INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 22, No. 2, p. 148-155, 2023

RESEARCH PAPER OPEN ACCESS

Public health implications of microbial contamination of restaurant tables in Abraka

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Key words: Microbiological, Table, Public, Health, Restaurants.

http://dx.doi.org/10.12692/ijb/22.2.148-155 Article published on February 08, 2023

Abstract

Foodborne diseases include an array of illnesses triggered by the ingestion of foods contaminated with microorganisms or chemicals, and the area where people eat is one of the significant sites from where microorganisms find their way into food. This study is aimed to microbiologically evaluate the table surfaces of some local restaurants within Abraka, Delta state. A total of fifteen samples collected from fifteen random restaurants within Abraka, Delta State, were evaluated for their microbial quality using standard procedures. The Bacteria counts ranged from 2.5×10^5 to 7.0×10^6 (CFU/ml), while the fungal counts ranged from 5.0×10^4 to 4.7×10^6 (CFU/ml). Microorganisms isolated were *Enterobacter spp* (13.33%), *Staphylococcus aureus* (53.33%), *Staphylococcus spp* (66.67%), *Klebsiella spp* (20.00%), *Aspergillus spp* (6.67%), *Candida albicans* (40.00%) and *Trichophyton spp* (6.67%). The result of this study showed a high prevalence of pathogenic organisms present on the tested table surfaces which include *Candida albicans* and *Staphylococcus spp* etc. The result revealed a high microbial count suggesting an increased possibility of cross-contamination which could lead to various gastrointestinal infections that can give rise to health hazards and also place an economic strain on the population. To curb this, there is a need for government legislation to be put in place to enforce proper microbial safety within all forms of food processing and handling facilities.

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Introduction

Eating at restaurants is a dietary pattern that used to be foreign but has gradually become a part of the lifestyle of people in Nigeria, especially those in urban areas (Konwea, 2012), and most of these eating stalls, especially around markets and in less urban areas in Nigeria are plagued by unsanitary conditions, including poor water supply and poor drainage systems, unsanitary waste disposal and overcrowding, resulting in poor personal and environmental hygiene (Onyeneho and Hedberg, 2013). Foodborne illnesses have become a major cause of morbidity and mortality, posing a major public health challenge globally and contributing to a marked economic loss and reduction in quality of life and productivity (Scharff, 2012). Although there are no reliable estimates for the burden of diarrheal diseases alone, it, however, makes up a sizable proportion of foodborne diseases. It is estimated that 1.9 million children die globally every year due to foodborne infections (WHO, 2015). Foodborne infections can result from a number of factors, such as poor hygienic practices, use of contaminated water, poor quality foodstuff, contaminated work surfaces, contaminated food packs and even food handlers. A number of studies have been done to ascertain the sources of food contamination. These include water analysis (Akpo and Umukoro, 2019), food analysis (Bukhari *et al.,* 2021), microbiological analysis of food handlers (Ifiora *et al.,* 2020) and more.

The safety of foods served in restaurants in Nigeria has been an ongoing concern. Health experts in Nigeria have said that the shortage of water may affect the success of any food safety campaigns. Food contact surfaces such as plates, to a large extent, are properly disinfected because they come in contact with food and there is a conscious effort by the restaurant staff to disinfect them properly. The same cannot be said for non-contact surfaces such as table surfaces and chairs that do not come in direct contact with food. These table surfaces can serve as a potential reservoir for microorganisms as they are not thoroughly cleaned and could just be wiped down with a wet rag, usually done in a hurried manner to save time and create space for newer customers.

There are a lot of unexplained illnesses that surface in our immediate environment, the most common being gastrointestinal tract infections which are mostly transmitted through food. These illnesses occur mostly as a result of contaminated food or water and are generally overlooked due to their not-so-severe nature. This is also a leading cause of drug misuse in our society.

Contaminated food can have severe detrimental effects on the health of all individuals, particularly school children, as children have poorly developed immunity compared to adults.

