JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2022, *28* (1), 35-45

Journal of Agroalimentary Processes and Technologies

Evaluation of Microbial Quality and Mycotoxin Residues Associated with Production of 'Kati' - A Nigerian Fermented Cereal Food

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Abstract

'Kati' purchased from local producers in Akoko, Ondo State, Nigeria and 'Kati' produced from the laboratory were microbiologically examined for presence of microorganisms and mycotoxins. The microbial counts at the different stages of production are significantly different ($p > 0.05$) with values ranging from 1.00×10^5 to 1.16×10^6 CFU/mL. Most predominated bacteria in commercial 'Kati' were *Lactococcus lactis Lactobacillus plantarum* and *Lactobacillus brevis*. *Saccharomyces cerevisiae* have the highest occurrence value of 32.6% and 55.6% in commercial 'Kati' and 'Kati produced in the laboratory. There were presence of aflatoxin B1 (18.52 µg/g), aflatoxin B2 (16.02 µg/g), aflatoxin G1 (17.84 µg/g), fumonisin B1 (4.01 µg/g) and ochratoxin A1 (0.93 µg/g) in sorghum used for commercial 'Kati' production. Likewise, presence of aflatoxin B1 (16.78µg/g), aflatoxin B2 (13.94 µg/g), aflatoxin G1 (14.89 µg/g), and aflatoxin G2 (0.04 µg/g) in sorghum used for 'Kati' in the laboratory. The presence of mycotoxin residues on the starting material (sorghum) indicated that, 'Kati' and other fermented foods from cereals need to be produced under hygienic conditions. It is therefore, imperative to take into consideration, high level of hygiene with the principle of Hazard Analysis and Critical Control Point (HACCP) at different stages of production in order to reduce microbial contamination and toxins associated with fermented foods.

Keywords: HACCP, aflatoxin, fumonisin, ochratoxin, fermented foods

1. Introduction

Cereals are staple foods with a high content of soluble non-starch, which have form part of human diets with health promoting effects (Achi and Ukwuru, 2015). A wide range of cereal-based fermented foods produced from basic biotechnology have fed millions of people (Guyot, 2012). Presently, varieties of fermented foods are produced from cereals as weaning food for infants or children and adults at household and on a semi industrial scale (Achi and Ukwuru, 2015). The microorganisms found in fermented foods are complex with a significant diversity observed among different products (Omenu, 2011). In the fermentation of sorghum, different microorganisms are involved. Few among these microorganisms are usually dominant over others during fermentation and they determine the quality of the end product after fermentation. It is, important to note that fermentation can lead end products that are not microbiologically safe to human consumption (Ekwem and Okolo, 2017). The reasons had been attributed to the quality of raw materials, chance or natural inoculum, unregulated conditions, contamination level, the degree of acidity, and unattractive packaging of the processed products (Gadaga et al., 2004).

'Kati' is the staple food of Akoko people of Ondo State, Nigeria. The cereals used for 'Kati' production are either fermented sorghum, maize or

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millet. The tendency of 'Kati' to be stored for upward of ten days without refrigeration and longer when refrigerated, accounts for its storage stability and this is due to the activities of lactic acid bacteria and its products in the fermented food (Omosuli et al., 2008). 'Kati' is usually eaten as a snack during hot weather. The level and types of microorganisms associated with ''Kati' may due to contaminations from raw materials (pre- and post-harvest), during processing and from handlers. Most of the unhygienic conditions during food processing are of great problem attributed to traditionally fermented-cereal foods (Sanni, 1993).

