high risk of

contracting food-borne infections. *E. coli* is also a coliform and its presence in sugarcane indicates fecal contamination and this could be linked to improper hygiene, lack of access to good quality water, improper disposal of sewage waste thereby, leading to increase in contamination (Oliveiera et al., 2006; Ima et al., 2016).

Table 2. Occurrence of bacterial species isolated from vended sugarcane

| Bacterial spp | Ombi 1 N=10 n (%) | Bukan Sidi N=10 n (%) | Lafia MT N=10 n (%) | Mararaba A N=10 n (%) | Total frequency N=40 n (%) |
|---------------|-------------------------|-----------------------------|---------------------------|-----------------------------|----------------------------------|
| ECO | 5 (50.00) | 5 (50.00) | 6 (60.00) | 6 (60.00) | 22 (55.00) |
| SAU | 2 (20.00) | 3 (30.00) | 2 (6.3) | 8 (18.2) | 15 (37.50) |
| SHI | 2 (20.00) | 3 (30.00) | 3 (30.00) | 6 (60.00) | 14 (35.00) |
| MIC | 2 (20.00) | 2 (20.00) | 5 (50.00) | 4 (40.00) | 13 (32.50) |
| SAL | 2 (20.00) | 2 (20.00) | 3 (30.00) | 6 (60.00) | 13 (32.50) |
| BAC | 3 (30.00) | 1 (10.00) | 4 (40.00) | 4 (40.00) | 12 (30.00) |
| EFA | 3 (30.00) | 2 (20.00) | 2 (20.00) | 4 (40.00) | 11 (27.50) |
| SEP | 2 (20.00) | 2 (20.00) | 5 (50.00) | 2 (20.00) | 11 (27.50) |
| STR | 1 (10.00) | 2 (20.00) | 2 (20.00) | 2 (20.00) | 7 (17.50) |
| PSE | 0 (0.00) | 0 (0.00) | 0 (0.00) | 2 (20.00) | 2 (5.00) |
| | P=0.983 | P=0.983 | P= 0.983 | P= 0.983 | P= 0.983 |

N= Total number of samples; n= Number of positive samples; MT=Main town, A=Akunza

ECO=*Escherichia coli*; SAU= *Staphylococcus aureus*; SHI= *Shigella* spp; SAL=*Salmonella* spp; MIC=*Micrococcus* spp; BAC=*Bacillus* spp; EFA=*Enterococcus faecalis*; SEP=*Staphylococcus epidermidis*; STR= *Streptococcus* spp; PSE= *Pseudomonas* spp.

Staphylococcus aureus is a normal flora of the skin. Isolating it from sugarcane could possibly be attributed to contamination via vendors' hand. The vendor uses the bare hands to sale the sugarcane and that same bare hand is been used to scratch the skin, hair and probably touch other places without proper washing, it could also be from vendors' dirty cloth as they ignorantly allow the sugarcane to touch their cloth while peeling (Scott & Bloomfield, 2008). A comparative study was carried out by Mensah et al. (2002) in Ghana on the risks involving the use of cutleries and bare hands to serve street foods and he found out that the use of bare hands to serve food increased the level of contamination of street food sold in Ghana.

Salmonella spp causes typhoid and paratyphoid in human and it might have gained entry through contaminated water used during processing or water used in sprinkling the sugarcane at point of sales to keep it fresh (Tulchinsky et al., 2015). *Shigella* spp causes dysentery (Mosupye & Holy, 2000). *Streptococcus* spp, *Micrococcus* spp are indication of unhygienic practices while *Pseudomonas* spp is a notorious bacterium that is associated from wounds and burns. Abrar et al. (2020) carried out various studies from street foods and have identified that most sources of food safety issues are associated with microorganisms belonging to the genus *Bacillus*, *Staphylococcus*, *Clostridium*, *Vibrio*, *Campylobacter*, *Listeria* and *Salmonella*.

Table 3 shows the occurrence of fungal species. Seven (7) fungal were isolated, they include *A. flavus*, *A. niger*, *A. fumigatus*, *Rhizopus* spp, *Penicillium* spp, *A. clavatus* and *Mucor* spp. Three fungal (*A. flavus*, *A. niger* and *A. fumigatus*) had the highest occurrences while the least occurrence was recorded in *Mucor* spp and *A. clavatus*. This correlate with the findings conducted by Arotupin et al. (2012) and Muinde & Kuria. (2005) where they reported that street vended sugarcane sold within Nigeria were contaminated with fungal isolates (Kana et al., 2013). Although from this study, there was no significant differences observed as P=0.991.

