CHARACTERIZATION AND IDENTIFICATION OF BACTERIA PRESENT IN THE BATH TOWELS OF FEMALE STUDENTS IN RIVERS STATE UNIVERSITY HOSTELS

Abstract

Bath towels are an important part of our everyday life, but they often amass a large number of micro-organisms which may sometimes be harmful to us. For the study a total of 10 samples plus a control were collected from bath towels of female students in NDDC hostel, post-graduate hostel and Mile 3 market respectively standard methods were employed for the sampling and determination of microbiological characteristics. Identification of bacteria was carried out using colonial, morphological and biochemical characteristics. Statistical analysis were performed using the T-test method and sensitivity was carried out on the isolates to detect pathogenicity. Range of microbial counts of NDDC hostel were: Total heterotrophic bacteria 2.0 x 10^4 cfu/ml to 3.17 x 10^4 cfu/ml, Total coliform count 0.48 x 10^4 cfu/ml to 2.99 x 10^4 cfu/ml in the first sampling. Post graduate hostel ranged from: Total heterotrophic bacteria 1.48 x 10^4 cfu/ml to 0.18 x 10^4 cfu/ml in the first sampling. For the second sampling, NDDC hostel microbial count ranged from 0.73 x 10^4 cfu/l to 1.15 x 10^4 cfu/ml in the total heterotrophic bacteria, and 0.31 x 10^4 cfu/ml to 0.13 x 10^4 cfu/ml for total coliform count. Post graduate hostel ranged from 0.27 x 10^4 cfu/ml to 0.93 x 10^4 cfu/ml for total heterotrophic bacteria and 0.22 x 10^4 cfu/ml to 0.18 x 10^4 cfu/ml for total coliform count. The control microbial count for total heterotrophic bacteria were 0.12 x 10^4 and 0.16 x 10^4 cfu/ml for the first and second sampling respectively and for the total coliform count, 0.18 x 10^4 cfu/ml and 0.17 x 10^4 cfu/ml for the first and second sampling respectively. Statistical analysis using student's T-test was carried out. The mean test values for total heterotrophic bacteria in the first and second samplings were 2.2750E2 and 57.4000 in NDDC hostel and 1.5060E2 and 66.8000 in post graduate hostel. The mean values for total coliform count for the first and second samplings were 1.6220E2 and 24.5000 in NDDC hostel and 99.8000 and 26.9000 in Post graduate hostel. The test revealed that there was no significant difference in the bacterial load of NDDC hostel and Post graduate hostel from the two samplings. In the antimicrobial susceptibility test carried out, results showed that Ciproflox, Reflacine and Tarrivid were most effective against the isolates, whileth the isolates mostly showed resistance against Amplicox, Amoxil and Azithromycin. The bacteria species isolated were *Staphylococcus aureus, Escherichia coli, Staphylococcus spp, Bacillus cereus, Klebsiella spp, Bacillus spp.* The study demonstrated that significant numbers of *E.coli,* and staphylococcus as well as other microbes occur in bath towels.

Key Words: Towels, Bathroom, Hostel, Bacteria, Coliforms, Pathogenicity.

INTRODUCTION

Bath towels are clothes we use to wipe or clean our body after bath. They collect and accumulate microorganisms from the body and surroundings where they are kept creating an avenue for changes in incidence, pathogens and outcome (Martin, 2012).

Commensals as well as mutualistic microorganisms habit the skin preventing pathogens from taking over the skin (Hadaway, 2003). At times these normal skin flora cause diseases especially in immune compromised persons (Fedricks, 2007).

As we know the environment is laden with consortium of microorganisms in dust suspensions, bath water bath sponge e.t.c. sometimes bacteria and viruses that habit the intestinal tract of humans can get into bathing water when it gets contaminated with feaces and hence when we clean our body with towels, these organisms are lodged on the bath towels. Some of these organisms include Escherichia coli, Salmonella, Rotavirus, Enterovirus, Pseudomonas aeruginosa, Aeromonas hydrophilia, Staphylococcus epodemidis, and Staphylococcus aureus (Corazza *et al.*, 2002, Botone & Perez, 1993; Madigan *et al*., 2000; Chapelle, 2002).