Food can be vehicle of transmission of diseases from person to person as well as serve as a growth medium for microorganisms that can cause foodborne illnesses (Shiklomanov, 2000). Most toxins from food sources are of fungal origin, and these start from fungal contamination of crops on the field to contaminations during storage (Oluwafemi et al., 2010; Rocha et al., 2014). Mycotoxins can appear in the food chain as a result of fungal infection of crops, which can be transmitted to humans by direct consumption or to livestock when used to prepare the feeds (Berger et al., 2005). The accumulation of mycotoxin in foods and feed represents a significant threat to human and animal health since the toxins are responsible for many different chronic health conditions, including cancer, digestive disorder, blood infection, and nerve defects (Reddy et al., 2011). There is a need to assess the microbial quality of fermented foods to ascertain their safety before consumption. Therefore, this study was carried out to provide essential information on microbial and mycotoxin contents of "Kati", a locally fermented cereal food in Akoko towns, Nigeria.

2. Materials and Method

2.1. Collection of cereal-based food 'Kati'

Samples of commercially prepared 'Kati' were collected at different stages of production from local producers in Akoko, Nigeria. The samples were aseptically transported in icepacks to the Microbiology laboratory, The Federal University of Technology, Akure for microbiological analysis. Likewise 'Kati' was hygienically prepared in the laboratory following food safety measures. Sorghum used for the preparation of 'Kati' in the laboratory was obtained from the King's market, Akure, Nigeria.

2.2. Preparation of 'Kati'

Commercial preparation of traditional fermented gruel was carried out by Akoko local producers (Figure 1). Briefly, 500 g of sorghum were washed with clean water and steeped in 1,000 mL of water. Thereafter, the water was removed and grains were wet milled using a local mill machine. The slurry was allowed to ferment for 24 h, after which, it was thoroughly mixed by hand-stirring and half-cooked for 15 min. The half-cooked 'Kati' was then molded and wrapped with two leaves; *Ficus carica* and *Thaumatococcus daniellii*. These medicinal leaves affirm particular flavour and aromatic characteristics to foods without any toxicity (Shukranul et al., 2013; Adeyemi et al. 2014). The wrapped 'Kati' was cooked in a pot under smoldering fire for 45 min. 'Kati' from laboratory was produced following the aforementioned steps except that possible hazards were controlled at various stages of production following HACCP stated in Jay et al. (2005).

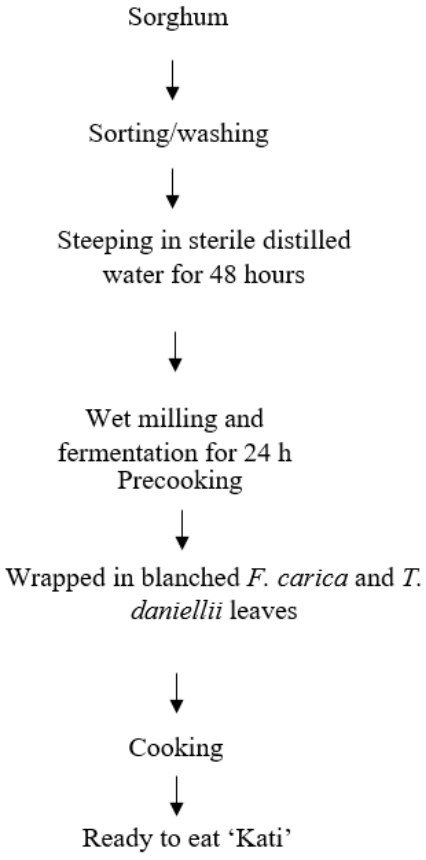


Figure 1. Steps involved in production of 'Kati'

2.3. Isolation of microorganisms from 'Kati' samples

A stock was prepared by taking 10 g of 'Kati' in 100 mL of sterile distilled water. Furthermore, 10-folds serial dilutions were carried out and 0.1 mL each of the highest dilution was cultured using pour plate technique. Microbial counts were enumerated on selective media as described by Jay et al. (2005) and Cheesbrough (2006).

2.4. Total aerobic plate count (TAPC)

Aliquots from diluted sample was plated on Nutrient agar (NA, Oxoid, Hampshire, UK) and the plates were incubated for 24 h at 37°C. The colonies were counted as colony forming unit per mL (CFU/mL) after incubation.

2.5. Staphylococcal count (SC)

Staphylococcal count was enumerated using Mannitol salt agar (MSA). Aliquots from sample dilution was plated on MSA followed by incubation at 37°C for 24 h. Colonies were counted as CFU/mL.

