American Journal of Microbiological Research, 2016, Vol. 4, No. 2, 51-55
Available online at http://pubs.sciepub.com/ajmr/4/2/1

DOI:10.12691/ajmr-4-2-1

Effects of High Customer Patronage on the Indoor Air Quality of Restaurants in Lokoja Metropolis and Its Public Health Impact

Udochukwu U.[1,*], Inetianbor J.[2], Omorotionmwan F.O.[3], Okpuruka N.S.[1]

[1]Department of Biosciences, Salem University-Lokoja, KogiState, Nigeria
[2]Department of Microbiology, Federal university Wukari, Taraba State, Nigeria
[3]Department of Microbiology, University of Benin, Edo State, Nigeria
*Corresponding author: rev.dr.ud@gmail.com

Abstract Indoor air is an essential environment for healthy living and it can become a dominant source of contaminants when it is incorporated with complex mixture of biological and non-biological particles as a result of human activities. The effect of high customer patronage on the indoor air quality of restaurants in Lokoja metropolis and its public health impacts was investigated. Twelve restaurants were sampled; seven from Lokoja-Abuja highway and five from IBB way using standard microbiological assays and biochemical test such as citrate utilization test, urease test, catalase test, indole test, oxidase test and coagulase test. Bacteria isolated from the sampled restaurants were *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Streptococcus pyogenes, Escherichia coli* and *Micrococcus luteus*. The airborne fungal isolates were *Aspergillus niger, Aspergilus flavus, Penicillium chrysogenum, Rhizopus stolinifer, Fusarium oxysporum and Clasdosporium fulvum*. Restaurant B on the Lokoja-Abuja high way has the highest bacterial count of 400cfu per minute of exposure while restaurant Y on the IBB way has the lowest bacterial count of 25cfu per minute of exposure. Restaurant B has the highest fungal count of 6.0 cfu per minute of exposure while restaurant Z has the lowest count of 1.5 cfu per minute exposure. *Escherichia coli was* the mostly distributed bacteria while *Streptococcus pyogenes* was the least distributed. *Rhizopus stolinifer* was the highest fungal distributed and *Clasdosporium fulvum* the least. Human activities contribute to the indoor air quality of these restaurants and this could pose a danger to customers especially the immunocompromised customers which will have a concomitant effect on the patronage of the restaurants. Proper sanitation, personal hygiene and good ventilation system is recommended to avoid contamination of food and spread of diseases.

Keywords: *high customer patronage, indoor air quality, restaurants, public health, microbial counts*

Cite This Article: Udochukwu U., Inetianbor J., Omorotionmwan F.O., and Okpuruka N.S., "Quality of Restaurants in Lokoja Metropolis and Its Public Health Impact." *American Journal of Microbiological Research*, vol. 4, no. 2 (2016): 51-55. doi: 10.12691/ajmr-4-2-1.

1. Introduction

Indoor air is the most vital environment with respect to our health besides being a dominant source of contaminants. It contains a complex mixture of biological and non-biological particles incorporated with dust [1]. Among these, microbiological contaminants confer a considerable meaning in the elevation of indoor air pollution as they can be pathogenic or may cause allergic reactions, trigger the respiratory problems after inhalation and cause adverse health effects [2]. Air movements favor the maintenance of microorganisms in the aerial media while their deposition is barely affected by gravity due to their small size. The number of occupants or visitors that patronizes a restaurant amongst other factors affects the indoor air quality within the restaurant environment [3]. The location and position of toilet in a restaurant, the number of persons and the frequency at which people move from the hall to the toilet contributes to its indoor air quality. Also factors as temperature, humidity, light and nutrient availability are determinants of microbial survival and abundance. Dampness shows that moisture damage and mould problems of buildings are strongly associated with adverse health outcomes. These include asthma and allergy, sick building syndrome (SBS), (chronic) respiratory infections, dry cough, eye irritations, skin symptoms including dermatomycosis, and non-specific symptoms as well as neurological problems, hypersensitivity pneumonitis, and rheumatic diseases. The type of ventilation system affects microbial concentrations in indoor environments [3]. Mechanical ventilation is more efficient than natural ventilation in filtering particles from the intake air and in removing pollutants. This difference is also reflected in microbial concentrations, which in naturally ventilated buildings can be 2 – 7 times higher than in buildings with mechanical ventilation [4,5]. There are also differences between mechanical ventilation systems: with a mechanical exhaust or fan coil unit system, microbial concentrations were reported to be higher than where there were mechanical supplies and exhaust systems or an air