According to Roth and James, (1988) some of these microorganisms are opportunistic especially when there are injuries to the skin or immune compromised persons, they cause severe infections.

MATERIALS AND METHODS

Study Area

The sampling area was the Rivers State University Female hotels

Station I: NDDC Female Hostel

Station II: Post-graduate Female Hostel

Station III: Control Towel Purchased from Mile 3 Market

Sample Collection

Female bath towels were swabbed from the hostels using sterile swab sticks while wearing sterile gloves. The swab sticks were put in sterile zip lock bags and transported to the

Preparation of Media

All the media used in this work including Nutrient Agar, Eosine Methylene blue and MacConkey was prepared according to manufacturers description

Antibiogram (Agar disk diffusion method)

Antibiogram or Antibiotic sensitivity testing is the measurement of the susceptibility of bacteria to antibiotics. A sterile swab stick was dipped into a tube containing, the bacteria suspension and its turbidity is equivalent to 0.5m Mcfarland turbidity standard and the swab stick was pressed against the tube above the fluid level to remove evenly which contained already prepared Mueller hinton agar in three dimension rotating the plate about 60^{o}c each time. The agar plate was allowed to dry for 5 minutes then the antimicrobial disk was

impregnated into the agar using a sterile forcep or the surface of the inoculated plate 1.5ml away from the edge of the plate. Using the head of the sterile forcep, the disk is slightly preserved down to ensure good contact with the agar. After applying the disk, the plates were incubated in an inverted position at 35^{o}c for 16 to 18 hrs. After incubation, the test plates were examined to ensure confluence growth or near confluence. The diameter of each zone of inhibition was measured in milimetres using a ruler on the underside of the plate and recorded for reference purposes (CLSI, 2017).

RESULTS

The results for the total heterotrophic count of bacteria for the first and second sampling of bath towels were presented in table 1 and 2. The results showed that NDDC hostel had the highest count for the first sampling at 3.17 x 10^4 cfu/ml and post graduate hostel had the highest count for the sample sampling at 1.17 x 10^4 cfu/ml.

In table 3 and 4, results for total coliform are presented and they showed that NDDC hostel had the highest count for first sampling at 2.99 x 10^4 cfu/ml and post graduate hostel had the highest count for the second sampling at 0.41 x 10^4 cfu/mu.

In table 5 and 6, results for occurrences of isolates on the samples were presented. In the first sampling the isolates Staphylococcus aureus, Bacillus cereus, E.coli and Klebsiella sp had the highest occurrence at 9.30% and the lowest occurrence at 2.33% for Staphylococcus sp & Bacillus sp. In the second sampling, the highest occurrence happened in E.coli at 21.7%, while the lowest was Staphylococcus aureus at 8.7%,

In table 7 and 8, results for morphological and Biochemical test were presented. The results showed that about 59% of the isolates were gram positive and 41% gram negative.

Table 1: Total Heterotrophic count (First Sampling)

Location	Sample	THB1	THB2	Mean	CFU/ml
NDDC Hostel	A	190	210	200	2.0×10^4
	B	113	92	103	1.03×10^4
	C	308	294	301	3.01×10^4
	D	220	215	218	2.18×10^4
	E	315	318	317	3.17×10^4
PG Hostel	F	150	145	148	1.48×10^4
	G	68	42	55	0.55×10^4
	H	207	195	201	2.01×10^4
	I	40	37	39	0.39×10^4
	J	321	301	311	3.11×10^4
	Control	8	15	12	0.12×10^4

Table 2: Total Heterotrophic count (Second Sampling)