2.6. Coliform count (CC)

Enumeration of coliforms in the sample were carried out on MacConkey agar and incubated at 37°C for 24 h.

2.7. Lactic acid bacteria count (LABC)

Lactic acid bacteria were enumerated on de Mann Rogosa Sharpe agar (MRSA, Oxoid). Plates were incubated in anaerobic condition for 48 h at 30 °C. Thereafter, colonies were counted as colony forming unit per mL (CFU/mL).

Enumerated bacteria isolates were subjected first to morphological characterization and biochemical tests such as catalase, indole, urease, methyl red, oxidase, coagulase, motility, starch hydrolysis and sugar fermentation were performed according to method of Fawole and Oso (1995). The results of biochemical tests were interpreted to identify the bacterial isolates using Cowan and Steel (1993).

2.8. Mould and yeast count

Fungi were enumerated on Sabouraud Dextrose Agar (SDA) treated with chloramphenicol to inhibit bacteria growth. Spread plate method was carried out by transferring 0.1 mL of diluted sample on sterile SDA plates and evenly spread with the aid of a sterile glass spreader. The inoculated plates were incubated at 28 ± 2°C for 48 h. Fungal isolates were identified by macroscopic and microscopic techniques according to Samson et al. (2010) and Barnett et al. (2013).

2.9. Determination of mycotoxins in sorghum and 'Kati'

Traditional quantitative methods described by Klarić et al. (2009), Singh and Mehta (2020) were adopted to determine the level of aflatoxin, ochratoxin and fumonisin in sorghum and 'Kati'. Sample (5.0 g) were transferred into a 250 mL conical flask, while 50 mL of chloroform was added for extraction. The mouth of the conical flask with a plug and was shaken for 1 h. The sample was filtered in a separating funnel, while chloroform layer was allowed to filter through anhydrous sodium-sulphate. The extraction procedure was repeated twice using 30 mL chloroform, while filtrate was collected and concentrated. The filtrate of each sample was re-dissolved in 1 mL chloroform and 10 µl of the re-dissolved filtrates were applied on TLC plates for aflatoxin, ochratoxin and fumonisin presence. Standard solutions (0.25 µg) of aflatoxin, ochratoxin and fumonisin were spotted on TLC plates in parallel lane to the spotted sample filtrates. The plates were developed in a solvent system of toluene: ethyl acetate: formic acid (6:3:1 v:v:v) in a chromatographic tank for about 25 min thereafter, visualized under UV light (366 nm).

2.10. Statistical analysis

Data are presented as mean ± standard error (SD). A significant difference between different treatment groups was tested using One-way Analysis of Variance (ANOVA) using SPSS (Statistical Package for Social Sciences) version 20 software. For all tests, the significance was determined at the level of $P<0.05$.

3. Results

The microbial count of samples taken at the various stages of commercially prepared 'Kati' are shown in Table 1. The microbial load of the raw sorghum was found to be the highest, having a total count of 11.6±0.2 CFU/g. There was a gradual increase in the lactic acid bacteria count from 8.0±1.1 to 8.8±1.7 CFU/mL and in yeast cell counts from 6.1±0.2 to 7.1±1.1 CFU/mL during steeping, which corresponds to a general decrease in microbial load observed for coliforms and *staphylococcus* spp.,

