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Research Article

Bacteriological Assessment of Air Quality in Male and Female Hostels At Federal University Dutsin-Ma, Katsina State

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ABSTRACT

The evaluation of microorganisms present in indoors has become necessary, as how safe the air in our surrounding environment where we spent time is fundamental to our wellbeing. Hence, this study was aimed at assessing the indoor air quality of Male and Female hostel in Federal University Dutsin-Ma, Katsina State. Using the settle plate sampling technique using open Petri dishes containing culture with sampling done twice daily morning and evening consecutively. The microbial isolates were characterized and identified based on macroscopic, microscopic and biochemical characteristics. Total aerobic bacterial isolated ranged between the average of 40cfu/m^3 - 164cfu/m^3& 20cfu/m^3 – 182cfu/$m^3$for male and female respectively. The predominant bacterial species isolated and characterized from all sample were Staphylococcus sp, Micrococcus sp and Bacillus spp. Staphylococcus sp having the highest percentage of 57.7%, followed by Bacillus sp with 32.78% and Micrococcus sp having the least with 9.83%. The result of this studies shows that the organisms isolated which are Staphylococcus spp, Micrococcus spp and Bacillus spp. May be the potential cause of several infections to the students living in the hostels which may be due to overcrowding, limited indoor air and higher activities of the occupants.

Keywords: Bacterial Isolates; Indoor; Hostels; Male and Female; Gender

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INTRODUCTION

Many factors have been shown to influence the bacterial transfer between surfaces, including the source and destination of surface features, bacterial species involved, moisture levels, pressure and friction between the contact surfaces and inoculums size on surfaces (Chen *et al.,* 2002; Rusin*et al.,* 2002). Studies have also shown that household surfaces can easily be contaminated with bacteria and that viruses can easily be transferred to hands and from hands to mouth (Rusin *et al.,* 2002**)**. As people come in contact with surfaces as desks, keyboards and office furniture, toilet lock handles, there is possibility of picking up microbes deposited on them. The toilet and offices lock handles are contact more frequently with their users and visitors, especially public toilets and offices. The hazards associated with toilet facilities office furniture and other fomites had been established but less attention had been directed to toilets and offices lock handles as inanimate objects which could harbor and transmit infectious agents (Amala *et al.,* 2015).

However, air is not a natural medium of growth and reproduction of microorganism, any organism, that air-borne contain must have originated from living (human, animal and plant) or nonliving. (Yaghoub and Elabash, 2010). Indoor air quality is one of the most significant factors affecting the health and wellbeing

of people who inhale $10m^3$ of the air every day and spend between 80-95% of their lives indoors as reported by Annals of Agricultural and Environmental Medicine (ACGIH, 1995). The air inhaled by people is abundantly populated with microorganisms which form so called bioaerosol. Bioaerosol is a colloidal suspension, formed by liquid droplets and particles of solid matter in the air, whose components contain or have attached to them fungal spores, viruses, conidia and bacterial Endospores (ACGIH, 1995).

Possible sources of biological contamination of indoor air include people, organic dust, various materials stored in the building and the air flowing from the ventilation and air conditioning systems. Microorganisms may affect the general health of people who live in such places (Borne hag et al., 2004). Indoor air quality is rapidly becoming an environmental concern because a significant number of people spend most of their time in a variety of different indoor environment. This indoor environment includes but is not limited to homes, offices, hotels, restaurants, Government buildings, factories, Warehouses and vehicles including cars, planes, buses and trains. (Holmes *et al.*, 2008). In addition, long term contact of people with bio-aerosols can influence a person's mental power and learning ability (Naruka and Gaur 2014). Different environmental conditions such as temperature, UV light, dryness and humidity, play role in controlling the growth of air borne particles. Nevertheless the microbes manage to reach new hosts through the air for its survival (Sheik *et al*., 2015). Poor ventilation, crowded conditions and increase in number of air conditions inside building nowadays can facilitate the Spreading and the survival rates of air bone particles and also can increase the chance of people at risk of air bone infections. Among dust particles present in the indoor environment, fungus which reproduces by forming spores, some bacteria especially gram positive bacteria and viruses can survive for a long time in the air (sheik *et al*., 2015).