Location	Sample	THB1	THB2	Mean	CFU/ml
NDDC Hostel	A	76	69	73	0.73×10^4
	B	40	33	37	0.37×10^4
	C	46	54	50	0.5×10^4
	D	17	10	14	0.14×10^4
	E	117	112	115	1.15×10^4
PG Hostel	F	33	20	27	0.27×10^4
	G	50	28	39	0.39×10^4
	H	66	52	59	0.59×10^4
	I	112	122	117	1.17×10^4
	J	87	98	93	0.93×10^4
Mile 3 Market	Control	10	22	16	0.16×10^4

Table 3: Total Coliform count (First Sampling)

Location	Sample	THB1 (10^{-1})	THB2 (10-1)	Mean	CFU/ml
NDDC Hostel	A	50	46	48	0.48×10^4
	B	47	36	42	0.42×10^4
	C	140	210	175	1.75×10^4
	D	281	215	248	2.48×10^4
	E	292	305	299	2.99×10^4
PG Hostel	F	288	292	290	2.9×10^4
	G	15	21	18	0.18×10^4
	H	140	165	153	1.53×10^4
	I	26	16	21	0.21×10^4
	J	18	17	18	0.18×10^4
	Control	17	19	18	0.18×10^4

Table 4: Total Coliform count (Second Sampling)

Location	Sample	THB1 (10^{-1})	THB2 (10^{-1})	Mean	CFU/ml
NDDC Hostel	A	33	29	31	0.31×10^4
	B	31	25	28	0.28×10^4
	C	36	24	30	0.30×10^4
	D	24	17	21	0.21×10^4
	E	16	10	13	0.13×10^4
PG Hostel	F	16	28	22	0.22×10^4
	G	21	32	27	0.27×10^4
	H	32	23	28	0.28×10^4
	I	39	42	41	0.41×10^4
	J	15	21	18	0.18×10^4
Mile 3 Market	Control	13	20	17	0.17×10^4

Table 5: Frequency Table (First Sampling)

Isolates	A	B	C	D	E	F	G	H	I	J	Control	Total	Percentage (%)
HO_1	+			+					+	+		4	9.30%
HO_2			+			+				+		3	6.97%
HO_3									+	+	+	3	6.97%
HO_4	+								+			2	4.65%
HO_5									+			1	2.33%
HO_6			+	+					+			4	9.30%
HO_7						+			+			2	4.65%
HO_8			+			+			+			3	6.97%
HO_9	+			+	+						+	4	9.30%
HO_A					+				+			2	4.7%
HO_B									+		+	2	4.7%
HO_C									+			1	2.33%
HO_D			+									1	2.33%
HO_E						+						1	2.33%
HO_F	+					+						2	4.65%
HO_{E1}			+			+				+	+	4	9.30%
HO_{E2}		+			+					+	+	4	9.30%
Total												**43**	**100%**

Table 6: Frequency Table (Second Sampling)

Isolates	1	2	3	4	5	6	7	8	9	10	Control	Total	Percentage (%)
1	+			+						+		3	13.0%
2			+					+				2	8.7%
3			+			+		+				3	13.0%
4	+								+	+		3	13.0%
5	+				+		+					3	13.0%
6		+		+	+						+	4	17.4%
7	+				+				+	+	+	5	21.7%
Total												**23**	**100%**