which decreased from 8.4±0.3 to 0.6±0.1 CFU/mL and 6.9±1.3 to 4.9±0.3 CFU/mL, respectively. Following wet milling, there was increase in total microbial content of milled gruel from 6.9±0.9 to 11.5±0.4 CFU/mL, which were latter reduced to 5.8±0.2 CFU/mL during 24 h fermentation and to 3.9±0.0 CFU/mL during precooking stages of the gruel. An increase in total microbial load form 3.9±0.0 to 6.5±0.1 CFU/mL was observed after wrapping the dough in leaves, which may be as a result of contaminants from leaves. In contrast, the trends of microbial load observed at different stages of 'Kati' prepared in the laboratory appeared to be moderately lowered since various production stages has been hygienically and microbiologically controlled (Table 2). There was a decrease in mould count from 2.0±0.1 to 0.0±0.0 from washed sorghum to steeped sorghum. For the subsequent stages there was no observable mould counts recorded as lactic acid bacteria and yeast count increased from 5.7±0.0 and 3.02±0.0 in sorghum to 7.8±0.0 and 7.01±0.0 during fermentation, respectively. Following the 24 h fermentation, there was a general decrease in *Staphylococcus* count, coliforms and mould count.

Tables 3 and 4 show microorganisms and their occurrence (%) at different stages of processing commercial 'Kati' and Kati produced in the laboratory, respectively. The predominant microorganisms were *Lactococcus lactis* (30.6%) and *Saccharomyces cerevisiae* (32.6.3%) in commercial 'Kati'. Similarly, 'Kati' produced in the laboratory have the highest occurrence of *Lactococcus lactis* (31.4%) and *Saccharomyces cerevisiae* (55.6.3%).

Table 1. Microbial count ($\times 10^5$ CFU/g) of commercially produced 'Kati" at various stages

Processing steps	TAPC	SC	CC	LABC	MC	YC
Sorghums	11.6±0.2	5.2±0.3	5.7±0.8	8.7±0.0	6.7±0.0	4.1±0.1
Sorghums after washing	10.3±0.3	6.9±1.3	8.4±0.3	8.0±1.1	6.1±0.2	5.4±0.1
Sorghums after 72h steeping	6.9±0.9	4.9±0.3	0.6±0.1	8.8±1.7	7.1±1.1	5.8±0.1
Sorghums after wet milled	11.5±0.4	6.7±0.0	5.4±0.3	8.4±0.3	4.8±0.1	6.3±0.2
Fermented milled sorghum at 24h	5.8±0.2	4.5±0.4	2.3±0.1	9.9±0.0	4.1±0.0	6.9±0.0
Precooked Sorghum slurry	3.9±0.0	3.8±0.0	2.0±0.0	7.4±0.2	1.9±0.0	3.3±0.0
"Kati" wrapped in *T. daniellii* and *F. carica* leaves	6.5±0.1	5.8±0.0	2.6±0.0	7.0±0.1	4.7±0.2	4.4±0.1
Cooked "Kati"	4.1±0.2	3.3±0.2	2.2±0.2	6.2±0.0	0.2±0.0	1.2±0.0
Ready to eat "Kati"	5.3±0.3	2.4±0.3	1.0±0.0	7.1±0.0	2.6±0.4	1.5±0.3

Data are represented as mean ± standard error (n=3).

Keys: TAPC= Total aerobic plate count; SC= Staphylococcal count; CC= coliforms count; LABC= lactic acid bacteria count; MC= Mould count; YC= Yeast count

Table 2. Microbial count of samples taken at the various stages of the laboratory prepared 'Kati'

Processing steps	TAPC	SC	CC	LABC	MC	YC
Sorghum	7.6±0.2	5.2±0.3	0.0±0.0	5.7±0.0	5.6±0.0	3.0±0.0
Sorghum grains after washing	5.7±0.2	5.5±0.4	1.1±0.0	5.9±0.3	2.0±0.1	3.5±0.1
Sorghum grains after 72h steeping	6.5±0.4	4.9±0.3	1.6±0.0	6.8±0.0	0.0±0.0	4.8±0.0
Sorghum grains after wet milling	5.2±0.7	5.7±0.0	1.0±0.2	7.8±0.1	0.0±0.0	5.0±0.2
Fermentation at 24h	6.3±0.2	3.4±0.4	0.0±0.0	7.8±0.0	1.3±0.4	7.0±0.0
Precooked Sorghum slurry	5.0±0.2	0.0±0.0	0.0±0.0	3.9±0.0	0.0±0.0	1.3±0.1
"Kati" wrapped in blanched *T. daniellii* and *F. carica* leaves	5.9±0.1	0.0±0.0	0.0±0.0	3.5±0.5	0.0±0.0	1.1±0.0
Cooked "Kati"	4.8±0.1	0.0±0.0	0.0±0.0	4.1±1.6	0.0±0.0	0.2±0.00
Finished "Kati"	7.3±0.3	0.0±0.0	0.0±0.0	7.5±0.0	0.0±0.0	2.9±0.0

Data are represented as mean ± standard error (n=3).

