International Journal of Innovative Agriculture & Biology Research 5(1):18-31, Jan.-Mar., 2017

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Disinfectant Susceptibility of Bacterial Isolates from Door Handles in a Tertiary Institution in Uyo, Akwa Ibom State

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ABSTRACT
Bacteriological assessments of randomly selected door handles of offices (n=12), classrooms (n=12), laboratories (n=12), hostels (n=12) and toilets (n=12) were determined using standard bacteriological techniques. The susceptibilities of the bacterial isolates to different concentrations of Savlon, Purit, Dettol and hydrogen peroxide were evaluated by disc diffusion method. The bacterial isolates obtained with varied percentages of occurrences were *Staphylococcus aureus*, *Bacillus* spp, *Streptococcus* spp, *Escherichia coli*, *Enterococcus faecalis*, *Klebsiella pneumoniae*, *Proteus* spp and *Pseudomonas aureginosa*. A total of 10 (16.7 %) swab samples from the surface of door handles had single bacterial growth, while 50 (83.3 %) had mixed bacterial flora. The results of the disinfectant susceptibility of the isolates showed Savlon as the most potent disinfectant compared to Dettol, Purit and hydrogen peroxide. Of the 10 Gram-positive bacteria used, the narrowest and widest inhibitory zones were observed in the plates containing *E. faecalis* EF-15 and *S. aureus* SA-09 with the corresponding value (mean ± SD) of 6.9 ± 0.3 mm and 15.1 ± 1.5 mm, respectively, while among the ten (10) Gram-negative bacteria, the widest and narrowest inhibitory zones were observed in the plates containing *Proteus* spp PS-16 and *E. coli* EC-21 with the corresponding value (mean ± SD) of 13.8 ± 1.2 mm and 6.8 ± 0.1 mm, respectively. The regression coefficient (r^2) values of disinfectants and inhibitory zones as exhibited by the bacterial isolates ranged between 0.75 and 0.999. The possibility of transmission of pathogenic bacteria among the staff and students may be high as the door handles are not routinely disinfected and Savlon could be first choice of disinfectant for the cleansing / disinfecting these door handles in the tertiary institutions environment.
Keywords: Disinfectant, Door handle, Susceptibility, Regression, Bacteria.

INTRODUCTION
The increasing incidence of epidemic outbreaks of certain diseases and its rate of spread from one community to the other has become a major public concern (Galtelli *et al*., 2006). Micro-organisms that cause infections can be found in the soil, air, water, food and as well as environmental surfaces (Neely and Sting, 2002). Microorganisms may live as transient contaminants in fomites and hands where they constitute major hazards as sources of community and hospital-acquired infections (Pittet *et al*., 1999; Itah and Ben, 2004). Fomites consist of either porous or non-porous surfaces or inanimate objects that when contaminated with pathogenic microorganisms can transfer them to a new host thereby serving as vehicles in transmission. The colonisations of inanimate objects by viable pathogenic microorganisms have been reported (Oluduro *et al*., 2011; Akinjogunla *et al*., 2016).
Escherichia coli, *Klebsiella* spp., *Citrobacter* spp have been found to contaminate various contact surfaces including door handles. Some micro-organisms possess virulence factors that enhance or contribute to their pathogenicity (Prescott *et al*., 2008; Akinjogunla *et al*., 2014). These virulence factors such as toxins, cell surface protein and hydrolytic enzymes are frequently involved in the direct interaction with the host tissues or in concealing the bacterial surface from the host's defense mechanism (Whitehead and Cotta, 1995; Prescott *et al.*, 2008). The hand also serves as a medium for the propagation of microorganisms from place to place and from person to person. Although, it is nearly impossible for the hands to be free of microorganisms, the presence of pathogenic bacteria may lead to chronic or acute illness (Oranusi *et al*., 2013). Besides the day to day interaction of people,

which constitute one way of spreading infectious diseases, the major source of and spread of community acquired infections are fomites such as door handles of conveniences, showers, toilet seats and faucets, sink lockers, chairs and tables, especially those found in public offices and restroom (Osterholm *et al*., 1995; Li *et al.*, 2009; Bright *et al*., 2010). Feacal matter remains a major reservoir source of human pathogens, which in adverse situation may bring about outbreaks of infection and the occurrence of this may be attributed to the unhygienic use of the toilet facilities, which results in the gross contamination of the place including the door handles.