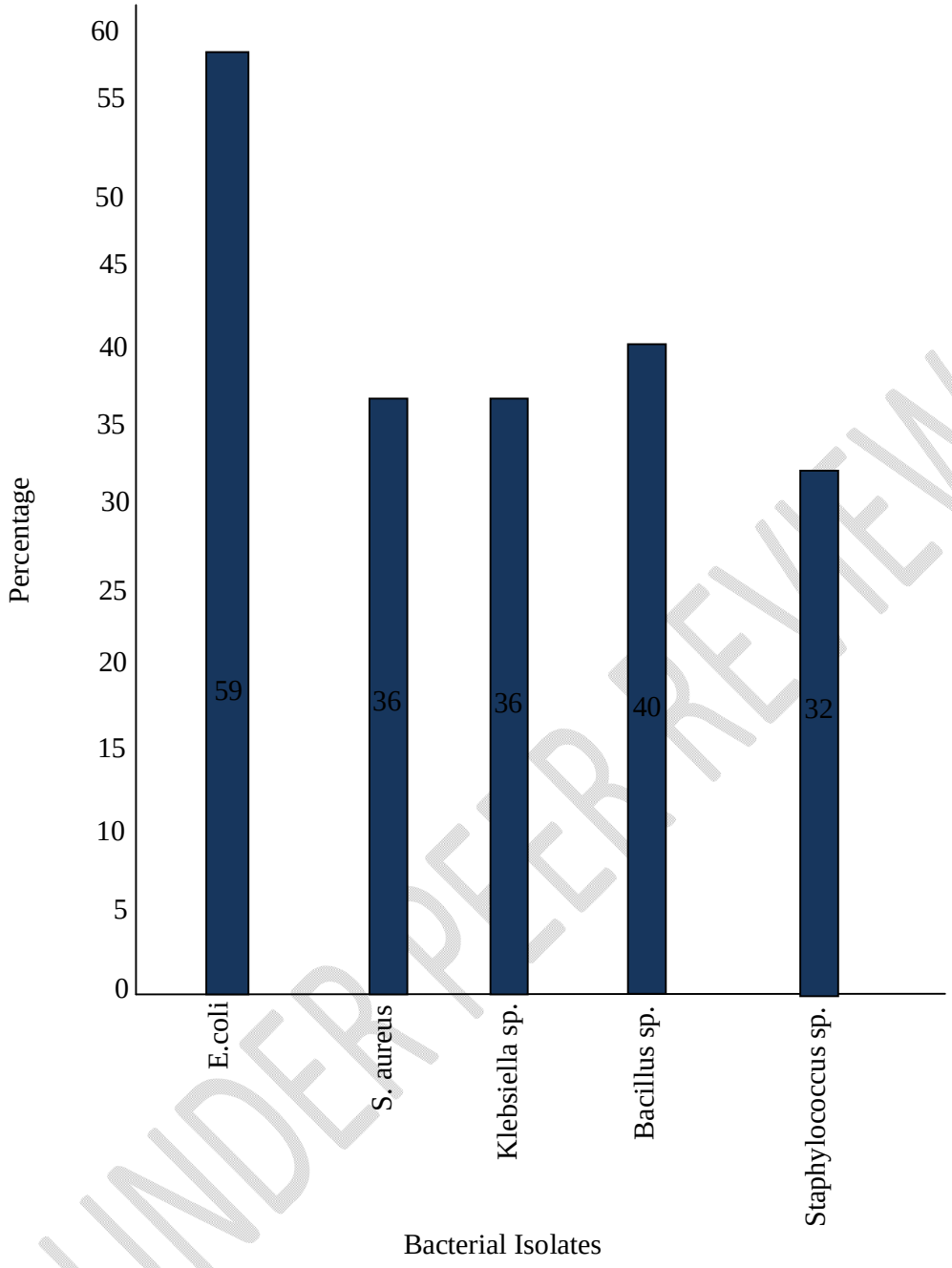

Figure 1: % Occurrence of Bacterial Isolates in the Towel Sample

Table 7 Colonial Morphology

	Colonial Morphology						Biochemical Reaction								Sugar Fementation				Probable Organism
Isolates	**Margin**	**Colour**	**Texture**	**Shape**	**Elevation**	**Surface**	**Gram**	**Indole**	**Citrate**	**Methyl Red**	**Vogus-Proskaue**	**Motility**	**Oxidase**	**Catalase**	**Lactose**	**Sucrose**	**Glucose**	**Mannitol**	
HO_1	Entire	Yellow Gold	Moist	Cocci	Raised	Smooth	+	-	-	+	-	-	-	+	A	A	A	-	*Staphylococcas aureus*
HO_2	Entire	Creamy	Moist	Rod	Raised	Smooth	-	+	+	-	+	+	+	+	-	A	AG	AG	*Escherichia coli*
HO_3	Entire	Creamy	Dry	Rod	Flat	Smooth	-	-	-	+	+	+	+	-	-	A	AG	AG	*Klebsiella sp*
HO_4	Entire	Creamy	Dry	Rod	Flat	Smooth	+	-	+	+	-	-	-	+	-	-	A	-	*Bacillus sp*
HO_5	Entire	Yellow Gold	Moist	Cocci	Raised	Smooth	+	+	+	+	+	+	-	+	-	-	A	-	*Staphylococcus sp*
HO_6	Entire	Milky	Dry	Rod	Flat	Smooth	+	-	+	+	-	+	+	+	-	-	A	-	*Bacillus cereus*
HO_7	Serrated	Creamy	Dry	Cocci	Flat	Smooth	+	-	+	-	+	-	+	+	-	A	AG	AG	*Staphyloccus aureus*
HO_8	Entire	Yellow Gold	Moist	Cocci	Raised	Smooth	+	+	+	-	-	-	+	+	A	A	A	A	*Staphylococcus sp*
HO_9	Entire	Creamy	Moist	Rod	Raised	Smooth	-	+	+	+	-	+	+	+	-	AG	A	AG	*Escherichia coli*
HO_A	Serrated	Creamy	Moist	Rod	Raised	Smooth	-	+	+	-	+	-	+	+	A	AG	A	A	*Escherichia coli*

HO_C	Entire	Creamy	Dry	Rod	Raised	Smooth	+	+	+	+	-	+	+	+	A	A	A	-	*Bacillus sp*
