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Antibacterial Activity of some Antibiotics and Disinfectants against Airborne Bacteria Isolated from Restaurants in Yola

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Abstract

The aim of this study was to determine the antibacterial activity of some antibiotic and disinfectant against airborne bacteria from restaurants. Airborne bacteria were isolated from five different restaurants using open plate method and were characterized using standard microbiological techniques. The susceptibility of the isolates to some antibiotics and disinfectants was determined using Kirby-Bauer disc diffusion method and well diffusion. The predominant bacteria identified in the air of the restaurants were S. aureus 9 (45%), Micrococcus spp. 5 (25%), Bacillus subtilis 4 (20 %) and P. aeruginosa 2 (10 %). The results showed that the highest and lowest average densities of bacteria for both morning and afternoon release were for 71 and 86 CFU/ m^3 and 37 and 46 CFU / m^3 respectively. Antimicrobial susceptibility test results revealed that S. aureus was susceptible to Ciprofloxaxin (88.9%), Ampiclox (66.7%), Amoxicillin (66.7%), Rocephin (55.6%) and Gentamycin (55.6%), but resistant to streptomycin and erythromycin. Micrococcus spp was susceptible to Pefloxacin (60%), Erythromycin (100%), Ciprofloxacin (100%), and Streptomycin (80%), but were resistance to Gentamycin, Zinnacet, and Co-trimoxazole. Bacillus subtillis were susceptible to Amoxicillin 4 (100 %), Pefloxacin, Gentamycin, Streptomycin and Ampiclox (50 %), and Zinnacet (75 %), but were resistance to Rocephin, Erythromycin and Co-trimoxazole. P. aeruginosa were susceptible to Ciprofloxacin (100%) and Augmentin (50%) but resistant to Gentamycin, Pefloxacin, ofloxacin, streptomycin, Chloramphenicol, Co-trimoxazole, Sparfloxacin, Amoxicilin and Rocephin. All the bacteria species showed multiple drug resistance. Disinfectants (Hypo and Dettol) showed antibacterial activity with varying magnitudes (50-100% concentrations but showed no efficacy at concentrations lower than 25%. The study identifies the presence of potentially pathogenic bacteria in the air of restaurants with varying degree of antimicrobial susceptibilities which may pose a serious health hazard to both students and workers.

Keywords: Airborne bacteria, Antimicrobial, Disinfectant, Restaurants

INTRODUCTION

Air quality is one of the most significant factors affecting human health. The air inhaled by people in their residential and occupational environment, both indoor and outdoor, is mostly populated with microorganisms, bacterial endospores trapped in colloidal suspensions (Kalwasińska *et al.*, 2012). Poor air quality is responsible for an estimated seven million deaths globally (Anna, 2016).

Indoor air pollution problem has received attention, with many studies on chemical and physical pollutants; however, less attention has been paid to pollutants of biological origin (Macher, 2017). Scientist and public interest in indoor air pollutants has gradually increased (Rajasekar and Balasubramanian, 2011). Monitoring airborne microorganisms in indoor air is one of the essential components of environmental monitoring (Kalwasińska *et al.*, 2012) and are said to be a mirror of hygienic conditions of any place (Sabharwal and Sharma, 2015).

Bioaerosols, mostly bacterial and fungal spores, are actively living complex particles that have been associated with contamination of indoor air (Brodie *et al.*, 2007). As dangerous as bioaerosols are by themselves, they enter into the human body via various ways (inhalation, ingestion, or skin absorption), and make various health effects which include communicable diseases, acute toxic effects, allergy, and cancer. Inhalation is the most important transmission route of these microorganisms into the body. Respiratory infection and reduced lung function are created by health effects caused by bioaerosols (Haliki-Uztan, *et al.*, 2010).