Keys: TAPC= Total aerobic plate count; SC= Staphylococcal count; CC= coliforms count; LABC= lactic acid bacteria count; MC= Mould count; YC= Yeast count

Table 3. Occurrence (%) of microorganisms isolated at various stages of commercial 'Kati'

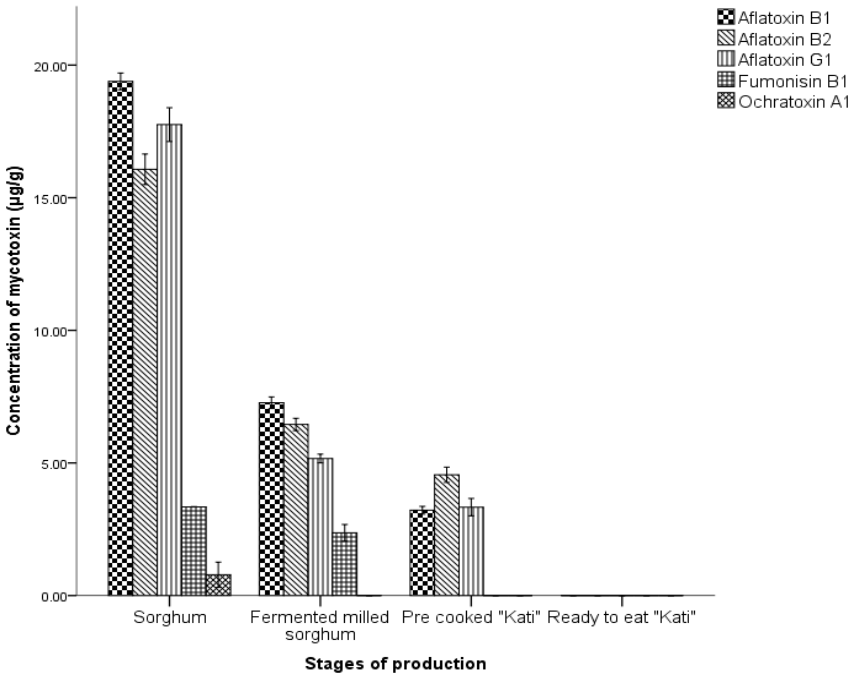
Bacterial Isolates	A	B	C	D	E	F	G	H	I	N	Occurrence (%)
Bacteria											
Lactococcus lactis	-	+	+	+	+	-	-	+	+	15	30.6
Lactobacillus brevis	-	+	+	-	+	-	+	+	-	10	20.4
Lactobacillus plantarum	-	-	-	+	+	+	+	+	+	10	20.4
Lactobacillus casei	-	-	-	+	-	-	+	+	+	8	16.4
Staphylococcus aureus	-	+	-	-	-	-	-	-	+	2	4.1
Escherichia coli	-	-	+	-	-	-	-	-	+	2	4.1
Pseudomonas aeruginosa	-	+	-	-	-	-	-	-	-	1	2.0
Bacillus licheniformis	-	-	-	-	+	-	-	-	-	1	2.0
Fungi											
Saccharomyces cerevisiae	-	-	+	+	+	+	+	+	+	14	32.6
Aspergillus flavus	+	+	+	+	-	-	-	-	-	10	23.2
Penicillium spp.	+	+	+	-	-	-	-	-	-	6	14.0
Fusarium spp.	+	+	+	-	-	-	-	-	-	6	14.0
Aspergillus niger	+	+	+	+	-	-	-	-	-	4	9.3
Candida albicans	-	+	+	-	-	-	-	-	-	2	4.6
Mucor mucedo	+	-	-	-	-	-	-	-	-	1	2.3