Disinfectant-resistant bacterial strains have been arisen as a result of the lack in standardization of some factors, such as criteria for use of chemical agents, specifications in the label of available products and scarcity of well trained personnel (Pannuti and Grinbaum, 1995). The widespread use of disinfectant products has prompted some speculation on the development of microbial resistance, in particular cross-resistance to disinfectants and antibiotics (McDonnell and Russell, 1999). The antimicrobial properties of some disinfectants such as Dettol, Savlon and hydrogen peroxide (H_2O_2) on some pathogenic bacteria have been reported (Olowe *et al*., 2004; Okesola and Olola, 2011; Akinjogunla and Divine-Anthony, 2015). Savlon and Dettol are widely used for various purposes including disinfection of skin, objects and equipment, as well as environmental surfaces (Rutala *et al*., 2006; Saha *et al*., 2009).. The quality of cleaning services is a vital condition in the prevention and control of microbial spread, as we as the type of disinfectants used to reduce the risks of infection (Kramer *et al*., 2006). Thus, this study aimed to determine the susceptibility to bacterial isolates from surfaces of door handles to disinfectants.

MATERIALS AND METHODS

Preparation and Sterilization of Sensitivity Discs

Discs of 6 mm diameters were punched out from Whatman No.1 filter paper with the aid of paper punch and place in Petri dishes. The Petri dishes containing the discs were sterilized in the hot air oven at 180^{o}C for $1^{1/2}$ hrs, after which they were allowed to cool before use.

Collection and Bacteriology of Samples

Sixty (60) swab samples from door handles, consisting of swab samples from office (n=12), toilet (n=12), hostel (n=12), classroom (n=12) and laboratories (n=12) in University of Uyo campuses were aseptically collected using commercially available sterile swab sticks moistened with sterile normal saline solution. Each swab sample obtained was inoculated onto each test tube containing 2 ml nutrient broth and all the samples were taken immediately to the microbiology laboratory for bacteriological analysis. Each swab sample in the tube containing nutrient broth was vortexed and 0.1 ml was inoculated onto each plate of blood agar, MacConkey agar, mannitol salt agar, nutrient agar, eosine methylene blue agar and aerobically incubated at 37 °C for 24 hr. Bacterial colonies were picked from the plates using sterilized inoculating loops, subcultured onto plates of nutrient agar and aerobically incubated at 37 ^{o}C for 24 hr. After incubation, pure colonies obtained were streaked onto nutrient agar slants, incubated at 37 ^{o}C for 24 hr and stored in the refrigerator at 4 ^{o}C for characterization and identification using standard microbiological techniques.

Disinfectant Susceptibility of the Bacterial Isolates

The susceptibility of the twenty (20) bacterial isolates from the surfaces of door handles to disinfectants (Dettol, Savlon, Purit and hydrogen peroxide) were determined by disc diffusion method (Somchit *et al*., 2003). Zero point one (0.1) ml of each bacterial isolates prepared directly from an overnight agar plate adjusted to be equivalent to 0.5 McFarland Turbidity Standard was inoculated using sterile pipette onto each of the plates containing Mueller-Hinton Agar (Oxoid, UK). The sterile filter paper discs (6 mm diameter) impregnated with disinfectants were aseptically placed onto the surfaces of the Mueller-Hinton Agar plates using a sterile forceps, gently pressed to ensure even contact and were incubated at 37 ºC for 18 hr. After incubation, the diameters of inhibitory zones around the disinfectant discs were observed and measured in millimeters (mm) using a ruler.

Statistical Analysis

The relationship between the different concentrations of each disinfectant (Dettol, Savlon, Purit and H_2O_2) and the overall antibacterial activity, assessed as diameters of inhibitory zones with regard to the bacterial isolates was determined by linear regression analysis.