Disinfectants play an important role in infection control and the prevention of transmission of disease-causing microorganisms (Kumiko *et al.*, 2010). The mode of action of disinfecting agents is said to be linked to the destruction of proteins, lipids or nucleic acids in the cells or its cytoplasmic membrane. Microorganisms susceptibility to chemical agents may, however, vary from one organism to another (Olowe, 2004; Cheesbrough, 2005). However, pathogens have been reported to be resistant to disinfectant and can also grow in them. Both growth and concentration of the colony forming units of bacteria at sites of application of disinfectants have been reported in the literature (Gajadhar *et al.*, 2003).

Antimicrobial agents are crucial in reducing the burden of infectious diseases worldwide; however, resistance to antibiotics and other antimicrobials poses alarming threats to public health (Daniel, 2004). One of the more disturbing recent trends in infectious diseases has been the increasing frequency of antimicrobial resistance among microbial pathogens causing infections (Livermore, 2007; Diriba, 2016). Pathogens especially bacteria may resist antimicrobials by using a number of mechanisms, including (i) alteration of the antimicrobial agent, (ii) mutation of the target site, (iii) decreased accessibility to the target through decreased uptake or increased efflux, and (iv) implementation of alternative metabolic pathways not affected by the drug or by acquisition of drug-sensitive enzymes (McDermott *et al.*, 2003).

The kitchen is one of the most important areas that harbors and transmits infection (Anwar, 2018). Good air quality in restaurants is important in the protection of people's health since we pass a significant part of our time in restaurant (Chan *et al.*, 2009). Given the importance of bacteria in indoor pollution, the aim of this study was to determine the antibacterial activity of some antibiotics and disinfectant against airborne bacteria from restaurants in Modibbo Adama University, Yola.

MATERIAL AND METHODS

Study Area

The study was carried out in Modibbo Adama University, Yola which is located in Girei local government area (LGA) of Adamawa State which is domicile in the northeast geopolitical zone of Nigeria. The area is situated between latitudes 9º .09 and 9º .33 N and longitudes 12º .21 and 12º .54 E of the state and has an elevation of 339 meters above the sea level. The estimated population of girei LGA is 149,738 inhabitants with an average humidity level of 24 percent while the average wind speed is 10 km/h. (Adebayo, 1999).

Sample Collection and isolation

Twenty (20) airborne bacteria samples were collected from five (5) different restaurants in MAU Yola Campus using open plate technique. Restaurants were selected because they are public places within the campus where students eat. Petri dishes with an external diameter of 90 mm were used. A prepared nutrient agar medium was exposed to air for 15 minutes at the height of one meter. The petri dishes' lids were closed immediately and transported to the laboratory and were incubated aerobically at 37 °C for 24 hours as described by Yassin and Aimouqatea (2010). The samples were both collected in the morning and afternoon.

Colony Count

After 24 hours of incubation at 37°C, all the plates were brought out from the incubator and Standard plate count was performed to determine the bacterial loads across the sampled site. The total number of CFU was noted manually and results were expressed in CFU (Colony Forming Units) / Plate / time or in CFU / meter square. In order to get the CFU values in CFU/m3, first the settling rate was calculated. For a 90 mm plate (surface area ≈ 63.6 cm^2) exposed for 15 minutes, the settling rate was calculated and expressed as CFU/m^2/min (Tshokey *et al.*, 2016).

The relation between CFU/m^2 /min and CFU/m^3 was analyzed after getting the CFU/m^2 /min from the number of colonies with 15 minutes exposure, the CFU/m^3 of air was calculated using the formula of Parker (1978). Parker stated that "the number of particles settling on 1m^2/min is equal to the number of such particles in 0.3 m^3 of air". The conversion of CFU/m^2/min for the settle plate into CFU/m^3:

1m^2 / min = 0.3 m^3 of air Most probable number of colonies in air sample= MPN x 0.3 = 9 CFU/m^3

Identification of bacteria

To obtain a pure culture, each morphologically distinct colony from mixed culture was picked using a sterile wire loop and was inoculated onto freshly prepared agar plates using streak plate method. After streaking, the Petri dish was incubated for 24 hours at 37°C. All isolates from this pure culture were maintained in an agar slant for further analyses (Cheesbrough, 2006; Manga and Oyeleke, 2009). Bacterial isolates was identified using colonial (shape, colour, odour, pigmentation), Gram-staining and biochemical tests viz: Voges Proskauer test, citrate, Bacterial Spore stain, Motility test, oxidase, catalase, coagulase, and urease test as suggested by Cheesbrough (2006).