Good indoor air quality (IAQ) is important for all of us most people spend 90% or more of their time indoors (sheik *et al.,* 2015). Most of this consists of the hours spent at home or at work, but for example, school age children spend 20% of their time in schools (Holmes *et al.*, 2008). Good IAQ consists of many aspects. It is an interaction of functioning and efficient ventilation and the lowest achievable amounts of chemical, inorganic or organic and microbial compounds which should not evoke symptoms in the occupants (sheik *et al*., 2015). Moisture damage and microbial growth indoors are associated with adverse health effects among the occupants (Bornehag *et al*., 2004). Dampness or moisture damage is common problem in building all over the world. High moisture load in building can also be found in repeatedly damp facilities, such as instructional kitchens. This may lead to microbial growth on surfaces and structures. There are however, few studies, which have evaluated microbial conditions in these kinds of facilities.

Exposure to bio-aerosols, containing airborne microorganism and their bye-products can result in respiratory disorders and other adverse health effects such as infections, hypersensitivity pneumonia and toxic reactions (Gorny *et al.,* 2002). In many environment including hospitals, animal sheds, clean rooms, pharmaceutical facilities and space craft environment the presence of bio-aerosols can compromise normal activities making efficient monitoring crucial (Rusin *et al.,* 2002). Microbial damage in indoor/outdoor areas, is caused mostly frequently by molds and bacteria. These microorganisms have very important role in the biogeochemical cycle, as their task consists of dis integrity organic mass reusable metabolites. In the environment spores of molds and bacteria may become air borne and are therefore ubiquitous. They can enter indoor areas either by means of positive ventilation or by means of ventilation system.

Several studies have identified human activities as an important source for indoor bio-aerosols. (Douwes, 2003). Human bodies can generate bio-aerosol directly through activities like talking, sneezing and coughing, while other residential activities (i.e. washing, flushing toilet, sweeping floors) can generate bio-aerosols indirectly (Chen and Hildemann, 2009). In a study by (wouters *et al*. (2009), they investigated the effect of indoor storage of organic household waste on microbial contamination among 99 households in the mother lands in the summers of 1997, and indicated that increased microbial contaminated levels in homes are associated with indoor storage of separated organic waste which might elevate the risk of bio-aerosol related respiratory symptoms in susceptible people.

Infectious diseases are a part of daily life, and acute respiratory infections are most common of human illness. Most of the agents responsible for respiratory infection are spread through the air. Primary from person to person (anthropones) but also from living animals (zoonosis) and the abiotic environment, for example soil, water, or decaying plant or animal matter (Hubalek, 2003), the common acute respiratory infections is influenza which produces the most source illness and account for the greatest number of days of restricted activity in the united

states (Akazawa *et al.,* 2003). Respiratory infections occur so often and usually mild, therefore, many persons take them for granted. This study determined and accessed the bacteriological air quality in some selected rooms in male and female hostels, Federal University Dutsin-Ma Katsina.

MATERIALS AND METHODS

Study Area

This study was carried out in male and female hostels of bock A, B, C and D at federal university Dutsin-Ma Katsina state Nigeria with latitude and longitude of 12.4545^0N and 7.4977^0E.

Sampling Size and Methods

20 Samples were randomly selected using piloting system from male and female hostel rooms each in triplicate in each of the four Block (A, B, C and D). The settle plate method was done by exposing petri dishes containing culture media at different locations in the corners of the rooms. The sampling was done in the morning and afternoon. The Nutrient agar was aseptically prepared and was exposed for 30 min at height of 6 feet above the ground in all the laboratories sampled. Thereafter, the plates were covered and transferred immediately to the laboratory for incubation. Incubation was done in an inverted position and the agar plates were incubated at 36°C for 24-48 hrs.

Media Preparation

28g of nutrient agar were weighed and suspended in to one liter of distilled water. The homogenous mixtures were sterilized in an autoclave at 121^{0c} for 15 minutes. The sterilized mixtures were allowed to cool at about 40^0c and dispensed in to petri dishes (Cheesebrough, 2000).

Sample Collections

Sedimentation technique which involves the opening of plate with specific culture media was employed for this study. Prepared plates of nutrient agar were exposed to air for 30mins at different rooms in respective hostels. After sampling, all plates were immediately taken to the microbiology laboratory and incubated at 37^0c for 24 hours for isolation of bacteria. The colonies were sub-cultured on to a new fresh medium in order to obtain pure culture. (Sekulska, 2003).

Isolation of pure culture

In order to obtain the pure culture, colonies from precisely incubated plates were sub-cultured (using streak method) on to another freshly prepared nutrient agar and incubated at 37^0c for 24hrs. (Cheesebrough, 2000).