RESULTS

A total of 140 bacterial isolates, comprising 64 Gram positive and 76 Gram negative bacteria, in the genera *Staphylococcus*, *Enterococcus*, *Streptococcus*, *Escherichia*, *Bacillus*, *Proteus*, *Klebsiella* and *Pseudomonas* were isolated from the door handle swab samples obtained from offices, toilets, hostels, classrooms and laboratories (Table 1). The most common bacterial isolate on the surfaces of door handles of offices was *S. aureus* n = 8/12 (66.7%), followed by *E. coli* 4/12 (33.3%), *E. faecalis* 4/12 (33.3%), *P aureginosa* 4/12 (33.3%) and *Proteus* spp 2/12 (16.7%). Table 1 shows the percentages of occurrence of bacterial isolates from the surfaces of toilet door handles. The bacterial isolates were *S. aureus* 50.0% (n = 6), *E. coli* 66.7% (n= 8), *E. faecalis* 50.0% (n= 6), *Bacillus* spp 33.3% (n= 4), *Proteus* spp 16.7% (n= 2), *K. pneumoniae* 33.3% (n= 4), *P. aureginosa* 16.7% (n= 2) and *Streptococcus* spp 16.7% (n= 2). The results of the frequencies of occurrence of the nine (9) different bacterial isolates obtained from the surfaces of door handles of hostels showed that *E. coli* had the highest occurrence of 8 (66.7 %), followed by *S. aureus* 6 (50.0%), *Bacillus* spp 4 (33.3%), *Proteus* spp 4 (33.3%), while *K. pneumoniae*, *E. faecalis*, *P aureginosa* and *Streptococcus* spp had the lowest occurrence of 2 (16.7 %) each. The percentages of occurrence of bacterial isolates from the surfaces of classroom door handles were: *S. aureus* 83.3% (n = 10), *E. coli* 50.0% (n= 6), *E. faecalis* 16.7% (n= 2), *Bacillus* spp 33.3% (n= 4), *P aureginosa* 33.3% (n= 4), *Proteus* spp 16.7% (n= 2) and *Streptococcus* spp 16.7% (n= 2). Table 1 also shows the percentage of occurrence of bacterial isolates from the surfaces of laboratories door handles. The bacterial isolates were *S. aureus*, *E. coli*, *E. faecalis*, *Bacillus* spp, *P. aureginosa* and *Streptococcus* spp and their percentage of occurrence was 83.3%, 33.3% , 33.3% , 33.3%, 16.7% and 16.7% , respectively.

A total of 10 (16.7%) swab samples from the surfaces of door handles had single bacterial growth, while 50 (83.3%) had mixed bacterial flora. Of the 12 swab samples from office door handles, 4/12 (33.3%) showed growth of single bacterial isolate, while 8/12 (66.7%) had mixed bacterial growth (Table 2). The 12 swab samples from surfaces of the toilet door handles and the 12 swab samples from the surfaces of hostel door handles had mixed bacterial growth. Of the 12 swab samples from the surfaces of classroom door handles, 2/12 (16.7%) showed growth of single bacterial isolate, while 10/12 (83.3%) had mixed bacterial growth. The occurrences of single and mixed bacterial flora on laboratory swab samples are similarly shown in Table 2.

The results of antibacterial activities of the varied concentrations of disinfectants on the bacterial isolates from the surfaces of door handles are presented in Tables 3 and 4. Of the four disinfectants evaluated, Savlon showed the highest antibacterial activities on both Gram positive and Gram negative bacterial isolates. Among the Gram-positive bacteria (n=10), the narrowest and widest inhibitory zones were observed in the plates containing *E. faecalis* EF-15 and *S. aureus* SA-09 with the mean ± SD of 6.9 ± 0.3 mm and 15.1 ± 1.5 mm, respectively. Among the Gram-negative bacteria (n=10), the widest and narrowest inhibitory zones were observed in the plates containing *Proteus* spp PS-16 and *E. coli* EC-21 with the mean ± SD of 13.8 ± 1.2 mm and 6.8 ± 0.1 mm, respectively. The results also showed that 10 (50.0%), 17 (85.0%), 8 (40.0%) and 6 (30.0%) of the bacterial isolates were sensitive to Dettol, Savlon, Purit and H_2O_2 at 10% concentration, respectively. At 20% concentration, 17 (85.0%), 19 (95.0%), 18 (90.0%) and 14 (70.0%) bacterial isolates were sensitive to Dettol, Savlon, Purit and H_2O_2, respectively, while 19 (95.0%), 20 (100%), 20 (100%) and 20 (100%) bacterial isolates were sensitive to Dettol, Savlon, Purit and H_2O_2 at 30% concentration, respectively (Tables 3 and 4). The regression coefficient (R^2) of inhibitory zones and concentration of disinfectants are shown in Table 6 and figures 1- XVI. The regression coefficient (r^2) values of disinfectants and inhibitory zones as exhibited by the bacterial isolates ranged from 0.75 to 0.999 (Table 5).