Standardization of inoculum

The suspension of the test organisms was made by inoculating a loopful of the colony into 5 ml of nutrient broth and incubated at 37°C for 18 hours. After incubation, 0.2 ml of the broth culture of each test isolates were diluted in 6 ml of distilled water to obtain an inoculum size equivalent to Mcfarland standard of $1.5x10^6$ which was immediately inoculated after dilution (Ewansiha *et al.*, 2020)

Antibiotic susceptibility test

The antimicrobial susceptibility test on isolated airborne bacteria was determined using Kirby-Bauer disc diffusion method on Muller-Hinton agar (MHA) according to the clinical and laboratory standard institute (CLSI) (2020). A standardized inoculum equivalent to 0.5 McFarland standard of the isolate was inoculated aseptically on the surface of prepared Mueller-Hinton agar plates. The inoculated plates were allowed for pre-diffusion of the antibiotics for 10-15 minutes. The following standard antibiotic discs were tested against the isolates; Septrin (30µg), Chloramphenicol (30µg), Sparfloxacin (10µg), Ciprofloxacin (10µg), Amoxicillin (30µg), Augmentin (30µg), Gentamycin (10µg), Pefloxacin (30µg), Tarivid (10µg) and Streptomycin (30µg). Whereas for Gram-positive, the following were tested: Vancomycin (30µg), Oxacillin (30µg), Cloxacillin (30µg), Penicillin (30µg), Erythromycin (30µg), Tetracycline (30µg), Chloramphenicol (30µg), Ceftriaxone (10µg), Amoxicillin (30µg), Gentamycin (10µg), Ciprofloxacin (10µg) and Trimethoprim (30µg). Sterilized forceps were used to place the antibiotic discs evenly on the inoculated Mueller-Hinton agar so that the disc should be about 15 mm from the edge of the plate and not closer than 25 mm from disc to disc. After 30 minutes, the plates were inverted and incubated for 24 hours. A ruler was used to measure the diameter of each zone of inhibition in mm on the underside of the plate. The inhibitory zone diameter was interpreted as susceptible or resistant according to the criteria of CLSI (2020).

Preparation of Various Concentrations of the Disinfectants

The disinfectants used in the study were purchased from commercial sellers. Dettol (Chloroxylenol 4.85% w/w, Pine oil, Isopropyl Alcohol, Castor Oil, Caramel and Deionized Water) and Hypo (Sodium hypochlorite) (3.5% w/v). For each disinfectant, the following concentrations were prepared in percentage v/v from the main concentration; (100, 50, 25 and 12.5 % v/v) using sterile distilled water as diluent in 10 ml solution.

Antibacterial Activity of Disinfectants

Antimicrobial activity of each disinfectant was independently carried out on the isolates using agar well diffusion method as described by Valgas *et al*. (2007). Sterile Mueller Hinton agar plates were inoculated with standardized test organisms. With the aid of a sterile 6mm cork borer, 6 equally spaced holes were bored in the agar plate with a fifth hole in the center of the plate. For each isolate per disinfectant, six wells were bored and labeled as 100%, 50%, 25% and 12.5% while the remaining two wells were for both negative and positive controls, the well label negative was filled with sterile distilled water while the well label positive was filled with 10mg/ml chloramphenicol using calibrated Pasteur's pipette. The wells on the inoculated MHA with test organisms were filled with the appropriate concentrations following standard procedure. All the plates were incubated at 37˚C for 24 hours after which the plates were observed for activity. The diameter of the zone of inhibition around each well was measured in millimeters using a ruler and recorded.