Table 3. Occurrence of fungal species isolated from vended sugarcane

| Fungal spp | Ombi 1 N=10 n (%) | Bukan Sidi N=10 n (%) | Lafia MT N=10 n (%) | Mararaba A N=10 n (%) | Total frequency N=40 n (%) |
|------------|-------------------------|-----------------------------|---------------------------|-----------------------------|----------------------------------|
| AFU | 1 (10.00) | 1 (10.00) | 1 (10.00) | 1 (10.00) | 4 (10.00) |
| ANI | 1 (10.00) | 1 (10.00) | 1 (10.00) | 1 (10.00) | 4 (10.00) |
| PEN | 0 (0.00) | 0 (0.00) | 1 (10.00) | 1 (10.00) | 2 (5.00) |
| AFL | 1 (10.00) | 1 (10.00) | 1 (10.00) | 1 (10.00) | 4 (10.00) |
| MUC | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (10.00) | 1 (2.50) |
| RHI | 0 (0.00) | 0 (0.00) | 1 (10.00) | 1 (10.00) | 2 (5.00) |
| ACL | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (10.00) | 1 (2.50) |
| | P=0.991 | P=0.991 | P= 0.991 | P= 0.991 | P= 0.991 |

N= Total number of samples; n= Number of positive samples; MT=Main town, A=Akunza. AFL= *Aspergillus flavus*; ANI=*Aspergillus niger*; AFU= *Aspergillus fumigatus*; RHI= *Rhizopus* spp; PEN=*Penicillium* spp; ACL= *Aspergillus clavatus*; MUC= *Mucor* spp.

Pathogenic fungal could possibly be from air and dust particle since the sugarcane is mostly left uncovered and the vendors hawked along busy roads with heavy vehicular traffic which exposes dust and airborne particles and this concurred with research conducted by Muinde & Kuria (2005). Iyabo and Simon. (2019) also conducted their studies and found out that contact surfaces such as handsets or automated teller machine (ATM) harbor microorganisms while research by Hassan *et al.* (2011) revealed that money harbors microorganism. Since the vendors uses bare hands to collect the money and sale so this process of transaction will also serve as avenue for contaminating the sugarcane.

Figure 1 shows the distribution of various bacterial isolate with *Escherichia coli* having the highest frequency of 22 (55.00 %) and the least occurrence was *Pseudomonas* spp with a total frequency of 2 (5.00 %). On the other hand, Figure 2 shows the distribution of various fungal isolates. *Aspergillus flavus*, *Aspergillus niger* and *Aspergillus fumigatus* had the highest occurrence of 4 (10.00 %) while the least occurrence was *Mucor* spp and *Aspergillus clavatus* with total frequency of 1 (2.50 %).

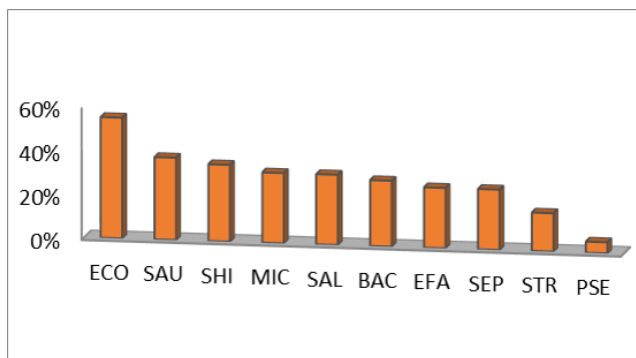


Figure 1. Percentage distribution of various bacterial isolates

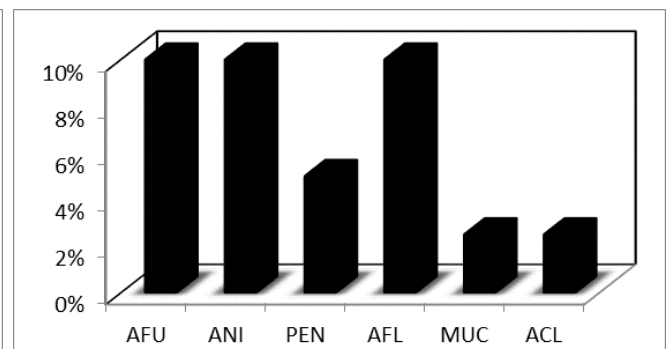


Figure 2. Percentage distribution of various fungal isolates

CONCLUSION

Street vended food is any food or drink sold on the street or in other public places. Schools, bus stops, train stations, entertainment venues, busy highways among others. Street vended sugarcane can be quickly consumed without any form of processing or preparation. There are no safety regulations on street vendors hence consumers are at risk. The study reveals that street vended sugarcane sold within Lafia metropolis were contaminated and it is of great concern because the

pathogenic species might pose threat to human health when consume. Many people prefer sugarcane to industrially produced beverages because of its affordability, nutritional values, associated health benefits and it also remains the cheapest energy giving drink to a common man. However, sugarcane will be beneficial if it is free from contamination. Hence, it is recommended that people in the studied area should be enlightened on the need to wash sugarcane properly before they chew so as to prevent foodborne infection while enforcement of standard policies on hygiene should be implemented to prevent foodborne illnesses.

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