HO_D	Entire	Creamy	Moist	Rod	Raised	Smooth	+	-	+	-	+	+	+	+	-	-	-	A	*Bacillus sp*
HO_E	Serrated	Creamy	Moist	Rod	Flat	Smooth	-	+	+	-	+	+	+	+	A	AG	AG	AG	*Escherichia coli*
HO_F	Entire	Creamy	Moist	Cocci	Flat	Rough	+	+	+	+	-	+	+	+	A	A	A	A	*Staphylococcus sp*
HO_{E1}	Entire	Creamy	Moist	Rod	Raised	Smooth	-	-	+	-	+	-	+	+	-	AG	A	AG	*Klebsiella sp*
HO_{E2}	Entire	**HO_B**	Entire	Creamy	Dry	Rod	-	-	+	-	+	+	-	+	+	+	A	A	A

Table 8 Colonial Morphology (Contd.)

Colonial Morphology							Biochemical Reaction								Sugar Fermentation				Probable Organism
Isolates	**Margin**	**Colour**	**Texture**	**Shape**	**Elevation**	**Surface**	**Gram reaction**	**Indole**	**Citrate**	**Methyl Red**	**Vogus-Proskauer**	**Motility**	**Oxidase**	**Catalase**	**Lactose**	**Sucrose**	**Glucose**	**Mannitol**	
1	Entire	Creamy	Moist	Rod	Raised	Smooth	-	+	+	-	+	+	+	+	-	AG	A	AG	*Escherichia coli*
2	Entire	Yellow Gold	Moist	Cocci	Raised	Smooth	+	-	-	+	-	-	-	+	A	A	A	-	*Staphylococcus aureus*
3	Entire	Yellow Gold	Moist	Cocci	Raised	Smooth	+	-	-	+	-	-	-	+	A	A	A	-	*Staphylococcus aureus*
4	Entire	Creamy	Moist	Rod	Flat	Smooth	-	+	+	-	+	-	+	+	-	A	AG	AG	*Klebsiella sp*
5	Serrated	Creamy	Dry	Cocci	Flat	Smooth	+	+	+	+	-	-	+	+	A	A	A	-	*Staphylococcus sp*
6	Entire	Milky	Dry	Rod	Flat	Smooth	+	-	+	+	-	-	-	+	-	A	-	-	*Bacillus sp*
7	Entire	Creamy	Moist	Rod	Flat	Smooth	-	+	+	-	+	+	+	+	A	AG	AG	AG	*Esherichia coli*