RESULTS

Isolation and Identification of Bacteria

Twenty (20) bacteria were isolated from five different restaurants in MAU Yola. Four (4) bacteria species were identified. Nine (45%) isolates were found to be *S. aureus*, five (25 %) *Micrococcus spp*, four (20 %) were *B. subtilis* and two (10 %) were *P. aerugenosa*. The morphological and biochemical characteristics of the isolates were represented in Table 1.

The densities of bacteria in the indoor air of restaurants in MAU Yola are shown in Table 2. Based on the sampling carried out in 5 restaurants, the highest density of bacteria was observed at restaurant with code R5, and the highest densities of 71 and 86 CFU/ m^3, followed by restaurant with code 1 which had densities of 62 and 71 CFU/ m^3 then restaurant with code R4 with 59 and 65 CFU / m^3, restaurant with code R2 had 43 and 52 CFU / m^3 densities and the lowest density of bacteria was observed in the restaurant with code R3, with 37 and 46 CFU / m^3 respectively for morning and afternoon release. The densities of bacteria were observed to be higher in all restaurants for afternoon release.

Table 1: Morphological and Biochemical Characteristics of Bacterial Isolate

Morphological Organism Appearance (%) identified	Microscopic	Biochemical Characterization									No of isolate	
		Grm	Ca	Co	Cit	Ox	Vp	Mo	Ur	Sp		
Circular, convex and Yellow	Cocci in bunches	+	+	+	+	-	+	-	+	-	9 (45)	*Staphylococcus aureus*
Circular, entire convex raise with green-blue pigmentation	Rod shape	-	-	-	+	+	-	+	-	-	2 (10)	*Pseudomonas aeruginosa*
Small, round entire yellow	Cocci in pairs and tetrads	+	+	-	-	-	+	-	+	-	5 (25)	*Micrococcus* spp
Creamish white, dry undulated and irregular	Rod shape	+	+	-	+	-	+	+	-	+	4 (20)	*Bacillus subtilis*

Key: + = Positive, - = Negative, Gram's stain (Grm), Catalase (Ca), Coagulase (Co), Citrate (Cit), Oxidase test (Ox), Voges proskauer test (VP), Motility (Mo), Urea (Ur), Spore stain (Sp)

Table 2: Average density of bacteria isolated from indoor air of restaurants (CFU/m^3)

Restaurant code	Sampling Time	Mean ± SD (CFU/ m^3)
R1	Morning	62±2.82
	Afternoon	71±2.12
R2	Morning	43±2.82
	Afternoon	52±2.0
R3	Morning	37±0.5
	Afternoon	46±52.0
R4	Morning	59±2.82
	Afternoon	65±4.5
R5	Morning	71±4.5
	Afternoon	86±4.5

Antibiotic Susceptibility Test

The result of antibiotic susceptibility test revealed that *S. aureus* was susceptible to Ciprofloxaxin (88.9%), Ampiclox (66.7%), Amoxicillin (66.7%), Rocephin (55.6%) and Gentamycin (55.6%), but resistant to streptomycin and erythromycin. *Micrococcus spp* was susceptible to Pefloxacin (60%), Erythromycin (100%), Ciprofloxacin (100%), and Streptomycin (80%), but were resistance to Gentamycin, Zinnacet, and Co-trimoxazole. *Bacillus subtillis* were susceptible to Amoxicillin 4 (100 %), Pefloxacin, Gentamycin, Streptomycin and Ampiclox (50 %), and Zinnacet (75 %), but were resistance to Rocephin, Erythromycin and Co-trimoxazole. *P. aeruginosa* were susceptible to Ciprofloxacin (100%) and Augmentin (50%) but resistant to Gentamycin, Pefloxacin, ofloxacin, streptomycin, chloramphenicol, Co-trimoxazole, Sparfloxacin, Amoxicilin and Rocephin. All the isolates were resistant to Co-trimoxazole.

Table 3: Activity of Antibiotics against Bacterial Isolates (Values in Brackets are Percentages).