handling units [6]. This is probably due to more effective filtering of the intake air. Fungi may also originate from contamination in special building structures, e.g. the crawl space [7]. Fungi are distributed in the building due to an under-pressure inside the building caused by mechanical ventilation, which is a normal situation in cold climates. The number of persons that visits the restaurant per hour greatly affects the indoor air quality of that restaurant. According to [3], who studied the microbial profile of student's dormitories in the University of Port-Harcourt. It was observed that the microbial load was influenced by the number of occupants in various dormitories and rooms. The relationship between the number of occupants and the microbial load is connected with the fact that humans are partly responsible for the distribution of airborne pathogens. It is known that a mere sneeze and cough in an enclosed room may release microorganisms (about 200miles/hour; 100ms-^{1}) from the mouth and lungs into and around the air, through millions of tiny droplets. These droplets contain living microorganisms and can remain suspended in air for hours or days. It means that all rooms attended by many visitors and costumers will be extremely exposed to risk of high microbial contamination [3]. The 'normal' air flora should be quantitatively lower than, but qualitatively similar to, that of outdoor air. The presence of one or more fungal species at significant levels in indoor samples is evidence of an indoor amplifier. Pathogenic fungi such as *Aspergillus fumigatus, Histoplasma* and *Cryptococcus* should not be present in significant numbers [8].The aim of this research is to compare the indoor air quality of those restaurants on the Lokoja-Abuja high and that of the IBB way which served as the control. The indoor air quality for this research was determined by random sampling of several restaurants on the two the major roads in lokoja town.

2. Materials and Methods

The study area, Lokoja, is located between latitudes $7^{0}46^{1}$N- $7^{0}52^{1}$ and longitudes $6^{0}38^{1}$E - $6^{0}46^{1}$. Lokoja is a transit city situated in the north central geopolitical zone of Nigeria. It can be said to be the center of Nigeria since it has border with the north, the east, the south and the west. Almost every movement by commuters across any of the geopolitical zones usually passes through Lokoja. This is the reason for the high patronage of fast food and restaurants experienced in Lokoja and this high patronage in turn exert lots of pressure which affects the air quality of restaurants in Lokoja especially those on the Lokoja-Abuja high way. Inside Lokoja town, there is another major road called the IBB way which also has some restaurants on it. The restaurants on this road do not have high customer patronage as that of the Lokoja-Abuja high way. Seven restaurants designated A, B, C, D, E, F and G were sampled along the Lokoja-Abuja high way and five restaurants; V, W, X,Y and Z were sampled along the IBB way. Samples were collected by plate sedimentation method and viable counts (bacterial and fungal) were determined both in the presence and absence of human activities [9]. This was done by placing duplicates of open sterile Petri-dishes containing already prepared nutrient agar medium and Sabouraud dextrose agar on floor in each room and they were exposed to the air in the rooms for 20 minutes in the afternoon [3]. Nutrient agar was for the isolation of culturable heterotrophic bacteria while the sabouraud dextrose agar was for fungi isolation. The samples were transported immediately to the laboratory and the nutrient agar plates after exposure were inverted and incubated for 18-24 hours at 37°C while plates of sabouraud dextrose agar were inverted and incubated at 28±2°C and observed daily for about 3days [10]. All observed colonies were sub-cultured and pure isolates identified. Each different appearing fungal culture isolate was transferred with a sterile needle to a sterile slide, stained with a drop of lacto phenol cotton blue and then examined macroscopically and microscopically to aid identification [11]. The bacteria isolates were identified using various biochemical tests such as citrate utilization test, urease test, catalase test, indole test, oxidase test and coagulase test [12,13].