Table 1: Percentage of Occurrence of Bacterial Isolates from Door Handles

Bacterial Isolates	Offices (N=12) No (%) of Occurrence	Toilets (N=12) No (%) of Occurrence	Hostels (N=12) No (%) of Occurrence	Classrooms (N=12) No (%) of Occurrence	Laboratories (N=12) No (%) of Occurrence	No (%) of Occurrence
S. aureus	8 (66.7)	6 (50.0)	6 (50.0)	10 (83.3)	10 (83.3)	40 (28.6)
E. coli	4 (33.3)	8 (66.7)	8 (66.7)	6 (50.0)	4 (33.3)	30 (21.4)
E. faecalis	4 (33.3)	6 (50.0)	2 (16.7)	2 (16.7)	4 (33.3)	18 (12.9)
Bacillus spp	0 (0.0)	4 (33.3)	4 (33.3)	4 (33.3)	4 (33.3)	16 (11.4)
Proteus spp	2 (16.7)	2 (16.7)	4 (33.3)	2 (16.7)	0 (0.0)	10 (7.1)
K. pneumonia	0 (0.0)	4 (33.3)	2 (16.7)	0 (0.0)	0 (0.0)	6 (4.3)
P aureginosa	4 (33.3)	2 (16.7)	2 (16.7)	4 (33.3)	2 (16.7)	14 (10.0)
Streptococcus spp	0 (0.0)	2 (16.7)	2 (16.7)	2 (16.7)	0 (0.0)	6 (4.3)
Total	22 (15.7)	34 (24.3)	30 (21.4)	30 (21.4)	24 (17.1)	140 (100)

Keys: Values in parenthesis are percentages

Table 2: Occurrence of Single and Mixed Bacterial Isolates of Door Handles

		Bacterial Isolates				
	No of	Single	Two	Three	Total Samples	Samples
No (%)		No (%)	No (%)	No (%) Isolate		
Offices	12	4 (33.3)	6 (50.0)	2 (16.7)	22(15.7)	
Toilets	12	0 (0.0)	2 (23.6)	10 (23.6)	34 (24.3)	
Hostels	12	0 (0.0)	6 (50.0)	6 (50.0)	30 (21.4)	
Classrooms	12	2 (16.7)	2 (16.7)	8 (66.7)	30 (21.4)	
Laboratories	12	4 (33.3)	4 (33.3)	4 (33.3)	24 (17.1)	
Total	60	10 (16.7)	20 (33.3)	30 (50.0)	140 (100)	

Table 3: Susceptibility of Gram Positive Bacterial Isolates from Door Handles to Disinfectants