Identification and Characterization of Isolates

The isolates were characterized using established microbial methods which included colonial morphology, Gram-stain characteristics, and Biochemical test. (Cheesebrough, 2000).

Colony Count

A colony forming unit (CFU) is a unit used to estimat e the number of viable bacterial or fungal cells in a sample. Viable is defined as the ability to multiply via binary fission under the controlled conditions. Counting with colony-forming units requires culturing the microbes and counts only viable cells, in contrast with microscopic examination which counts all cells, living or dead (Chen and Hildemann, 2009).

Gram Staining

Gram's staining was done to find the reaction of the bacterial isolates to gram's reagents. A smear was prepared and heat fixed. The crystal violet (primary stain) stain was flooded over the fixed culture for 60 Seconds; the stain was washed with water. The iodine solution was added on to the smear for 60 seconds, pours off and missed with water. A few drop of decolorizer (ethyl alcohol/acetone) was added and washed with water immediately after 5 seconds and finally safranin (secondary stain) was added for 60 seconds and washed, the smear was allowed to air dry. After drying the slide was mounted under the microscope and observed. The stain differentiate bacterial species in to two groups; Gram-positive bacteria, which takes up crystal violet dye (primary stain) and are stained Blue-Purple and Gram-negative, which pick up safranin (secondary stain) and these stain Pink-red after decolorization with alcohol (Fawole and Osho, 2002).

Biochemical Test

Biochemical test such as catalase, indole, methyl red (MR), Coagulase, voges proskauer (VP) and citrate utilization were carried out on the isolated bacteria according to Cheesbrough (2009).

Procedure for Catalase Test

Pour 1-2ml of hydrogen peroxide solution in to a test tube, using a sterile wooden stick or a glass rod take several colonies of the 18hours to 24 hours test organism and immerse in the hydrogen peroxide

solution.Observed for immediate bubbling of oxygen which shows the presence of catalase enzymes, which breakdown the hydrogen peroxide in to oxygen and water which is the catalase positive and absence of oxygen bubbles indicate catalase negative (Cheesbrough, 2009)

Procedure for Indole Test

The tryptophan broth was inoculated with isolated colony of the test organism in tryptophan broth and incubated at 37^0c for 24-28 hours in a burnt air. 0.5ml of kovac's reagent was added to the both culture. Positive result shows red/pink colored inks within 1minute no color change indicate negative (Cheesbrough, 2009).

Procedure for Citrate Utilization Test

A Simmon citrate agar, was prepared in test tubes, 5ml of the medium was autoclaved for 15 minutes till the test tube containing melted citrate medium to prepare district slant and butt. The given sample of organism was inoculated on the slant of the media using sterile wire and label the tube, the tubes was incubated at 37^0c for 24-28 hours. Citrate positive change color of media to blue (Cheesbrough, 2009)

Procedure for Methyl Red/Voges Proskauer Test

MR-VP broth is used for both MR test and VP test. Only the addition of reagent differs and both tests are carried out consecutively.

Inoculate two tubes containing MR-VP broth with a pure culture of the organism and incubate at 35^0c for 4days, add about 2-3 drops of the methyl red indicator. Te rest part of the broth was used and 5drops of 40% potassium hydroxide (KOH) was added followed by 15drops of 5% napthol in ethanol and shake, loosen the cap of the tube and place in a sloping position, the development of red color within 1hour indicate positive, no color change is negative (Cheesbrough,2009).

Procedure for Mannitol Fermentation Test

Mannitol salt agar were prepared according to the manufacturer's directions in a conical flask; it was then allowed to cool down to 50^0C in a water bath, afterwards poured in a sterile Petri dish and allowed to set. The organism to be identified was inoculated on the agar plate with the aid of a wire loop by streaking, incubated at 37^0C for 18hrs and checked for evidence of growth on the surface and as well for color change from red to Golden yellow was answered positive and no color change indicate negative (Cheesbrough,2005)

Urea Test

This test is used to determine an organism's ability to split Urea to form Ammonia by the action of the enzyme Urease. Medium used for Urease test contains a PH indicator. Phenol red which turns pink at an alkaline PH. Urea broth was inoculated with test organism and incubated for 24hours at 37^0C. Intense pink/red color indicates a positive test and yellow or no color change indicates negative test. (Cheesbrough, 2006).