Gastrointestinal tract infections are very common and diarrhoea is the most prevalent symptom. Diarrhoea may occur for varied reasons; however, most episodes of diarrhoea in developing countries are infectious in origin. Three clinical forms of diarrhoea (acute watery diarrhoea, invasive diarrhoea, and persistent diarrhoea) have been identified to formulate a management plan (Alam and Ashraf, 2003). Organisms such as *Staphylococcus aureus, Bacillus cereus, Clostridium perfringens, Clostridium botulinum, Escherichia coli, Salmonella species, Shigella species, Campylobacter species, Yersinia enterocolitica, Clostridium difficile, Vibrio cholerae, Vibrio parahaemolyticus, Listeria monocytogenes, Aeromonas hydrophila, Plesiomonas species,* etc. Also, Viruses such as *Rotaviruses, Norwalk virus, Noroviruses (Norwalk-like viruses), Adenoviruses, Astroviruses, other Caliciviruses, Parvoviruses,* etc., can cause mild to severe GIT infections.

Public spaces are an important source of pathogenic microorganisms and can be a springboard for infectious disease outbreaks due to poor or non-effective microbial control measures applied (Querido *et al.,* 2019). Local eateries or restaurants are places where people don't just go to eat when hungry, but also the restaurants serve as a platform for interaction between people. The table surfaces in these places could also act as a reservoir for microorganisms. This can occur due to food droppings on the table surfaces, exudates and saliva dripping from various humans, directly from raw or under-processed foods, unsanitized hands of the people, packaging materials, contaminated or poorly washed kitchen wares, and cleaning wipes or lack of microbial awareness of the restaurant staff as people consider the visual sign of sanitation and cleanliness as the key criteria to be a good food handling surface (Paul *et al.,* 2019). The general public is sparsely aware of these pathogenic microorganisms and the possibility of developing infections is very high. Therefore the need to access and properly disinfect table surfaces in restaurants can't be over-emphasized.

A previous study done in Northern Nigeria (Kaduna State) revealed the presence of *Escherichia coli* on food contact surfaces (Mohammed *et al.,* 2018). In a similar study in India, Paul *et al.* (2019) isolated *Staphylococcus aureus, Enterobacter spp, Klebsiella spp., Pseudomonas aeroginosa, Corynbacterium xerosis and Escherichia coli.* Molecular studies should further be done in order to investigate the genes involved in the contamination and any associated risks.

The need has arisen for the general public to be enlightened on maintaining hygienic practices at all times. It is therefore imperative that restaurant table surfaces are kept clean and properly disinfected. The objective of this study is to determine the microbial load of the restaurant tables by bacterial counts and; to isolate and identify the bacteria and fungi present on those surfaces.

Materials and methods

Study area

Abraka is a town located in Ethiope East Local Government Area of Delta State. The indigenes are of Urhobo ethnicity. However, it holds Delta State University which consists of three (3) sites where undergraduates from every part of the country study.

All the reagents and equipment used for this work were employed in the laboratory of the Department of Pharmaceutical Microbiology, Faculty of Pharmacy Delta State University, Abraka.

Sampling

Samples used for this study were collected from fifteen restaurants randomly selected within Abraka. All samples were tested to ascertain the microbial load as well as the presence of pathogenic microbial contaminants using the spread plate technique and other standard microbiological and biochemical methods.

Bacterial and fungal counts were done by taking an aliquot of 0.1 ml of each sample from 10^4 dilutions of the serially diluted sample. The dilution was spread onto nutrient agar (NA) plates for the enumeration of bacteria and on sabouraud dextrose agar (SDA) plate for the estimation of fungal load (Querido *et al.,* 2019; Paul *et al.,* 2019). The plates were incubated at 37 ^oC for 24 and 72 hours, respectively.

