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Microbiological Assessment of Laboratory Workbench Surfaces

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Abstract

The microbiological assessment of twenty laboratory workbench surfaces within University of Ilorin was carried out. Surface swabbing method was used for the collection of the sample over an area of 25cm by 25cm of the laboratory workbench surfaces. Antimicrobial Susceptibility test was carried on the bacterial isolates using the agar disk diffusion method. The bacterial count ranged from 4.0×10^2 - 2.5×10^5cfu/ml per 25 x 25 cm^2 of the surface area while the fungal count ranged from 2.0×10^2 - 1.6×10^5cfu/ml of the surface area. A total number of six bacteria and six fungi were isolated. The bacteria isolated were *Staphylococcus auricularis*, *Staphylococcus aureus*, *Aerococcus* sp., *Micrococcus* sp., *Micrococcus kristinae*, and *Pseudomonas aeruginosa* while fungi isolated were *Verticillium lateritium*, *Candida* sp., *Cladosporium sphaerospermum*, *Alternaria alternata*, *Rhodotula* sp., and *Scopulariopsis* sp. The results of antibiotic susceptibility test showed that all the Gram positive bacteria were sensitive to gentamicin while the only Gram negative bacterium, isolated *Pseudomonas aeruginosa*, and was sensitive to nitrofurantoin alone. It is concluded from this study that the laboratory workbench surfaces contain viable bacteria and fungi, some of which are known to be pathogenic. It is recommended that the laboratory workbenches should be disinfected regularly.

Keywords: Microbial load, Pathogens, Workbench, surfaces, Laboratory

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1. Introduction

A laboratory is a facility that provides controlled conditions in which scientific or technological research, experiment, and measurement may be performed (Wehmeister *et al*., 2005). Scientific laboratories can be found in schools, universities, industries, government and military facilities. Laboratory can take different forms based on the requirements of specialists involved in the various fields of science and engineering. Despite the great differences among laboratories several features are common to them, one of which is the laboratory workbench or countertop on which the researcher work. Laboratory workbenches are made of some materials such as epoxy resin, stainless steel, phenolic resins, edge grain maple, high-pressure laminate etc. Almost all workbenches are rectangular in shape (Vesley *et al*., 2001).

Microorganisms are present on inanimate surfaces creating ubiquitous sources of possible contamination in the laboratory (Kozajda and Szadkowska-Stanczyk, 2010). Laboratory-acquired infections (LAIs) refer to all infections acquired through laboratory work or laboratory-related activities with or without the onset of infections, and result from occupational exposure to infectious agents (Wei *et al.*, 2011). It can also be referred to as occupational illness. Reports have indicated that bacteria account for more than 40% of infections (Gralton *et al*., 2011). The laboratory-acquired infections mostly reported were primarily due to bacteria, viruses, and fungi.

LAIs are of public health concern as an infected worker may present a risk of transmission to his colleagues, relatives and family members or other citizens. The most important routes of laboratory infections are inhalation particularly by aerosols; percutaneous inoculation (needles injury, broken glass injury, animal bites and scratches, and other contaminated sharp objects); direct contact between contaminated surfaces, skin and hands of individuals; contamination of the mucous membrane during nose picking; ingestion during smoking, eating, or mouth pipetting (Traxler *et al.*, 2013). Any incident associated with a

given microbiological hazard is probably most likely to happen in a microbiology laboratory. However, these incidents are not associated to a single factor but the interaction of several of them (Kozajda and Szadkowska-Stanczyk, 2010).

The safe handling of microorganisms in the teaching laboratory is a top priority. Biosafety guidelines have been developed for safe handling of microorganisms in the teaching laboratory (James, 2008; Emmert, 2013). Experimental success in a microbiology laboratory relies on the ability of the scientist to sterilize work surfaces and equipment as well as prevent contact of sterile instruments and solutions with non-sterile surfaces.