Motility Test

A motility medium was used for this test. The medium was sterilized and dispensed into sterile test tubes. The inoculum was stabbed horizontally into the tube and incubated at 37^0C for 24hours. The medium has a soft consistency which allows motile bacteria to migrate readily through it causing cloudiness. Thus, a negative result is detected by growth in a distinct zone directly along the stab. A positive result is indicated by diffuse or cloudy growth mostly at the top and bottom of the stab. (Cheesbrough, 2006)

Endospores Staining

The heat-fixed smear of each isolate was prepared by passing the slide over a Bunsen burner flame about 3-4times. Malachite green solution was used to flood the slide and steam heated over a beaker of boiling water for 10minutes with continuous addition of more stain to prevent drying. The slide was rinsed with water, blotted dried and examined under immersion lens (*100) objective lens. Vegetative cells stain red while the spores appears green in color, (Fawole and Osho, 2002).

RESULTS

Average aerobic bacteria were recorded in all of the selected hostel rooms of Federal University Dutsin-Ma; Table 1 shows the total aerobic count of isolates in block A-D hostel rooms. This table revealed that the total aerobic bacteria enumerated in the morning and in the afternoon during the period of study. 150cfu/m^3 was the highest value recorded in the morning in block A and 65 cfu/m^3 in the afternoon in male hostels while in the female hostels 155cfu/m^3 and 95 cfu/m^3in the morning and afternoon in female hostels respectively. 95 cfu/m^3 and 160 cfu/m^3 are recorded in the morning and afternoon in male hostels B. 121 cfu/m^3 is the highest number observed and 113 cfu/m^3 in the afternoon and morning in female respectively. 160 cfu/m^3 was the highest value recorded in the afternoon in block C and 136 cfu/m^3 in the afternoon in male hostels while in the female

hostels too numerous to count was observed and 73 cfu/m^3in the morning and afternoon in female hostels respectively. In block D 101 cfu/m^3 and 100 cfu/m^3 were the values recorded in the morning in male hostels and 135 cfu/m^3 and 94 cfu/m^3 are also the high values recorded in the afternoon in female hostels respectively.

Table 2 shows the average bacteria count in all the blocks (A, B, C and D) for the Male and Female hostels 502 cfu/m^3 and 604 cfu/m^3 are recorded in block A in male and female hostels respectively. While 426 cfu/m^3 and 484 cfu/m^3 values were observed in block B in male and female hostels respectively In Block C 425 cfu/m^3 and 252 cfu/m^3 was recorded in male and female hostels respectively. And also in block D 430 cfu/m^3 and 315 cfu/m^3 are the average values observed in both male and female hostels respectively.

Table 3 shows the biochemical characteristic and the bacterial isolates from Block A, B, C and D in male hostels which includes *Bacillus spp, Micrococcusspp* and *Staphylococcus aureus*

Table 4 shows the biochemical characteristic and the bacterial isolates from Block A, B, C and D in Female hostels which includes *Bacillus spp, Micrococcusspp* and *Staphylococcus aureus*

Table 5 shows the occurrence and the percentage of occurrence of the three dominant bacteria isolates in which *Staphylococcus aureus* have 57.37% *Micrococcus spp have 9.83%* , *Bacillus spp* have 32.78%. The bacteria were also shown in pie chart (fig. 1 and 2).

Table 1. Bacteria Count in Air Samples from the Male and Female hostels

Block/room number	**Male Hostels**		**Female Hostels**	
	Morning(cfu/m3)	**Afternoon (cfu/m3)**	**Morning(cfu/m3)**	**Afternoon (cfu/m3)**
A1	33	30	105	80
A3	150	60	40	25
A7	23	39	155	35
A5	83	65	75	60
A2	60	46	80	95
B1	95	160	20	45
B4	45	71	49	25
B8	12	81	113	75
B7	32	16	98	121
B10	62	30	32	51
C1	127	160	TNTC	35
C7	63	30	58	45
C9	136	55	85	73
D10	84	95	_	20
D3	79	100	18	22
D6	67	30	62	30
D8	101	50	_	26
D9			135	94
D7			67	_
D3			36	19

Key: - = No growth. TNTC = Too Numerous To Count.