Keys: A- Sorghum, B- washed Sorghum, C- sorghum during 72 hours of steeping, D- wet milled sorghum E- 24 hours fermented and milled sorghum, F- Precooked ''Kati'', G- wrapped ''Kati'',
H- Cooked ''Kati'', I- finished ''Kati'', N- Number of isolates

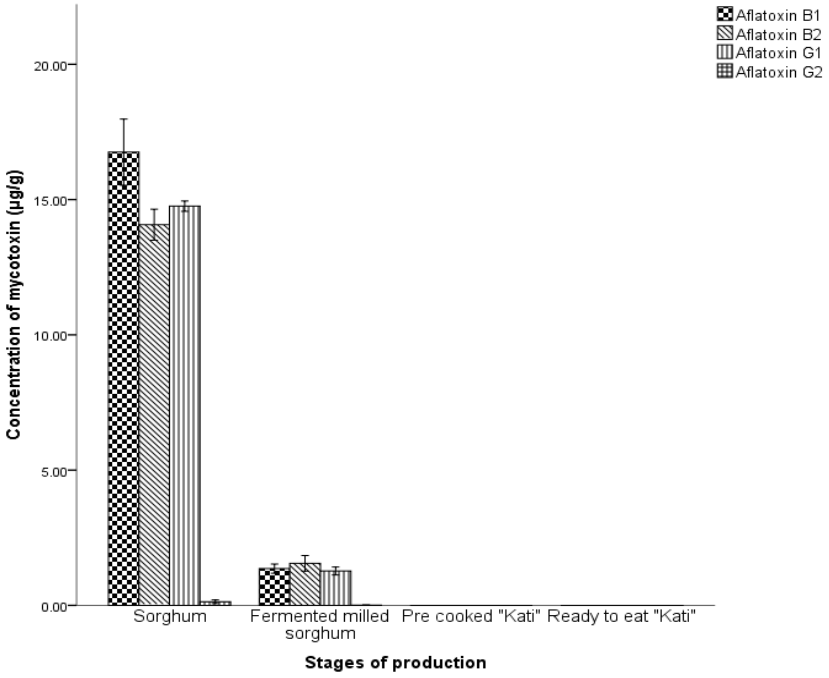
Table 4. Occurrence (%) of microorganisms isolated at various stages of 'Kati' produced in the laboratory

Isolates	A	B	C	D	E	F	G	H	I	N	Occurrence (%)
Bacteria											
Lactococcus lactis	-	_	+	+	+	+	+	+	+	11	31.4
Lactobacillus plantarum	-	-	-	+	+	+	+	+	+	10	28.5
Lactobacillus casei	-	-	-	-	-	-	+	+	+	8	22.8
Staphylococcus aureus	-	+	-	+	-	-	-	-	+	4	11.4
Escherichia coli	-	+	+	-	-	-	-	-	-	2	5.7
Fungi											
Saccharomyces cerevisiae	-	-	+	+	+	+	+	+	+	10	55.6
Aspergillus flavus	+	+	+	-			-	-	-	4	22.2
Candida albicans	-	+	+	-	-	-	-	-	-	4	22.2

Keys: A- Sorghum, B- washed Sorghum, C- sorghum during 72 hours of steeping, D- wet milled sorghum E- 24 hours fermented and milled sorghum, F- Precooked ''Kati'', G- wrapped ''Kati'',
H- Cooked ''Kati'', I- finished ''Kati'', N- Number of isolates



(a)



(b)

Figure 2. Mycotoxin in (a) commercially prepared 'Kati' and (b) 'Kati' prepared in laboratory at their various stages of production

Mycotoxin content of commercially and laboratory prepared 'Kati' at various stages of production were presented in Figure 2a and 2b, respectively. During sorghum fermentation of commercial 'Kati', there was a decrease in aflatoxin content as fermentation progressed. Aflatoxin B1 decreased from 19.4±0.3 to 0.7±0.4 µg/g, aflatoxin B2 decreased from 16.1±0.6 µg/g to 0.0±0.0 and aflatoxin G1 from 17.8 µg/g to 0.0±0.0 when compared to sorghum and ready to eat 'Kati'.