3. Results and Discussion

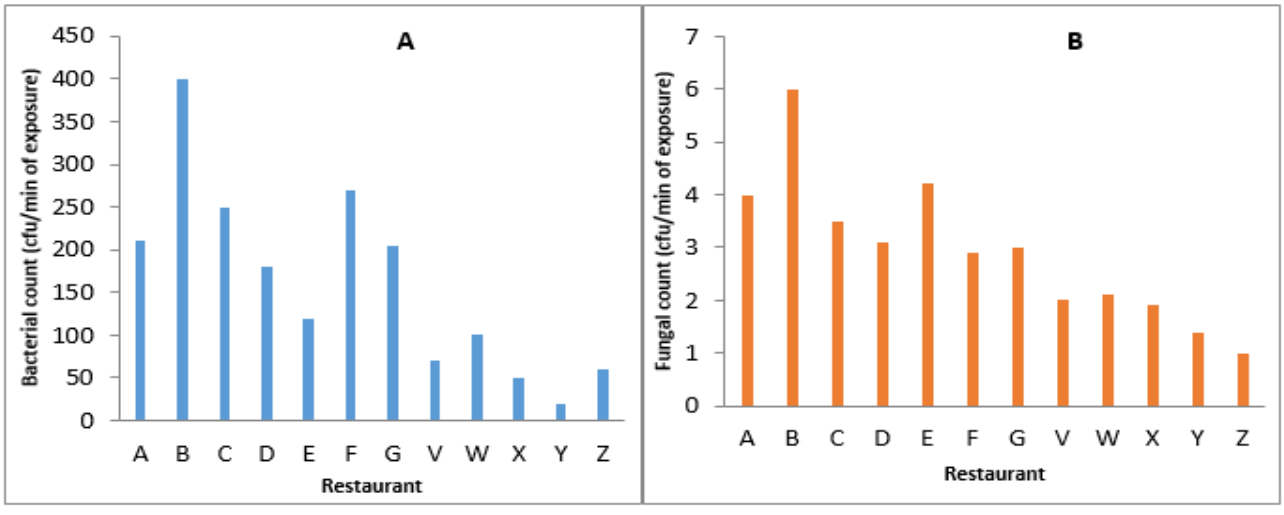

Figure 1. Total microbial count of the indoor air in the sampled restaurants along Lokoja-Abuja highway and IBB way. (A) Bacterial count of the indoor air with restaurants B and Y having the highest and least count respectively. (B) Fungal count of the indoor air with restaurants B and Z having the highest and least count respectively