This research is of importance since in the course of laboratory activities, workbench surfaces could be contaminated. Therefore, it is necessary to know the level of safety of laboratory workbench surfaces. The objectives of this study were to determine the bacterial and fungal loads on the laboratory workbench surfaces; isolate specific pathogenic bacteria on these surfaces; characterize and identify the isolates; determine the occurrence and the antibiotic susceptibility patterns of the bacterial isolates; and provide recommendations on measures that would help in reducing microbial loads on surfaces.

2. Materials and Methods

Collection of Samples

Swab samples were taken from 20 different laboratories across different departments within university of Ilorin, Ilorin, Nigeria. They were coded A to T. The sample was taken from a measured area of 25cm by 25cm portion of the laboratory workbench surface using a sterile swab stick.

Serial Dilution of Samples

The swab stick from each sampling site was thoroughly shaken into a test tube containing 10ml of sterile distilled water. This gave10^{-1} dilution. Then, ten-fold serial dilution was done to obtain 10^{-2} dilution (Fawole and Oso, 2007).

Isolation and Enumeration of Microorganisms

Microbial count was done by plating 1ml aliquot from 10^{-1} and 10^{-2} dilutions. Nutrient agar was used for bacterial isolation by pour plate technique. Furthermore, fungal count was determined using spread plate method on potato dextrose agar supplemented with streptomycin (Fawole and Oso, 2007).

Isolation of Pathogenic Bacteria

Spread plate technique was used for isolation of pathogenic bacteria from 10^{-1} dilution using selective media. Eosin methylene blue agar, MacConkey agar, Mannitol salt agar, Salmonella-Shigella agar, and Cetrimide agar were used for tentative isolation of *E. coli*, Total coliform, *Staphylococcus aureus*, *Salmonella/Shigella* sp., and *Pseudomonas aeruginosa* respectively. Positive isolates were confirmed by suitable biochemical tests (Collins and Lyne, 1970).

Maintenance of Pure Culture of Microorganisms

The bacterial and fungal isolates were subcultured until pure cultures were obtained using nutrient and potato dextrose agar respectively (Fawole and Oso, 2007).

Characterization and Identification of Isolates

The bacterial isolates were characterized and identified mainly on the basis of their colonial morphology, cellular morphology, and biochemical reactions. Identification of bacteria

was based on standard literatures (Cowan and Steel, 1985). Furthermore, the fungal isolates were identified by making reference to Onions *et al.* (1981).

Antimicrobial Susceptibility Test of Bacterial Isolates

The bacterial isolates were standardized using 0.5 McFarland's standard. Then, the inoculum was streaked on solidified Mueller Hinton agar followed by placing the antibiotic disc on it. After incubation period, the diameter of zone of inhibition was measured in mm (CLSI, 2005; Brown and MacGowan, 2010).

Statistical Analyses

Statistical analysis package SPSS 15.0 was used to determine the mean, range, standard deviation of each parameter. Then, Duncan's multiple range test (DMRT) was used to separate differences within the means (SPSS, 2010).

3. Results and Discussion

The viable bacterial and fungal counts on laboratory workbench surfaces ranged from 4.0 x 10^2-2.5 x $10^5$and 2.0 x 10^2-1.6 x10^5cfu/ml per 25 by 25 cm^2 respectively (Table 1). The counts of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and total coliform ranged from 0 to 7.5 x 10^3, 0 to 1.0 x 10^4, and 0 to 2.6 x 10^4cfu/ml per 25 by 25 cm^2 of the workbench surfaces. The counts of *Salmonella* sp., *Shigella* sp. and faecal coliform were zero (Table 2). Science laboratories have been found to have the highest prevalence of microorganisms due to the fact that organic matters are mostly dealt with. All blood specimens are considered potentially infectious (Sewell, 1995; Emmert, 2013). There are some acts of laboratory workers which can contribute to increase rate of laboratory-acquired infections. For instance, placing of contaminated pipette on the workbench instead of designated container. Materials such as mobile phones, computer keyboards, mouse, keys can serve as vehicles of transmission of infectious agents if they are kept on a

contaminated workbench. Respiratory droplets can also contaminate these inanimate objects (formites) via coughing or sneezing. Mouth pipetting also influence the rate of laboratory-acquired infections (CDC, 2002). Reduction of environmental microbial contamination by convectional cleaning procedures is often enough to prevent environmentally mediated transmission (Vesley *et al*., 2001).