For 'Kati' prepared in the laboratory, aflatoxin B1 content decreased from 16.8±1.2 µg/g in sorghum to 0.0±0.0 in ready to eat 'Kati', 14.1±0.6 µg/g to 0.0±0.0 for aflatoxin B2, 14.8±0.2 µg/g to 0.0±0.0 for aflatoxin G1 and 0.1±0.1 µg/g to 0.0±0.0 for aflatoxin G2.

4. Discussion

This study focuses on the microorganisms associated with the processing of 'Kati', a traditionally fermented cereal-based food in Nigeria. The large array of microorganisms isolated at the different stages during the processing of commercially produced 'Kati' could be as a result of unhygienic practices such as the use of contaminated water, materials and hands when compared to 'Kati' hygienically produced in the laboratory. This corroborates with the findings of Danbaba et al. (2014). The researchers observed an increase in microbial contamination in fermented 'Kunun-zaki' made from millet whose production was not duly controlled by following HACCP procedures. The high microbial load observed from the commercially prepared 'Kati' could be as a result of grains not well sorted and washed before steeping, use of contaminated water, mill machine, hands, use of contaminated vessels during precooking and poor handling of the finished product. This corroborates with the findings of Ekwem and Okolo (2017) who revealed that higher microbial load could be externally introduced from producers or the processing materials during the fermentation of sorghum to 'Akamu'. The presence of *Staphylococcus aureus* in the fermented sorghum despite the control of critical points agreed with Danbaba et al. (2014). The researchers suggested that the possible source of *Staphylococcus aureus* are more carried in nasal passage, *Staphylococcus epidermidis* are carried on fingers and hands of processor during food processing. Franz et al. (2014) reported that fermented foods are hub of consortia of microorganisms since they are either present as natural indigenous microbiota in uncooked plant substrates, utensils, containers, earthen pots, or the environment. Microorganisms in some fermented cereal foods have been investigated by Hur et al. (2014) who studied traditional fermented cereal in many parts of the world and thus, revealed the presence of various microorganisms majorly LAB and *S. cerevisiae* in these fermented foods.

There was no coliform isolated from the grains, but subsequently, after 48 h of steeping, the coliforms were detected from the commercially processed of 'Kati'. This shows that the coliform could have been introduced through the water. This corroborates with the work of Ekwem and Okolo (2017), who reported presence of coliform in fermented and milled sorghum during the processing of Akamu, a Nigerian fermented gruel. Hence, application of hygienic procedures during fermentation need to be adopted and thus, serves as preventive measures to avoid microbial contaminates and food intoxicants during production.

Lactic acid bacteria significantly increased throughout the production processes. The bacteria play major roles in the production of cereal-based food. These microorganisms produce antimicrobial substances such as lactic acid, which reduces pH of the fermenting medium, produced bacteriocin, hydrogen peroxide and other organic acids that inhibit the growth of other microorganisms during fermentation (Reis et al., 2012). Wakil and Doudu (2011) revealed that lactic acid bacteria are the major players in fermenting maize gruel. Likewise, the findings of Olukoya et al. (1994) described lactic acid bacteria to be the dominant microorganisms during the fermentation of DogiK: an improved and supplemented 'Ogi'. There was a drastic reduction in the microbial load when the fermented milled sorghum was cooked. The elimination of microorganisms in the cooked gruel may due to high temperature applied during cooking. Oyarekua et al. (2015) suggested that reduction in microbial load of cooked, co-fermented walnut and maize used for production of 'Ogi' was as a result of the inactivation of some microbes or microbial metabolic activity by heat during the cooking of the gruel.