Bacterial Isolates	Code	Dettol inhibitory zone (mm ± SD)			Savlon Inhibitory zone (mm ± SD)			Purit Inhibitory zone (mm ± SD)			Hydrogen Peroxide Inhibitory zone (mm ± SD)		
		10 %	20 %	30 %	10 %	20 %	30 %	10 %	20 %	30 %	10 %	20 %	30 %
S. aureus	SA01	7.8±0.2	10.6±0.5	11.8±0.5	8.0±0.2	11.5±1.0	13.2±1.0	6.9±0.3	9.2±0.5	9.8±0.5	NZ	8.4±0.5	9.0±1.0
S. aureus	SA04	7.1±0.5	7.4±0.1	9.0±1.0	7.6±0.5	10.1±0.6	14.1±1.2	NZ	NZ	8.3±0.3	7.0±0.2	7.1±0.2	8.6±0.1
S. aureus	SA15	8.7±0.4	8.8±0.5	11.1±0.7	9.4±0.4	9.6±0.5	12.0±0.7	7.0±0.5	8.0±0.5	10.6±1.0	NZ	8.0±0.5	8.4±0.2
S. aureus	SA09	10.5±0.5	11.2±0.8	14.2±1.2	10.9±1.0	12.5±0.8	15.1±1.5	8.2±0.5	9.7±1.1	12.5±1.0	7.4±1.0	9.5±0.5	11.4±1.0
E. faecalis	EF15	7.4±0.5	7.6±0.2	8.7±0.5	7.4±0.1	8.3±0.5	9.5±1.2	6.9±0.3	7.0±0.5	8.5±1.0	NZ	NZ	8.0±0.5
E. faecalis	EF02	8.9±0.8	11.6±1.0	11.8±1.4	9.3±0.5	12.1±1.0	12.8±1.5	8.0±1.0	10.9±1.0	11.9±0.5	8.2±0.5	9.8±1.0	11.3±1.2
Bacillus spp	BS16	NZ	NZ	NZ	NZ	NZ	9.3±0.5	NZ	NZ	7.5±0.5	NZ	NZ	7.0±0.2
Bacillus spp	BS20	NZ	NZ	8.1±0.5	7.2±0.1	8.0±0.3	8.9±0.1	NZ	7.9±0.5	8.7±0.2	NZ	NZ	8.2±0.1
Streptococcus spp	SS19	NZ	9.1±0.5	10.9±1.0	NZ	9.1±1.0	12.2±0.5	NZ	8.4±0.5	9.5±0.8	NZ	9.0±0.3	10.5±1.0
Streptococcus spp	SS02	NZ	8.7±0.2	9.0±1.0	8.1±0.1	9.6±0.5	10.4±0.7	NZ	7.7±0.3	8.6±0.5	NZ	NZ	8.1±0.3

\keys: NZ: No zone of Inhibition; mm: mean; SD: Standard Deviation; Each inhibitory zone included 6 mm diameter of the disc;. Each value represents the mean of three replicates and standard deviation.

Table 4: Susceptibility of Gram Negative Bacterial Isolates from Door Handles to Disinfectants

\\\\\\\\\\\\\\\\\\\\\\\\ Bacterial Isolates	Code	Dettol Inhibitory Zone (mm ± SD)			Savlon Inhibitory Zone (mm ± SD)			Purit Inhibitory Zone (mm ± SD)			Hydrogen Peroxide Inhibitory Zone (mm ± SD)		
		10 %	20 %	30%	10 %	20 %	30 %	10 %	20 %	30 %	10 %	20 %	30 %
E. coli	EC28	7.0±0.1	10.6±0.3	11.8±0.5	8.0±0.2	11.5±1.0	13.2±1.0	6.9±0.1	9.2±0.5	9.8±0.5	NZ	8.4±0.5	9.0±0.5
E. coli	EC04	NZ	8.9±0.2	12.0±1.0	9.1±0.5	12.7±0.5	13.5±1.0	NZ	8.3±0.3	10.6±0.2	NZ	8.3±0.2	11.3±0.3
E. coli	EC09	8.5±0.1	9.2±0.2	9.8±0.5	9.0±0.1	10.2±0.2	12.9±0.7	NZ	7.7±0.2	9.2±0.1	8.0±0.2	8.6±0.1	9.5±0.1
E. coli	EC21	7.1±0.2	10.0±0.5	10.6±0.2	9.7±0.4	10.9±0.5	11.7±0.2	6.8±0.1	8.4±0.1	10.2±0.3	6.8±0.1	9.1±0.2	10.3±0.2
Proteus spp	PS11	NZ	7.6±0.2	9.5±0.3	8.1±0.1	11.7±1.0	12.0±1.0	NZ	7.3±0.3	9.0±0.3	NZ	6.9±0.1	8.4±0.1
Proteus spp	PS16	8.5±0.2	11.2±0.5	12.9±1.0	8.8±0.2	12.4±1.0	13.8±1.2	8.3±0.1	11.0±0.5	11.7±0.5	8.5±0.2	10.2±0.5	10.5±0.5
K. pneumoniae	KP01	NZ	8.1±0.2	10.5±0.2	8.5±0.2	8.8±0.5	11.0±0.5	NZ	7.5±0.2	7.9±0.5	NZ	7.0±0.2	7.2±0.2
K. pneumoniae	KP15	NZ	7.9±0.1	8.7±0.5	7.2±0.1	8.0±0.3	9.6±0.1	NZ	7.5±0.5	8.1±0.2	NZ	NZ	8.5±0.2
P aureginosa	PA06	NZ	NZ	8.0±0.5	NZ	9.4±1.0	12.0±0.5	NZ	NZ	7.7±0.1	NZ	NZ	7.5±0.1
P aureginosa	PA23	NZ	8.3±0.2	9.4±1.0	8.5±0.1	9.1±0.3	10.8±1.0	NZ	7.3±0.5	8.9±0.5	NZ	6.6±0.5	8.6±0.2