The bacterial species isolated from the workbench surfaces were: *Staphylococcus auricularis, Staphylococcus aureus, Aerococcus* sp., *Micrococcus* sp., *Micrococcus kristinae,* and *Pseudomonas aeruginosa* (Table 3) while the fungal isolates were *Verticillium lateritium, Candida* sp., *Cladosporium sphaerospermum, Alternaria alternata, Rhodotula* sp., and *Scopulariopsis* sp. The occurrence of these bacterial and fungal isolates are presented in Tables 4 and 5. The bacteria isolated from this study belong to genera: *Staphylococcus*, *Aerococcus, Micrococcus,* and *Pseudomonas*. *Staphylococcus aureus* is a commensal bacterium, asymptomatically colonizing about 30% of the human population but it can sometimes cause disease. It can be transmitted through skin to skin contact with an infected person, and contact with objects used by an infected person such as towels, sheets, clothing, or athletic equipment (Tong *et al.*, 2015). Furthermore, *Staphylococcus auricularis* has been isolated from human and animal skin, ears and mucous membranes. It is ubiquitous (Holt *et al*., 1994).

Aerococcus sp. has been isolated from air, vegetation, dust, hospital, and marine environments, humans and animals (Vela *et al.,* 2007). *Micrococcus* is generally thought to be a commensal organism, though it can be an opportunistic pathogen, particularly in hosts with compromised immune systems, such as HIV patients (Smith *et al.*, 1999). *Micrococcus kristinae* is a Gram positive bacterium whose normal flora is the skin. It has also been found in many other environments including water, dust, and soil.

Pseudomonas aeruginosa is a pathogenic bacterium found mostly in soil, water and skin of animals including humans. It is a multidrug resistant pathogen which is responsible for

various illnesses especially nosocomial infections such as ventilator-associated pneumonia and various sepsis syndromes (Gerard, 2016). *Verticillium* spp. are fungi that is pathogenic to plant. *Candida* spp. are present in the environment because they inhabit the skin and gastrointestinal tract of humans. They are one of the most common causes of fungal infections worldwide (Manolakaki *et al.*, 2010). Many of its species are harmless commensals or endosymbionts of hosts including humans; however, when the immune system is compromised, they can invade and cause disease (Kourkoumpetis and Themistoklis, 2011).

Cladosporium sphaerospermum is one of the most commonly isolated airborne fungal contaminants (Tasic *et al.*, 2007). *Alternaria alternata* is a fungus mostly found in the soil and therefore can be transmitted via aerosols. *Alternaria alternata* is pathogenic and it can cause cutaneous mycoses of the skin and scalp (Timmer *et al.*, 2015). *Rhodotorula* spp. are common environmental inhabitants. They can be found in the soil, air, fruit juices and water. There have been reports of skin infection in chickens and lung infection in sheep (Onions *et al*., 1981). *Scopulariopsis* spp. are fungi commonly found in soil, decaying wood, mattress dust and various plants and animal products (Kirk *et al*., 2008).

All the Gram positive bacteria were sensitive to gentamicin but resistant to ceftazidime. cefuroxime, ceftriaxone, cloxicillin and amoxycillin-clavulinate. *Pseudomonas aeruginosa* was only sensitive to nitrofurantoin (Table 6). *Aerococcus* sp. was resistant to ofloxacin and erythromycin. *Staphylococcus auricularis* was also resistant to erythromycin. The following recommendation were made in order to lessen the microbial loads of laboratory workbenches. Laboratory workbenches should be well taken care of because it has the closest contact to every work that is being carried out in the laboratory. In order to ensure cleanliness and safety, the laboratory workbenches must be disinfected before and after each working session; mechanical pipetting should be used instead of mouth pipetting; policies should be made and implemented for safe handling of hazardous materials; the workbenches should have impervious and easily cleaned surfaces; personnel must wash

their hands after working with potentially hazardous materials; laboratory supervisor should enforce the institutional policies that control access to the laboratory; everyone in laboratory areas must wear a protective laboratory coat or gown; the coats and gowns should be removed and hanged in wardrobe close to the exit; and there should be enough coats in suitable sizes to ensure that staff can change them regularly, and immediately if contaminated.