The presence of aflatoxin on the sorghum agreed with the findings of Rocha et al. (2014), who suggested that this could be as a result of mould contamination on the field or under improper storage condition of grains. Mycotoxin contamination of cereal crops by toxigenic fungal species such as *A. flavus*, *A. niger*, and *Fusarium verticillioides* during production and processing had been reported by Bhat et al. (2010). This has been a limitation to food safety and thus, has been unfavorably affecting the wellbeing of humans. Fungal contamination has been of higher incidence due to the humid tropical climatic conditions that produce a favourable environment for mycotoxin production (Mannaa and Kim, 2017). In contrast to the laboratory processed 'Kati', the commercially prepared 'Kati' have more of different toxin content. The presence of aflatoxin, fumonisin and ochratoxin could be as a result of fungi contamination of grains from the field, stores, during sales in the markets or unhygienic processing of 'Kati' by the residents, the utensils, packaging materials and poor handling since the critical points are not well controlled. This similar incidence of fungi and mycotoxins in fermented foods have been reported by Adekoya et al. (2018) who associated toxigenic fungi with pre- and post- harvest contamination of raw materials, poor processing techniques, and improper marketing practices. Likewise, findings from this research agreed with Adebo et al. (2019) who have reported mycotoxins; fumonisin B1 (FB1), B2 (FB2), B3 (FB3), T-2 toxin (T-2), zearalenone (ZEA), alpha-zearalenol (α-ZOL) and beta-zearalenol (β-ZOL) in cereal-based food; Ting', a Southern African food.

Although, after fermentation, mycotoxin level was substantially reduced. This corroborate with findings of Okeke et al. (2015) and Ezekiel et al. (2019) who reported a reduction of mycotoxin during maize fermentation to 'Ogi' and during the processing of different formulations of 'Kunu'. The subsequent reduction could be attributed to degradation of mycotoxins to less toxic products by fermenting microbiota that is; dominating lactic acid bacteria (LAB). Relatively low pH, high alcohol content, lactic acid and increase production of other relevant metabolites by LABs during fermentation could have instigated a better mycotoxin reduction during fermentation (Adebo et al., 2019). The increased acidity may provide some assurance of microbiological safety of the product, as most of the organisms count reduced with increased acidity and the mycotoxin levels in food are safely within the limits set by the Codex Alimentarius Commission (CAC, 1995).

Findings from Oluwafemi et al. (2010) reported that lactic acid bacteria will at any time remove about 31% to 46% aflatoxin B1 (AFB1) from any concentration level around 140 ng/g. El-Nezami et al. (2000) reported an average of 54% aflatoxin degradation within one minute when investigating the ability of two strains of *Lactobacillus rhamnosus* (GG and LC-705) and a *Propionibacterium* spp. to eliminate AFB1 from the intestinal luminal liquid medium of a chicken. According to Cao et al. (2011), degradation of aflatoxin was as a result of the cleavage of the difuran ring of the aflatoxin molecule by the antimicrobial products produced by the bacteria.

5. Conclusions

Findings from this study revealed the presence of high microbial loads and the presence of mycotoxins in sorghum have a public health implication. This makes considerations such as good agricultural practices (GAP), Good manufacturing practices as well as Hazard analysis critical control points (HACCP) imperative. The drastic reduction of contamination in the laboratory processed 'Kati', suggests a hygienic practice when processing 'Kati'. This immensely reduces hazards associated with cereal-based foods. Safety measures such as controlling hazards at the different stages during food production or fermentation using HACCP procedures improve the food safety and quality of foods. The use of lactic acid bacteria as starter culture during the fermentation of sorghum for 'Kati' production can also be adopted to further enhance the detoxification of aflatoxins. This eliminates the tendency of aflatoxicosis incidence among food consumers.

Authors' contributions. BJA and COO designed the studied work. POG and AMA carried out the study and was supervised by BJA and COO. COO and POG prepared the manuscript. All authors read and approved the final manuscript.

Competing interests. Authors declared no competing interests

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards. Authors declare that they present their own literature survey and results/discussion/conclusion in the article.

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