Table 2.Average bacterial count in relation to the blocks of male and female hostel

MEAN BACTERIAL COUNT (cfu/m^3)			
Block/Room No.	Males hostel	Block/Room No.	Female hostel
A1	48	A2	145
A2	180	A5	53
A3	43	A9	173
A5	83	A7	105
A7	148	A10	128
TOTAL	**502**		**604**
Block/Room No	Males hostel	Block/Room No	Female hostel
B1	175	B1	62
B4	81	B3	151
B7	40	B4	170
B8	53	B8	58
B10	77	B9	43
TOTAL	**426**		**484**
Block/Room No	Males hostel	Block/Room No	Female hostel
C1	132	C3	81
C7	129	C5	122
C9	164	C7	20
		C10	29
TOTAL	**425**		**252**
Block/Room No	Males hostel	Block/Room No	Female hostel
D3	90	D3	43
D6	82	D4	26
D8	126	D5	77
D10	132	D7	67
		D9	182
TOTAL	**430**		**395**

Table 3. Biochemical reaction of each isolates in male hostel to different biochemical test with the presumptive microorganisms

BLOCK	Isolates	Grams reaction	Catalase Test	Coagulase Test	Motility Test	Urease Test	Citrate Test	Indole Test	MR Test	VP Test	Mannitol	Spore	Presumptive Microorganism
A	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	_	_	_	_	_	_	_	_	N.C	-	*micrococcusspp*
B	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	_	_	_	_	_	_	_	_	N.C	-	*micrococcusspp*
C	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	_	_	_	_	_	_	_	_	N.C	-	*micrococcusspp*
D	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	_	_	_	_	_	_	_	_	N.C	-	*micrococcusspp*

Keys: + = positive**; -** = negative; N.C = not conducted

Table 4. Biochemical reaction of each isolates in female hostel to different biochemical test with the presumptive microorganisms

BLOCK	Isolates	Grams reaction	Catalase Test	Coagulase Test	Motility Test	Urease Test	Citrate Test	Indole Test	MR Test	VP Test	Mannitol	Spore	Presumptive Microorganism
A	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	+	_	_	+	_	_	_	_	N.C	-	*micrococcusspp*
B	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	+	_	_	+	_	_	_	_	N.C	-	*micrococcusspp*
C	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	+	_	_	+	_	_	_	_	N.C	-	*micrococcusspp*
D	Isolate A	+	+	+	_	_	_	_	_	+	N.C	N.C	*Bacillus spp*
	Isolate B	+	+	+	_	+	+	_	_	_	+	-	*Staphylococcus aureus*
	Isolate C	+	+	_	_	+	_	_	_	_	N.C	-	*Micrococcusspp*

Keys: + = positive**; -** = negative; N.C = not conducted

Table 5. Distribution of bacterial species from the isolates recovered from indoor air.

Isolated microorganism	Number of isolate	Percentage (%)
Staphylococcus spp	35	57.37
Micrococcus spp	6	9.83
Bacillus spp	20	32.78
TOTAL	**61**	**100**