Table 9: Antibiotic suceptivity pattern of Bacterial isolates from Bath Towels

Gram Positive										
Isolates	**CPX**	**S**	**SXT**	**E**	**PEF**	**CN**	**APX**	**Z**	**AM**	**R**
Bacillus sp.	S	I	R	I	S	S	I	S	S	S
Staphylococcus sp.	S	S	S	I	S	S	R	R	R	I
Bacillus cereus	S	R	R	R	S	R	R	R	R	R
Bacillus sp.	S	R	R	S	S	S	R	R	R	R
Staphylococcus sp.	S	I	R	I	S	R	R	R	R	I
Staphylococcus aureus	S	I	R	I	S	R	R	R	R	I
Bacillus sp.	S	R	R	S	S	I	R	R	R	R
Bacillus sp.	S	I	S	S	S	R	R	R	R	I
Staphylococcus sp.	S	S	R	R	S	R	R	R	R	I
Staphylococcus sp.	S	S	S	I	S	S	R	R	R	I

Table 10: Antibiotic suceptivity pattern of Bacterial isolates from Bath Towels

Gram Negative										
Isolates	**OFX**	**S**	**SXT**	**CH**	**SP**	**CPX**	**AM**	**AU**	**CN**	**PEF**
E. coli	S	S	S	S	S	S	R	R	R	S
Klebsiella sp.	S	R	S	R	S	S	R	R	R	S
E. coli	S	I	S	I	S	S	R	I	R	I
E. coli	R	R	R	R	R	R	R	R	R	R
E. coli	S	S	I	R	S	S	R	R	I	S
E. coli	S	R	R	R	S	S	R	R	R	S
Klebsiella	S	R	S	R	S	S	R	R	R	S

Key:

CPX	-	Ciproflox,	PEF	-	Reflacine	S - Sensitive
S	-	Streptomycin	CN	-	Gentamycin	I - Intermediate
E	-	Erythromycin	AM	-	Amoxil	R – Resistant
APX	-	Ampiclox	SXT	-	Septrin	
Z	-	Azithromycin	R	-	Rifampicin	
AU	-	Augmentin	SP	-	Spectinomycin	
CH	-	Chloramphenicol	OFX	-	Tarrivid	

DISCUSSION

The analyses in this study were carried out to know the characteristics and identified bacteria in towels of female students in Rivers State University hostels.Counts of total heterotrophic bacteria ranged 2.0 x 10^4cfu/ml to 3.17 x 10^4 cfu/ml in the NDDC hostel and 1.48 x 10^4 cfu/ml to 3.11 x 10^4 cfu/ml in post graduate hostel for the first sampling with the control at 0.12 x 10^4 cfu/ml. Total heterotrophic count for the second sampling ranged from 0.73 x 10^4 cfu/ml to 1.15 x 10^4 cfu/ml in NDDC hostel, 0.12 x 10^4 cfu/ml to 0.93 x 10^4 cfu/ml in the post graduate hostel with the control having 0.16 x 10^4 cfu/ml. Total coliform count for first sampling ranged from 0.48 x 10^4 cfu/ml to 2.99 x 10^4 cfu/ml in NDDC hostel and 2.9 x 10^4 cfu/ml to 0.18 x 10^4 cfu/ml in the post graduate hostel with the control having 0.18 x 10^4 cfu/ml. Total coliform count for the second sampling ranged from 0.31 x 10^4 to 0.13 x 10^4 cfu/ml in NDDC hostel, 0.22 x 10^4 to 0.18 x 10^4 cfu/ml in the post graduate hostel and the control having 0.17 x 10^4cfu/ml.

The bacterial isolate identified were *staphylococcus aureus, Escherichia coli, staphylococcus sp., Bacillus cereus, klebsiella spp, Bacillus spp.* This agrees with the work of (Hannah et al., 2020) in which *E.coli* and *Staphylococcus aureus* were isolated from towel samples.