\keys: NZ: No zone of Inhibition; mm: mean; SD: Standard Deviation; Each inhibitory zone included 6 mm diameter of the disc;. Each value represents the mean of three replicates and standard deviation.

Table 5: Regression Coefficient between different Concentrations of Disinfectants and Inhibitory Zones Diameters Exhibited by Bacterial Isolates

Group	Bacterial Isolates	Code	Regression (R^2) Dettol	Savlon	Purit	H_2O_2
Gram Positive Bacteria	*S. aureus*	SA01	0.9494	0.9616	0.8972	0.7998
	S. aureus	SA04	0.8650	0.9826	0.7500	0.8073
	S. aureus	SA15	0.7812	0.8073	0.9382	0.7856
	S. aureus	SA09	0.8859	0.9815	0.9704	0.9992
	E. faecalis	EF15	0.8622	0.9932	0.7967	0.7500
	E. faecalis	EF02	0.8015	0.8929	0.9267	0.9997
	Bacillus spp	BS16	NA	0.7500	0.7500	0.7500
	Bacillus spp	BS20	0.7500	0.9988	0.8183	0.7500
	Streptococcus spp	**S**SS19	0.8699	0.9254	0.8355	0.8547
	Streptococcus spp	SS02	0.7750	0.9700	0.8275	0.7500
Gram Negative Bacteria	*E. coli*	EC28	0.9231	0.9616	0.8972	0.7998
	E. coli	EC04	0.9278	0.8811	0.9035	0.9317
	E. coli	EC09	0.9980	0.9530	0.8685	0.9868
	E. coli	EC21	0.8742	0.9868	0.9988	0.9681
	Proteus spp	PS11	0.8929	0.8073	0.8857	0.8789
	Proteus spp	PS16	0.9831	0.9394	0.8966	0.8596
	K. pneumoniae	KP01	0.9106	0.8322	0.7879	0.7708
	K. pneumoniae	KP15	0.8183	0.9643	0.8052	0.7500
	P aureginosa	PA06	0.7500	0.9033	0.7500	0.7500
	P aureginosa	PA23	0.8226	0.9292	0.8797	0.9129

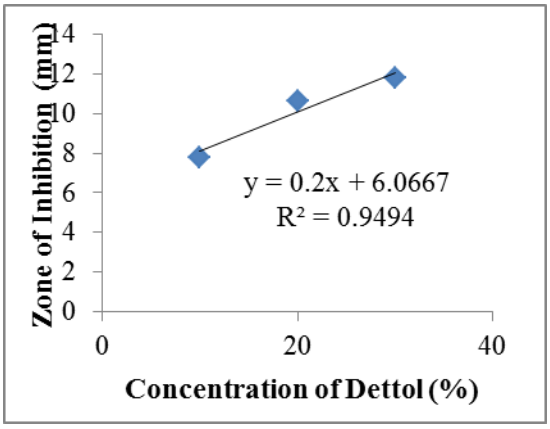

Fig I: Relationship between Conc. of Dettol and Inhibitory Zones as exhibited by SA01

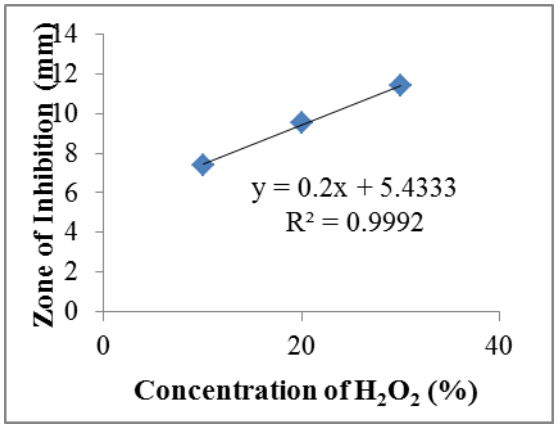

Fig II: Relationship between Conc. of H_2O_2 and Inhibitory Zones as exhibited by SA09