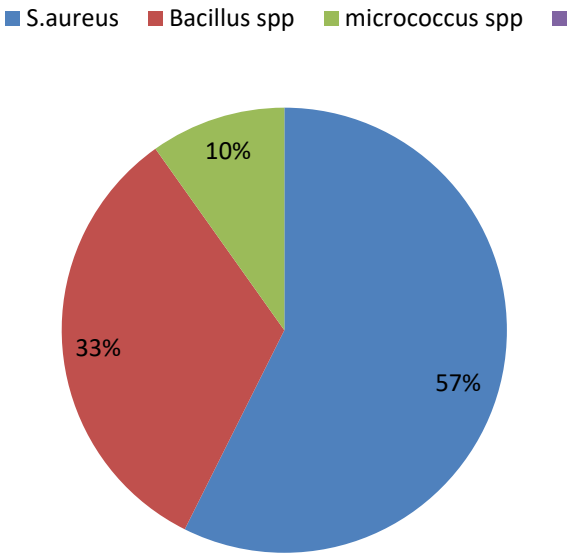

Fig. 1. Percentages of bacterial isolates

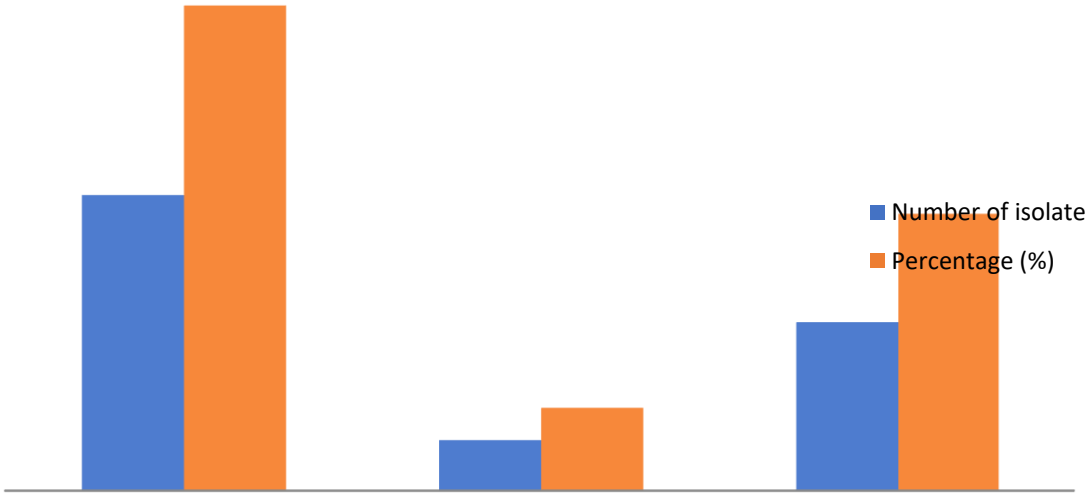

Fig. 2. Occurrence and bacteria percentages

DISCUSSION

Average aerobic bacteria were recorded in all of the isolated from hostel rooms of Federal University Dutsinma; Table 1 shows the total aerobic count isolated in block A-D hostel rooms. The results from this study revealed that male students' hostels recorded the higher indoor airborne bacterial population than the female hostels. This high population of microbes in the indoor air of the male hostels may be due to the large number of occupants, especially when they returned to have rest in the afternoon when there are maximum activities by the students. This disagreed with the work of (Ibrahim *et al.,* 2019) in term of high number of isolated bacteria in male hostels. There was variation in concentration of bacteria across the various sample sites of male and female hostel recorded the highest count. This could be attributed to the variation intensity of human population activities taking place before and during sampling time as well as the variation of ventilation conditions. These findings do agree with earlier reports by Graduenz *et al.,* 2005 research findings on hostels with high count attributed to poor ventilation and student activities on going when sampling.

However. This difference could be attributed to the fact that there was less ventilation in the morning due to the shutdown of the doors and windows arising from the previous day human activities. This finding is in agreement with the work done by Awosika (2012) who research on male and female hostel of Asian Pacific University where the microbial load in their findings was more in the morning compares to evening due to previous day activities of student in the hostels.

The occurrence and the percentage of occurrence of the three dominant bacteria isolated are *Staphylococcus aureus* having 57.37%, *Micrococcus spp have 9.83%*, *Bacillus spp* having 32.78%.The higher incidence of *Staphylococcus spp* obtained from this study correlate with several and similar findings of the studies conducted by several researchers. A study conducted by (Yaghoub and Elagbash, 2010). These airborne micro-flora obtained were similar to those obtained by Ekhaise (2010) and these bacteria are common causative agent of various human diseases, it is responsible for many gastrointestinal tract infections, respiratory tract infections and skin disorders as reported by Yaghoub and Elagbash, (2010).

The predominant bacterial species isolated and characterized from all sample were *Staphylococcus spp, Micrococcus spp and Bacillus spp*. In this study *Staphylococcus spp* was the dominant isolated organism (Fig. 1). *Staphylococcus spp* belong to normal flora of the human skin and nose, it is likely that this organism may be originated from the nose and skin flora of the students staying in the hostel which is a similar study by Awosika (2012) *Staphylococcus aureus* was the predominantly isolated bacterium. Similarly, *Bacillus, Micrococcus, Microbacterium, Pseudomonas* and *Staphylococcus* were previously reported as the dominant bacteria in environments from different parts of the world (Fang et al., 2007; Gorny and Dutkiewicz, 2002)

Conclusion

This study reveals the presence of bacteria in rooms at both the female and male hostels of Federal University Dutsin-Ma, Katsina State. The presence and distribution of bacterial isolated in male and female hostels between the morning and afternoon may be due to the activities by the occupants, which May be potential cause of several infections to the students living in the hostels. Hence, there is need for proper ventilation systems in the hostels. A proper control measure has to be taken to prevent the environmental factors which facilitate the growth and proliferation of pathogenic bacteria in hostel. Disinfection of floors should be performed routinely and dust should be prevented. Also, construction more Student hostel should be encourage by school management, Government or private investors.

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