For the enumeration of specific pathogens, a volume of 0.1 ml was taken from the 10^{-4} dilution of each sample and spread on MacConkey agar, Mannitol salt agar (MSA) and Cetrimide agar. All plates were incubated at 37 ^oC for 48 hours, adopting the method of (Alao and Nejo, 2017). Biochemical tests were carried out for the further identification of the isolates Das *et al.,* 2013). Lactophenol cotton blue stain was used for the identification of filamentous fungi, while the germ tube test was used for yeasts.

Results

The total microbial counts of samples obtained from the tested restaurant table surfaces within Abraka, Delta state, for the period of analysis are presented in Table 1. The bacterial counts ranged from 2.5×10^5 to 7.0×10^6 CFU/ml, while the fungal counts ranged from 0 to 4.7×10^6 CFU/ml.

Table 2 presents the microbial count and the inferred organisms from various selective and differential media.

The bacteria isolated from the tested restaurant table surfaces and their frequency of occurrence is shown in Table 3. The microorganisms isolated were *Enterobacter spp* (13.33%), *Staphylococcus aureus* (53.33%), *Staphylococcus spp* (66.67%), *Klebsiella spp* (20.00%), for the bacteria, and *Aspergillus spp* (6.67%), *Candida albicans* (40.00%) and *Trichophyton spp* (6.67%) for the fungi.

Table 1. Total Microbial Count (CFU/ml) from Table Surfaces of Public Local Restaurants in Abraka.

	Total microbial count	
Samples	Total bacterial count (CFU/ml)	Total fungal count (CFU/ml)
A	1.5×10^6	0
B	2.5×10^5	0
C	5.0×10^5	0
D	4.0×10^5	5.0×10^4
E	5.5×10^5	1.0×10^5
F	4.0×10^5	5.0×10^4
G	3.5×10^5	5.0×10^4
H	3.4×10^6	1.4×10^6
I	3.4×10^6	5.0×10^4
J	1.5×10^6	0
K	4.5×10^5	5.0×10^5
L	2.0×10^6	0
M	7.0×10^6	4.7×10^6
N	6.2×10^6	0
O	1.3×10^6	0

Discussion

This study investigated the microbial safety of table surfaces of selected public local restaurants in Abraka. The total bacterial count, as shown in Table 1, ranges from 2.5×10^5(CFU/ml) to 7.0×10^6(CFU/ml) and the total fungal count ranges from 5.0×10^4(CFU/ml) to 4.7×10^6(CFU/ml). It is interesting to note that samples from Restaurant M had the highest bacterial as well as fungal counts. In a similar study, the table surfaces of the Out Patient Department of a tertiary care hospital in Ahmedabad were evaluated for bacterial contamination, where an increase in the mean bacterial count with time was observed (Mehta *et al.,* 2020). In another study, microbial counts were done on surfaces in contact with food in a hospital kitchen. The table surfaces in winter and summer had microbial counts ranging from ‹ 1 to 3.67 logarithmic colony forming units /100cm, with aerobic bacteria having the highest counts in summer and *E. coli* the least count in winter (Yousif *et al.,* 2013).

High microbial counts and the type of microorganisms implicated are among the microbe-associated factors which determine the likelihood of infection (Fraser *et al.,* 2007).

Table 2 shows that there was no growth on the Cetrimide agar, indicating the absence of *Pseudomonas aeruginosa*. This is in consonance with the work of (Mehta *et al.,* 2020, Yousif *et al.,* 2013 and Mohammed *et al.,* 2018). Bacterial counts from table surfaces of Restaurants A, B and C have obtained only in MacConkey agar, with Restaurant A tables having the highest count of 6.5×10^5 CFU/ml. The table surfaces of Restaurants D, E, F and G had bacterial counts in MacConkey agar (with a range of 1.0×10^5 - 2.0×10^5 CFU/ml) and fungal counts (ranging from 4.0×10^4 - 1.0×10^5 CFU/ml). Bacterial counts were determined in samples obtained from the table surfaces of Restaurants H, I, M, N and O in MacConkey agar and Mannitol Salt agar (yellow), and fungal counts in Saboraud dextrose agar. Samples from Restaurant J produced bacterial counts in Mannitol Salt Agar (yellow and red), while those from Restaurant K showed microbial counts in all the selective media except Cetrimide agar. Samples from Restaurant L had a bacterial count of 1.7×10^6 CFU/ml in Mannitol Salt Agar (yellow) only.