Antibiotics	Patterns	Bacterial Isolates / No of Isolates			
		S. aureus	*Micrococcus* spp	*Bacillus subtillis*	*P. aeruginosa*
		9 (45)	5 (25)	4 (20)	2 (10)
AU (10µg)	S	NT	NT	NT	1 (50)
	R	NT	NT	NT	1 (50)
CH (10µg)	S	NT	NT	NT	0 (0)
	R	NT	NT	NT	2 (100)
PEF (10µg)	S	2 (22.2)	3 (60)	2 (50)	0 (0)
	R	7 (77.8)	2 (40)	2 (50)	2 (100)
CN (30µg)	S	5 (55.6)	0 (0)	2 (50)	0 (0)
	R	4 (44.4)	5 (100)	2 (50)	2 (100)
APX (20µg)	S	6 (66.7)	1 (20)	2 (50)	NT
	R	3 (33.3)	4 (80)	2 (50)	NT
Z (30µg)	S	4 (44.4)	0 (0)	3 (75)	NT
	R	5 (55.6)	5 (100)	1 (25)	NT
AM (25µg)	S	6 (66.7)	2 (40)	4 (100)	0 (0)
	R	3 (33.3)	3 (60)	0 (0)	2 (100)
R (30µg)	S	5 (55.6)	1 (20)	0 (0)	NT
	R	4 (44.4)	4 (80)	4 (100)	NT
CPX (30µg)	S	8 (88.9)	5 (100)	1 (25)	2 (100)
	R	1 (11.1)	0 (0)	3 (75)	0 (0)
S (30µg)	S	0 (0)	4 (80)	2 (50)	0 (0)
	R	9 (100)	1 (20)	2 (50)	2 (100)
SXT (30µg)	S	0 (0)	0 (0)	0 (0)	0 (0)
	R	9 (100)	5 (100)	4 (100)	2 (100)
E (10µg)	S	0 (0)	3 (60)	0 (0)	NT
	R	9 (100)	2 (40)	4 (100)	NT
SP (30µg)	S	NT	NT	NT	0 (0)
	R	NT	NT	NT	0 (0)
OFX (10µg)	S	NT	NT	NT	0 (0)
	R	NT	NT	NT	2 (100)

Key: Amoxicillin + Clavulanic acid (AU), Gentamycin (CN), Pefloxacin (PEF), Ofloxacin (OFX), Streptomycin (S), Chloramphenicol (CH), Co-trimoxazole (SXT), Sparfloxacin (SP), Ciprofloxacin (CPX), Amoxicillin (AM), Ampiclox (APX), Erythromycin (E), Zinnacet (Z) and Sparfloxacin (SP), Rocepthin (R), R=Resistant, NT=Not Tested, S=Susceptible.

Antibacterial Activity of disinfectants

The results of the study revealed that the disinfectants both hypo and dettol exhibited appreciable antibacterial activity against the isolates at 100 % and 50 % concentrations (Table 4). There was no activity by dettol at 100% concentration against two isolates (R3, R13) of *Bacillus subtilis*, and one isolate of *S. aureus* (R17) and another isolate of *P. aeruginosa* (R19) (Table 4). However, for hypo at 100% concentration all the isolates were susceptible, except only one isolate of *S. aureus* (R17) (Table 4).

The result shows that as the concentration of the disinfectants reduce their activity on the isolates also reduce producing no activity by all the disinfectants at 12.5% concentration and at 25%, the only activity was produced against some isolates of *Bacillus subtilis*, *S. aureus* and *Micrococcus spp.* by hypo, while at the same concentration, dettol was only active against one isolate of *Micrococcus spp.* (Table 4).