The NDDC hostel recorded the highest heterotrophic bacteria count at 3.17 x 10^4 for the first sampling while post graduate hostel had the highest heterotrophic bacteria count for the second sampling at 1.17 x 10^4. For the total coliform count, NDDC hostel recorded the highest count at 2.99 x 10^4 cfu/ml for the first sampling and post graduate hostel had the highest count for the second sampling at 0.41 x 10^4 cfu/ml. The controls for both total heterotrophic bacteria

and total coliform counts for the first and second sampling were significantly low compared to these of NDDC hostel and post graduate hostel. This may be attributed to it being a new towel that had not been used for cleaning purposes.

The significant differences in bacterial counts between the two hostels may be due to variations in hostel conditions, water supply/quality and general handling by females in the different hostels. This is in agreement with the work of (Sturt, 2015, Bradford, 2018). The differences also in counts between the first and second sampling may be attributed to the week interval between the samplings. The students were told to wash the towels and use for a few days prior to the second sampling.

Based on this study, it was observed that *E.coli* occurred in about 57% of the samples. This can be attributed to the fact that bathrooms of all hostels sampled for this study were close to toilets. Toilets are very likely sources of *E.coli* contamination (Hannah et al., 2020). Staphylococcus aureus also occurred in about 36% of the samples. This is attributed to *S. aureus* being a normal flora of the skin. This agrees with the work of (Oller and Mitchel, 2008) that *S. aureus* occurs in cotton towels. It also agrees with the work of (Neely and Maley, 2000) that observed that Staphylococcus could survive for 19-21 days on cotton fabrics, which can be attributed to the significant occurrence of *Staphylococcus* species in the second sampling even after they were washed (Oller *et al*., 2008).

The results were analyzed using student's T test to compare bacterial loads in the samples from the two hostels and the mean values were: Total heterotropic bacteria 2.2750E2 for NDDC hostel and 1.5060E2 for PG hostel in the first sampling, 57.4000 for NDDC hostel and 66.8000 for post graduate hostel in the second sampling. Total coliform counts were 1.6220E2

for NDDC hostel and 99.8000 for post graduate hotel in the first sampling and 24.5000 for NDDC hostel and 26.9000 for post graduate hostel in the second sampling. It showed that there was no significant difference in the bacterial loads of NDDC hostel and post graduate hostel in the first and second sampling in our study, we have tested isolated bacterial species for their sensitivity pattern against the commonly prescribed antibiotics according to the CLSI guideline Antibiotic Suceptibilityy of Staphylococcus sp was tested against 10 commonly prescribes and available antibiotics (Ciproflox, Reflacine, Streptomycin, Gentamycin, Septrin, Erythromycin, Ampiclox, Amoxil, Rifampicin and Azithromycin), using agar diffusion method.

The results show that the susceptibility of Staphylococcus sp was higher Ciproflox, and Reflacine (100%) followed by Septrin (60%) and Gentamycin (40%). Staphylococcus sp showed higher resistance to Ampiclox and Amoxil with 100% for each of them.

For Bacillus species isolates, Ciproflox and Reflaxine also had the highest susceptibility rates at 100% each, followed by Erythromycin and Gentamycin with 40% sensitivity each Septrin had the highest resistance rate with 100% resistance followed by Ampiclox with 80% resistance.

In the case of E.coli isolates, the results showed that the susceptibility was higher for Tarrivid (100%), followed by Ciproflox with 80% sensitivity. The highest percentage of resistance was recorded against Ampiclox (100%) and Augmentin and Gentamycin at 80% sensitivity each.

For the Klebsiella species isolates, the results showed the susceptibility was 100% for Tarrivid, Septrin, Ciproflox and Reflacine while it recorded 100% resistance against Septrin, chloramphenicol, Augmentin, Amoxil and Gentamycin. In general, the results show that

Ciproflox and Reflacine were most effective against the isolates. All the isolates showed high level of resistance against Ampiclox, Amoxil and Azithromycin. E. coli and Klebsiella sp. were also highly sensitive to Tarrivid.

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