Restaurant M had the highest total bacterial count (7.0×10^6 CFU/ml), the highest fungal count (4.7 ×

10^6 CFU/ml) and the highest *Staphylococcus aureus* count (5.7×10^6 CFU/ml) of all the samples tested. It is, therefore, the restaurant with the greatest contamination among the table surfaces tested. However, Restaurant B had the least total bacterial count (2.5×10^5), the least count on MacConkey agar and no count in the other media employed for the enumeration of microorganisms.

Table 2. Microbial count (CFU/ml) of samples obtained from table surfaces of public local restaurants on various media.

Sample	Cetrimide agar	MacConkey agar (Mac)	Mannitol Salt Agar (MSA) (yellow)	Mannitol Salt Agar (MSA) (Red)	Sabouraud dextrose agar
A	0	6.5×10^5	0	0	0
B	0	2.0×10^5	0	0	0
C	0	3.0×10^5	0	0	0
D	0	1.5×10^5	0	0	5.0×10^4
E	0	2.0×10^5	0	0	1.0×10^5
F	0	1.5×10^5	0	0	5.0×10^4
G	0	1.5×10^5	0	0	5.0×10^4
H	0	1.0×10^6	3.6×10^6	0	1.4×10^6
I	0	1.0×10^5	3.1×10^6	0	5.0×10^4
J	0	0	1.2×10^5	5.5×10^5	0
K	0	1.0×10^5	2.5×10^5	5.0×10^4	5.0×10^5
L	0	0	1.7×10^6	0	0
M	0	5.0×10^6	5.7×10^6	0	4.7×10^6
N	0	4.3×10^6	3.7×10^6	0	0
O	0	6.5×10^5	1.0×10^5	0	0
Organism identified	Nil	*Staph spp, Enterobacter spp, Klebsiella spp*	*S. aureus*	*Staph spp*	*Candida albicans, Trichophyton spp, Aspergillus spp*

MacConkey agar yielded *Staphylococcus spp*, *Enterobacter spp*, *Klebsiella spp*, the Mannitol salt agar yielded *Staphylococcus aureus* as yellow colonies and *Staphylococcus spp* as red colonies, the Sabouraud dextrose agar yielded growth of *Candida albicans, Trichophyton spp, Aspergillus spp*. This is similar, to an extent, to work done by (Paul *et al.,* 2019) in India, where *Staphylococcus aureus, Enterobacter spp, Klebsiella spp,* other organisms such as *Pseudomonas aeroginosa, Corynbacterium xerosis and Escherichia coli* were found present on table surfaces. The difference in organisms identified could be due to simple coincidence or maybe a difference in the bacteria endemic to the regions in question, Nigeria and India. On the contrary, *S. aureus* was not present on the surfaces of tables, plates, chopping boards and spoons from five restaurants assessed for bacteria at Kaduna State University (Mohammed *et al.,* 2018). *Staphylococcus spp* had the highest frequency of occurrence at (66.67%), and *Staphylococcus aureus* had a (53.33%) frequency of occurrence.

This is contrary to the work of (Biranjia-Hurdoyal and Latouche, 2016), where the frequency of *S. aureus* isolated from table surfaces was 14.20%. *Klebsiella spp* had a (20.00%) frequency of occurrence and *Enterobacter spp* had the lowest frequency of occurrence with it, accounting for only (13.33%) of the total microorganisms identified, while *Aspergillus spp* and *Trichophyton spp* each made up (6.67%) of the total microorganisms isolated. However, *Candida albicans* was the most prevalent fungi with a 40.00% frequency of occurrence.