Table 4: Sensitivity of Bacterial Isolates to Disinfectant (Values in brackets are Percentages)

ISOLATED BACTERIA	NO. OF ISOLATE (%)	DISINFECTANTS AT DIFFERENT CONCENTRATIONS (%) HYPO				DETTOL			
		100	50	25	12.5	100	50	25	12.5
S. aureus	9 (45)	8 (88.9)	4 (44.4)	2 (22.2)	0 (0)	7 (77.8)	2 (22.2)	0 (0)	0 (0)
***Micrococcus* spp**	5 (25)	5 (100)	2 (40)	2 (40)	0 (0)	5 (100)	1 (20)	1 (20)	0 (0)
B. subtillis	4 (20)	4 (100)	1 (25)	1 (25)	0 (0)	2 (50)	1 (25)	0 (0)	0 (0)
P. aeruginosa	2 (10)	2 (100)	1 (50)	0 (0)	0 (0)	1 (50)	0 (0)	0 (0)	0 (0)

Key: S=*Staphylococcus*, B=*Bacillus*, P=*Pseudomonas*, Spp=Species.

DISCUSSION

A total of 20 bacterial species were identified from the indoor air of restaurants studied. The most predominant species were *S. aureus* and the least was *P. aeruginosa* (10 %). The study findings indicated that the predominant bacteria in these restaurants were gram-positive ones including *S. aureus*, *Micrococcus* spp. and *Bacillus* species. *P. aeruginosa* was the only gram negative bacteria isolated. Earlier findings suggested that high prevalence of gram-positive bacteria in air samples could be attributed to their ability to survive environmental stress as they possess pigments and photo-reactivation mechanisms that provide protection from sunlight (Chan *et al.*, 2009). High peptidoglycan content present in their cell walls have also been known to provide protection from drying and heat stress, thereby spreading across considerable distance which in turn results in infection (Moletta and Godon, 2007). Our findings were similar to the reports of Gulumbe and Kawo (2018) who isolated bacteria such as *S. aureus, Micrococcus spp., Staphylococcus spp., B. subtilis, S. pyogenes, P. aeruginosa, Corynebacterium sp., Proteus spp., Acinetobacter sp., and Enterobacter* sp. from restaurants in Nigeria. Also, the results of the present study were also found to be similar with that of Asgharzadeh *et al.* (2019) The presence of cocci in the air of the restaurants was not only due to overcrowding but also poor ventilation (Awad, 2007), and Gram-positive bacilli presence can be attributed to a number of outdoor sources, such as soil emissions, water, dust, air, vegetation, wounds and abscesses (Aydogdu *et al.*, 2010).

The average densities of bacteria in the restaurants were lower than WHO recommendation and guidance ACGIH (guideline value of 500 CFU/m^3). The study findings indicated that the concentration of bacteria was found to be higher during the day than in the morning. This could be due to adequate humidity, higher temperature, dusty conditions and higher human activities during the day (Mentese *et al.*, 2012). The highest density of bacteria was found to be in the restaurant with Code 5, which had a smaller area and more appropriate ventilation. The lowest density of bacteria, on the other hand, was the restaurant with Code 3, which was properly ventilated and had bigger space and sun rays. This may be linked to the fact that sunlight has disinfection properties and has the ability to destroy some bacteria. These observations have been supported by earlier reports that proper design of ventilated restaurants and its location could enable sun rays to prevent bioaerosol air pollution (Asgharzadeh *et al.*, 2019). In contrast to the present findings, Mushtaq *et al.* (2011) reported an average bacterial density of 805 CFU/m3 from indoor air in the kitchen. On the other hand Chan *et al.* (2009) reported a similar observation to the findings of this study and reported the density of bacteria in restaurants that ranges from 25 to 463 CFU/m^3, respectively. Asgharzadeh *et al.* (2019) reported also similar observation that the highest and lowest densities of bacteria in cold season were 15 CFU/m^3 and 63.7 CFU/m^3, and in warm season, they were 19.6 CFU/m3 and 80 CFU/m3, respectively.

The antibiotic susceptibility of airborne bacteria revealed that Ciprofloxacin, Ampiclox, Amoxicilin and pefloxacin were generally the most active antibiotics against gram-positive bacteria isolated from restaurants while Ciprofloxacin and Augmentin were active antibiotics against gram-negative bacteria.