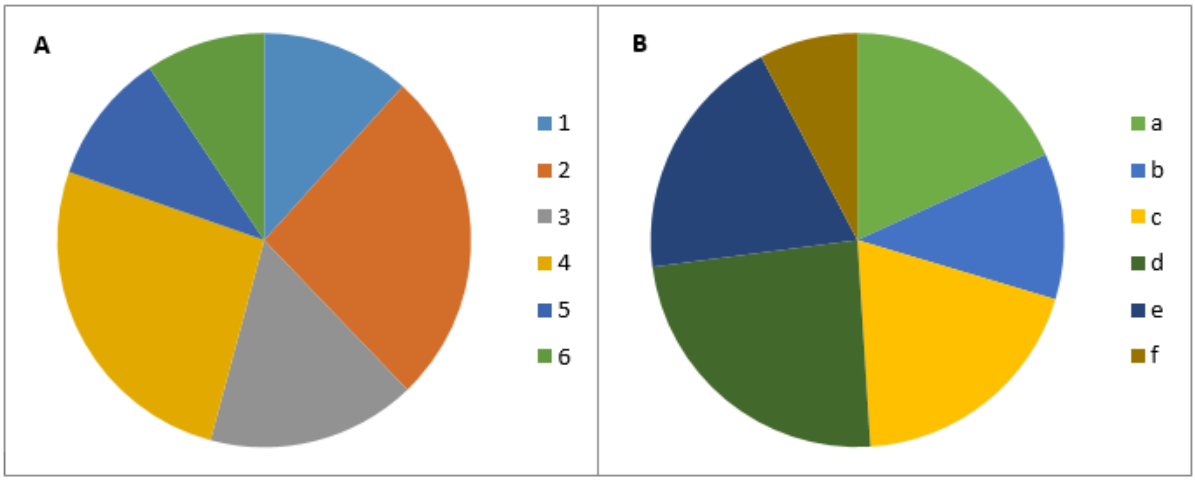

Figure 2. Distribution of isolated microbes in the sampled restaurants in Lokoja metropolis. (A) Frequency of bacterial isolates with *Escherichia coli* with the highest distribution and *Streptococcus pyogenes* with the least distribution. (B) Frequency of fungal isolates with *Rhizopus stolinifer* with the highest distribution and *Clasdosporium fulvum* the least distributed.

Key: 1 = Micrococcus luteus, **2** = Staphylococcus aureus, **3** = Bacillus subtilis,**4** = Escherichia coli, **5** = Pseudomonas aeruginosa,**6** = Streptococcus pyogenes, **a** = Aspergillus niger, **b** = Aspergilus flavus, **c** = Penicillium chrysogenum, **d** = Rhizopus stolinifer, **e** = Fusarium oxysporum and **f**= Clasdosporium fulvum.

Table 1. Bacteria isolates from restaurants on Lokoja-Abuja high way

Isolates	V	W	X	Y	Z	F	G	% Frequency
Micrococcus luteus	+	+	+	-	+	-	+	71.40
Staphylococcus aureus	+	+	+	+	+	+	+	100
Streptococcus pyogenes	-	+	+	-	+	+	-	57.10
Bacillus subtilis	+	+	+	+	+	+	+	100
Escherichia coli	+	+	+	+	+	+	+	100
Pseudomonas aeruginosa	-	+	-	+	+	-	-	42.90

Key: += Present and - = Absent.

Table 2. Bacteria isolates from restaurants on IBB way

Isolates	V	W	X	Y	Z	% Frequency
Micrococcus luteus	-	-	-	-	-	0.00
Staphylococcus aureus	+	+	-	+	-	60.00
Streptococcus pyogenes	-	-	-	-	-	0.00
Bacillus subtilis	+	-	-	+	-	40.00
Escherichia coli	-	+	-	+	+	60.00
Pseudomonas aeruginosa	+	-	-	-	-	20.00

Key: += Present and - = Absent.

Table 3. Fungal isolates from restaurants on Lokoja-Abuja high way

Isolates	V	W	X	Y	Z	X	G	% Frequency
Aspergillus niger	+	-	+	+	+	-	+	71.40
Aspergilus flavus	-	+	+	+	-	+	-	57.10
Penicillium chrysogenum	-	+	+	+	+	-	+	57.10
Rhizopus stolinifer	+	+	+	+	+	+	+	100
Fusarium oxysporum	-	+	-	-	+	+	-	57.10
Clasdosporium fulvum	+	-	-	-	+	-	-	28.60

Key: += Present and - = Absent

Table 4. Fungal isolates from restaurants on IBB way

Isolates	V	W	X	Y	Z	% Frequency
Aspergillus niger	-	-	-	+	-	20.00
Aspergilus flavus	-	-	-	-	-	0.00
Penicillium chrysogenum	+	-	-	+	-	40.00
Rhizopus stolinifer	-	-	-	-	+	20.00
Fusarium oxysporum	-	+	+	-	-	40.00
Clasdosporium fulvum	-	-	-	-	-	0.00

Key: += Present and- = Absent.