Table 1: Bacterial and Fungal Counts on Laboratory Workbench Surfaces

Codes	Sampling locations	Bacterial count (cfu/ml) x 10^3	Fungal count (cfu/ml) x 10^3
A	Chemistry lab. prep. Room	$250^{i} \pm 5$	$1.0^{a} \pm 0.1$
B	Biochemistry lab.	$12^{h} \pm 2$	$160^{f} \pm 5$
C	Chemistry lab.1	$11^{g} \pm 1$	$17^{e} \pm 2$
D	MCB office lab. 1	$1.9^{abc} \pm 0.2$	$1.2^{a} \pm 0.1$
E	Engineering lab.	$3.9^{bcd} \pm 0.4$	$2.2^{ab} \pm 0.2$
F	Agric. Lab.	$1.2^{ab} \pm 0.2$	$1.6^{ab} \pm 0.2$
G	Professor lab.1 (chemistry)	$1.3^{ab} \pm 0,1$	$1.2^{a} \pm 0.2$
H	Professor lab2 (chemistry)	$7.1^{ef} \pm 0.5$	$5.7^{c} \pm 0.5$
I	Industrial chemistry lab.	$1.9^{abc} \pm 0.3$	$2.7^{ab} \pm 0.2$
J	Chemistry PG lab.	$1.7^{ab} \pm 0.2$	$17^{e} \pm 2$
K	Chemistry lab. 2	$1.4^{ab} \pm 0.2$	$0.7^{a} \pm 0.1$
L	Biology lab.	$4.3^{cd} \pm 0.3$	$5.0^{c} \pm 0.5$
M	Biology teaching lab.	$7.3^{ef} \pm 0.5$	$2.1^{ab} \pm 0.3$
N	Biochemistry lab. 2	$7.7^{f} \pm 0.7$	$2.1^{ab} \pm 0.2$
O	Chemical Eng. Lab.	$2.0^{abc} \pm 0.2$	$0.4^{a} \pm 0.1$
P	MCB general lab.	$2.0^{abc} \pm 0.3$	$1.6^{ab} \pm 0.2$
Q	MCB PG research lab.1	$0.4^{a} \pm 0.1$	$4.0^{bc} \pm 0.5$
R	Physics lab.	$1.8^{abc} \pm 0.2$	$1.2^{a} \pm 0.2$
S	MCB staff lab. 2	$5.3^{de} \pm 0.5$	$0.2^{a} \pm 0$
T	MCB PG research lab.2	$1.8^{abc} \pm 0.3$	$9.o^{d} \pm 0.5$

Values along the same column with the same superscripts are not significantly different at $\alpha = 0.05$ based on Duncan's multiple range test.

Key: MCB = Microbiology, PG = Postgraduate, Lab = Laboratory, Prep = Preparation, Eng = Engineering.

Table 2: Enumeration of Pathogenic Bacteria on Laboratory Workbench Surfaces.