Staphylococcal species foodborne disease (SFD) is one of the most common foodborne diseases worldwide resulting from the contamination of food by preformed S. aureus enterotoxins. It is one of the most common causes of reported foodborne diseases in the United States. Although several Staphylococcal enterotoxins (SEs) have been identified, Staphylococcus Enterotoxin A (SEA), a highly heat-stable SE, is the most common cause of SFD worldwide (Kadariya *et al.,* 2014). *Staphylococcus aureus* can produce a wide variety of toxins including staphylococcal enterotoxins with demonstrated emetic activity and staphylococcal-like proteins, which are not emetic in a primate model (Argudin *et al.,* 2010). The genus *Enterobacter* is a member of the ESKAPE group, which contains the major resistant bacterial pathogens, *Enterobacter aerogenes* and *Enterobacter cloacae*. The complex exhibited a multidrug-resistant phenotype, which has stimulated questions about the role of cascade regulation in the emergence of these well-adapted clones (Davin-Regli *et al.,*2019). Though some species of Klebsiella, such as *Klebsiella pneumoniae* are not generally recognized as a foodborne pathogen, *Klebsiella pneumoniae* was shown to be capable of causing nosocomial infection being foodborne. *Klebsiella oxytoca* can cause gastroenteritis.

Table 3. Microbial isolates and the frequency of occurrence on table surfaces of selected public local restaurants in Abraka.

Organisms	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Frequency of Occurrence (%)
Enterobacter spp	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	13.33
Staphylococcus aureus	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	53.33
Staphylococcus spp	+	+	+	+	+	+	+	+	-	+	+	-	-	-	-	66.67
Klebsiella spp	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	20.00
Candida albicans	-	-	-	+	+	+	+	-	-	-	+	-	+	-	-	40.00
Trichophyton spp	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	6.67
Aspergillus spp	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	6.67

KEY: Spp…species.

Fungi of the genus *Aspergillus* are widespread in the environment Ifiora *et al.* (2020). Some Aspergillus species, most commonly *Aspergillus fumigatus,* can lead to a variety of allergic reactions and life-threatening systemic infections in humans, especially children. Invasive aspergillosis can occur in patients with severe immunodeficiency Paulussen *et al.* (2017).

The prevalence of GIT infections and foodborne bacterial infections has a major and perhaps an increasing effect on the public health and economy of developing countries. It is difficult to determine the exact mortality associated with bacterial infections that are usually foodborne. The quantification of the public health impact of bacterial foodborne infections is further complicated by their interaction with chronic underlying diseases and associated conditions. Most foodborne gastrointestinal infections are self-limiting. However, in a subset of patients, such as neonates, the elderly and patients with underlying health conditions, they can cause severe complications and increased risk of death Helms *et al.,* 2003).

The results of this study show a budding problem due to the lack of proper microbial awareness and hygiene which could lead to various GIT illnesses and, ultimately, to antibiotic abuse and microbial resistance.

Conclusion

The results of this research show a high level of contamination of the restaurant table surfaces tested. The high levels of microbial contaminants seen therefore indicate a high possibility of cross-contamination and the spread of foodborne diseases, which can be caused by microorganisms that get into food from different sources. One such source is the contaminated table surfaces from where bacteria can readily come in contact with food directly or indirectly through our hands which can carry bacteria into the food. It is important for regular disinfection to be done on each table in order to reduce or eliminate microbial contaminants. To nip this problem in the bud, restaurant owners, restaurant staff, both cooking and waiting, and even customers need to maintain proper hygiene and standard microbial safety practices. Alternatively, the government should impose legislation to enforce strict regulations for the maintenance of proper hygienic standards in all establishments related to food processing, food storage and especially food vendors and serving areas.

Acknowledgement

Conflict of interest statement

None declared

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