The quality of the air microbial contamination of the twelve (12) fast food eateries and restaurants was ascertained and determined. The results indicates that the highest bacterial count was recorded at restaurant B which is along Lokoja-Abuja high way with 400 cfu per minutes of exposure while the lowest bacterial count was recorded at restaurant Y which is along IBB way having 25 cfu/minute of exposure (Figure 1A). The highest fungal cfu/minute of exposure was recorded in restaurant B also which was 6.0 cfu/minute of exposure and the lowest recorded at Z which had 1.5 cfu/minute of exposure (Figure 1B). The frequency distribution of the isolates showed that *Escherichia coli* was the most isolated bacteria and *Streptococcus pyogenes* the least distributed bacteria isolate (Figure 2A) and *Rhizopus stolonifer* and *Clasdosporium fulvum* were the most and least distributed fungal isolates respectively (Figure 2B) from the restaurants along the Lokoja-Abuja high way and IBB way. The bacteria isolated from different restaurants include *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Streptococcus pyogenes, Escherichia coli and Micrococcus luteus* (Table 1 and Table 2). The airborne fungal isolates include *Aspergillus niger, Aspergilus flavus, Penicillium chrysogenum, Rhizopus stolinifer, Fusarium oxysporum and Clasdosporium fulvum* (Table 3 and Table 4). The sampling was done in the presence and absence of human customers. There was no significant microbial count obtained from the media plates sampled in the absence of the customers, given the fact that the sampling in the absence of the customers was in the early hours of the morning when the temperature was not as high as to influence much movement of microbes in the air. This sampling was in less than 2hours after the daily sanitation and cleaning of the individual restaurants and there were no human influence on aero microbiology of these restaurants. These factors contributed to insignificant microbial counts obtained in all the restaurants sampled. This is an evidence that humans contributes to the indoor air quality of those restaurants [3] and could pose a danger when the high customer patronage is not properly checked with proper sanitation and with good ventilation system to avoid contamination of food and spread of diseases. Fungi isolates like *Cladosporium fulvum*, *Rhizopus stolonifer*, *Penicillium chrysogenum* and *Aspergillus niger* have been recognized as opportunistic pathogens for humans and often associated with clinical manifestations of allergy, rhinitis, asthma and conjunctivitis. The control of the microbial load of the surrounding air is thus important to establish the quality and health conditions.

The concentrations of bacteria measured in all the restaurants varied from each other. These can be mainly explained by the number of customers that visited each of the restaurants alongside with other characteristics of the restaurants such as building maintenance, cleanliness, indoor temperature and relative humidity, type of furniture, and carpeting [14,15]. Thus, the type of ventilation affects microbial concentrations in indoor environment. Mechanical ventilation is more efficient than natural ventilation in filtering particles from the intake air and in removing pollutants [4,5]. The difference in the number of customers that visited these restaurants reflected in the microbial concentrations of the individual restaurants. From the tables above, it was observed that there was a high microbial load recorded from those restaurants on the Lokoja-Abuja high way which often have very high influx of customers especially between the hours of 10:00am to 3:00pm on a daily bases. The most isolated bacteria are Gram positive cocci which generally are associated with human skin and mucosa, thereby suggesting that the main bacterial contamination suspended in the indoor air were derives from human presence. The concentrations of Gram positive bacteria were also higher than those of Gram negative bacteria which are in agreement with a previous observation [16]. The concentrations of fungi measured in the entire restaurants varied significantly to each other like that of bacteria concentration [17]. Common fungal genera found in indoor environments mainly originate from outdoor a source [18], which means that common fungal genera found indoors are the same with those found in outdoor air. In addition to outdoor sources, microorganisms indoors can originate from indoor sources; these could be from the occupants themselves and their activities as well as from the indoor plants [19]. It is therefore of a public health concern that people should avoid over crowed restaurants especially during the festive periods. Also in the case of travelers-customer patronage, individual restaurant that record a very high number of visitors on daily bases should double and improved on their level of sanitations in other to keep their customers safe from contamination and food poisoning.

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