Interestingly, Ciprofloxacin was the only antibiotic that was active against all gram-positive and gram-negative bacteria isolated. Virtually all the bacterial isolates in this study were resistant to at least two antibiotics. Indeed, Co-trimoxazole had the highest level of resistance. Gufe *et al*. (2019) and Daniel *et al*. (2020) reported that all bacterial isolates were susceptible to gentamicin which is in contrast to this study findings.

Similarly, Teshome *et al*. (2016) and Gulumbe and Kawo (2018) also reported sensitivity of *S. aureus* to ciprofloxacin. Gentamicin, which was also sensitive, was also reported by Kabir *et al*. (2016) and Gulumbe and Kawo (2018) for *S. aureus*.

P. aeruginosa were only susceptible to Ciprofloxacin and Augmentin but resistant to all other antibiotics tested. This could be due to the fact that gram- negative bacteria may exhibit high resistance to broad-spectrum antibiotics, which is as a result of enzymatic responses, mutations in the antibiotic target, and modifications in envelope permeability, including porin alteration and induction of drug efflux (Chikere *et al*., 2008). Gulumbe and Kawo (2018), reported a similar observation that *P. aeruginosa* was sensitive to both Amoxicillin + clavulanic acid and ciprofloxacin. The low sensitivity of isolates generally to streptomycin, Pefloxacin, Erythromycin and Zinnacet could be due to common use of these antibiotics. This agrees with the findings of Kabir *et al*. (2016), who linked antibiotic resistance to misuse of antibiotics in chemotherapy. Also, spread of resistant strains may be attributed to inter-species gene transmission not only poor sanitation and hygiene in restaurants, communities and hospitals, but also, increased frequency of global travel, trade and disease transmission (Ramanan *et al*., 2013).

In the present study, susceptibility to Hypo and Dettol was appreciable. All the two disinfectants showed no efficacy at concentrations lower than 25%. Hypo showed more effectiveness as compared to Dettol. The findings of the present study is in agreement with the report of Gulumbe and Kawo (2018), who stated that Jik (Sodium hypochlorite (3.5%w/v)) at 100% concentration, inhibited the growth of *P. aeruginosa*, *B. subtilis*, *S. aureus*, *Micrococcus* spp, *Streptococcus* and *Staphylococcus* spp. Okore *et al*., (2014), reported that disinfectants had remarkable zones of inhibition against bacteria and fungi with Dettol showing broad spectrum activity and test organisms differ in their susceptibilities to the disinfectants which is slightly in variance with the present report. The activity of both hypo and Dettol recorded in this work could be based on their active component (sodium hypochlorite and denatured alcohol respectively) since their activities causes protein denaturation, disruption of tissue membranes and dissolution of several lipids in bacteria (Kar, 2008). Antimicrobial activity of disinfectants is affected by a number of factors such as the type, concentration and volume of alcohol used, the contact time, the test method (*in-vitro* and *in-vivo*) and target organism (CDC, 2004). El-Mahmood and Doughari (2009) and Ramanan *et al*. 2013) have also documented the antimicrobial properties of Dettol, Jik and other disinfectants.

CONCLUSION

This study has shown that airborne gram-positives (*S, aureus*, *B. subtilis* and *Micrococcus* spp.) and gram-negative bacteria (*P.aeruginosa*) were present in the various air sampled restaurants. *S. aureus* were most predominant among the airborne bacteria. Virtually all isolates in this study were multidrug resistant. Intriguingly, ciprofloxacin, Ampiclox, (Anwar, 2018). Amoxicilin and pefloxacin were generally the most active antibiotics against gram-positive bacteria while Ciprofloxacin and Augmentin were the active antibiotics against gram-negative bacteria. The activity of Hypo and Dettol were also effective against isolates at higher concentrations. The study recommends strict adherence to standard hygiene practices, including provision of well ventilated and bigger spaces for the operation of Restaurant services as well as adopting the correct concentration in the usage of disinfectants.

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