Sampling Locations	Counts (cfu/ml/25 x 25 cm^2)					
	Total coliform x 10^2	**Faecal coliform**	***S. aureus* x 10^2**	***Pseudomonas Aeruginosa* x10^2**	***Salmonella* sp.**	***Shigella* sp.**
A	10^{d} ± 1	0.0 ^{a} ±0	$70^{h\,a}$ ±5	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
B	74^{f} ± 5	0.0 ^{a} ±0	11^{e} ±2	85^{b} ±5	0.0 ^{a} ±0	0.0 ^{a} ±0
C	0.0^{a} ±0	0.0 ^{a} ±0	2^{ab} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
D	0.0 ^{a} ±0	0.0 ^{a} ±0	4^{abc} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
E	11^{e} ±2	0.0 ^{a} ±0	2^{ab} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
F	0.0 ^{a} ±0	0.0 ^{a} ±0	3^{ab} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
G	0.0 ^{a} ±0	0.0 ^{a} ±0	53^{g} ± 5	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
H	6.0^{c} ±1	0.0 ^{a} ±0	11^{e} ± 1	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
I	0.0 ^{a} ±0	0.0 ^{a} ±0	8^{cde} ±2	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
J	260 ± 20	0.0 ^{a} ±0	2^{ab} ± 0	100^{c} ± 10	0.0 ^{a} ±0	0.0 ^{a} ±0
K	0.0 ^{a} ±0	0.0 ^{a} ±0	4^{abc} ± 1	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
L	2.0^{b} ± 0	0.0 ^{a} ±0	9^{de} ± 2	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
M	0.0 ^{a} ±0	0.0 ^{a} ±0	75^{i} ± 5	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
N	0.0 ^{a} ±0	0.0 ^{a} ±0	9^{de} ± 2	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
O	0.0 ^{a} ±0	0.0 ^{a} ±0	46^{f} ± 4	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
P	0.0 ^{a} ±0	0.0 ^{a} ±0	3^{ab} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
Q	0.0 ^{a} ±0	0.0 ^{a} ±0	3^{ab} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
R	0.0 ^{a} ±0	0.0 ^{a} ±0	2.0^{ab} ± 0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
S	0.0 ^{a} ±0	0.0 ^{a} ±0	5^{bcd} ± 1	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0
T	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0	0.0 ^{a} ±0

Values along the same column with the same superscripts are not significantly different at α = 0.05 based on Duncan's multiple range test

Key: A= Chemistry lab preparation room; B=Biochemistry lab; C=Chemistry lab 1; D=MCB staff lab 1; E=Engineering lab; F=Agric lab; G=Professor Lab 1 Chemistry; H=Professor Lab 2 Chemistry; I=Industrial Chemistry lab; J=Chemistry PG lab; K=Chemistry lab2; L=Biology lab; M=Biology Teaching lab; N= Biochemistry lab2;O=Chemical Eng. Lab; P=Microbiology general lab; Q=Microbiology PG research lab1; R=Physics lab; S=MCB staff lab 2; T=Microbiology PG research lab2.

Table 3: Characterization and Identification of Bacterial Isolates.

Bacterial isolates	Gram reaction	Cell shape	Cells' arrangement	Motility	Oxidase	Catalase	Coagulase	Arabinose	Starch hydrolysis	Citrate	Indole	Urease	Glucose	Lactose	Sucrose	Maltose	Mannitol	Raffinose	VP	Nitrate	Cellobiose	Trehalose	Fructose	OF	Probable identity
1	+	C	cl	-	-	+	-	-	+	+	-	-	+	-	-	+	-	-	-	+	-	+	+	F	*Staphylococcus auricularis*
2	+	C	s	-	-	+	-	-	+	+	-	-	-	+	+	+	+	-	+	+	-	+	+	F	*Staphylococcus aureus*
3	+	C	s	-	-	+	-	-	+	-	-	+	+	-	-	+	-	-	-	+	-	+	+	F	*Aerococcus* sp.
4	+	C	cl	-	+	+	+	-	+	+	-	+	+	-	+	-	+	-	-	+	-	-	+	O	*Micrococcus* sp.
5	+	C	cl	-	+	+	+	-	-	+	-	-	+	-	+	-	+	-	+	-	-	-	+	O	*Micrococcus Kristinae*
6	-	R	s	+	+	+	-	-	+	+	-	-	+	-	+	+	-	-	-	-	+	-	+	O	*Pseudomonas aeruginosa*

Key: - = Negative reaction; + = Positive reaction; c = Cocci; r = Rod; s = Single; cl = Cluster; F = Fermentative; O= Oxidative; OF = Oxidation-Fermentation; VP = Voges proskauer

Table 4: Occurrence of Bacterial Isolates on the Laboratory Workbench Surfaces.

Isolates	Sampling locations																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Staphylococcus auricularis	+	+	+	+	+	+	-	-	+	+	-	-	+	+	-	+	+	+	-	+
Staphylococcus Aureus	+	+	+	-	-	-	+	+	+	-	+	-	+	+	+	-	-	+	-	+
Aerococcus sp.	-	-	-	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	+	-
*Micrococcus*sp.	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	+	-	-	-
Micrococcus kristinae	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	-	-	+	-	+
Pseudomonas aeruginosa	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-

Key: A= Chemistry lab preparation room; B=Biochemistry lab; C=Chemistry lab 1; D=MCB staff lab 1; E=Engineering lab; F=Agric lab; G=Professor Lab 1 Chemistry; H=Professor Lab 2 Chemistry; I=Industrial Chemistry lab; J=Chemistry PG lab; K=Chemistry lab2; L=Biology lab; M=Biology Teaching lab; N= Biochemistry lab2;O=Chemical Eng. Lab; P=Microbiology general lab; Q=Microbiology PG research lab1; R=Physics lab; S=MCB staff lab 2; T=Microbiology PG research lab2

Table 5: Occurrence of Fungal Isolates on the Laboratory Workbench Surfaces.

Isolates	**Sampling locations**																		
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**
Verticillium Lateritium	+	-	-	-	+	-	-	+	-	-	+	-	-	+	+	-	+	-	-	+
Candida sp.	-	+	+	-	-	-	+	-	-	-	-	+	-	+	-	-	-	+	+	+
Alternaria Alternata	-	-	-	+	+	+	-	+	-	+	-	+	+	-	-	-	+	+	-	+
Cladosporium Sphaerospermum	-	-	-	-	-	+	-	-	-	-	-	+	+	+	+	+	+	-	-	-
Rhodotorula sp.	-	-	-	-	-	+	-	-	-	+	-	-	+	-	-	+	-	+	-	-
Scopulariopsis sp.	-	-	-	-	-	-	+	-	-	-	+	-	-	+	-	+	-	+	-	+

Key: A= Chemistry lab preparation room; B=Biochemistry lab; C=Chemistry lab 1; D=MCB staff lab 1; E=Engineering lab; F=Agric lab; G=Professor Lab 1 Chemistry; H=Professor Lab 2 Chemistry; I=Industrial Chemistry lab; J=Chemistry PG lab; K=Chemistry lab2; L=Biology lab; M=Biology Teaching lab; N= Biochemistry lab2;O=Chemical Eng. Lab; P=Microbiology general lab; Q=Microbiology PG research lab1; R=Physics lab; S=MCB staff lab 2; T=Microbiology PG research lab2

Table 6: Antibiotics Susceptibility Patterns of Bacterial Isolates.

Bacteria	**Antibiotics**							
Gram Positive	**CAZ**	**CRX**	**GEN**	**CTR**	**ERY**	**CXC**	**OFL**	**AUG**
Staphylococcus auricularis	-	-	11	-	-	-	33	-
Staphylococcus aureus	-	-	13	-	19	-	36	-
Aerococcus sp.	-	-	17	-	-	-	-	-
Micrococcus sp.	-	-	20	-	21	-	30	-
Micrococcus Kristinae	-	-	20	-	22	-	35	-
Gram negative	CAZ	CRX	GEN	CPR	OFL	AUG	NIT	AMP
Pseudomonas aeruginosa	-	-	-	-	-	-	34	-

Key: -, absence of zone of inhibition; CAZ, Ceftazidime 30µg; CRX, Cefuroxime 30µg; GEN, Gentamicin 10µg; CTR, Ceftriaxone 30µg; ERY, Erythromycin 5µg;CXC, Cloxicillin 5µg ;OFL, Ofloxacin 5µg;AUG, Amoxycillin-Clavulinate 30 µg; AMP, Ampicillin 10 µg; NIT, Nitrofurantoin 300 µg; CPR; Ciprofloxacin 5 µg.

4. Conclusion

It can be concluded from this study that viable microorganisms are present on workbench surfaces. Some of these microorganisms are known to be pathogenic. Therefore, there is need to prevent contamination of the laboratory workbench surfaces.

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