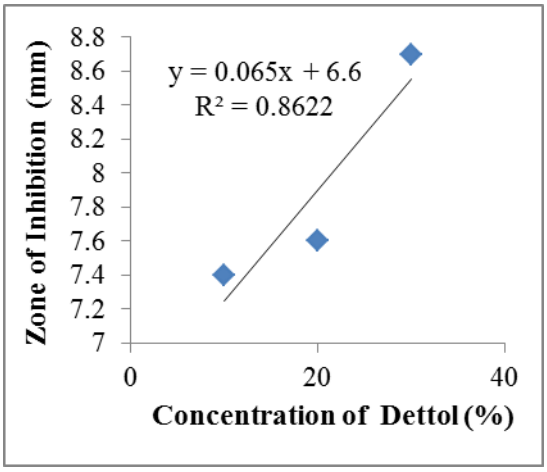

Fig III: Relationship between Conc. of Dettol and Inhibitory Zones as exhibited by EF15

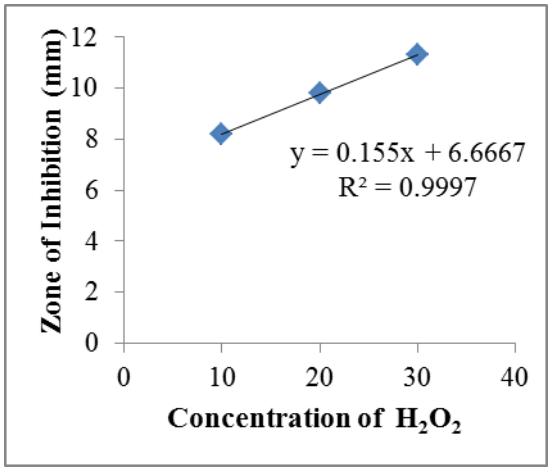

Fig IV: Relationship between Conc. of H_2O_2 and Inhibitory Zones as exhibited by EF02

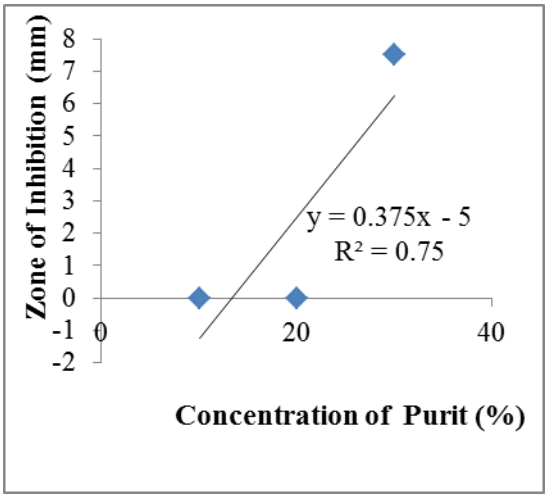

Fig V: Relationship between Conc. of Purit and Inhibitory Zones as exhibited by BS16

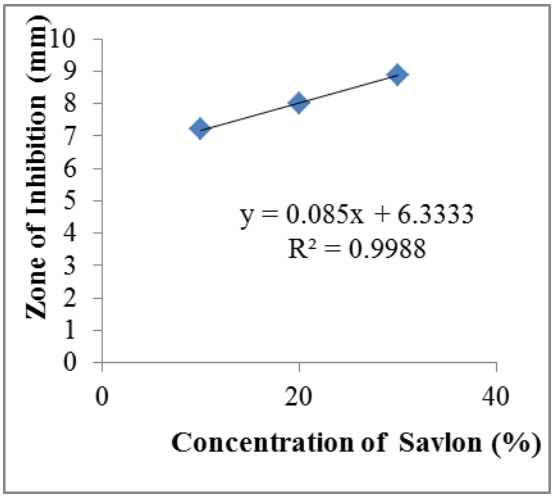

Fig VI: Relationship between Conc. of Savlon and Inhibitory Zones as exhibited by BS20

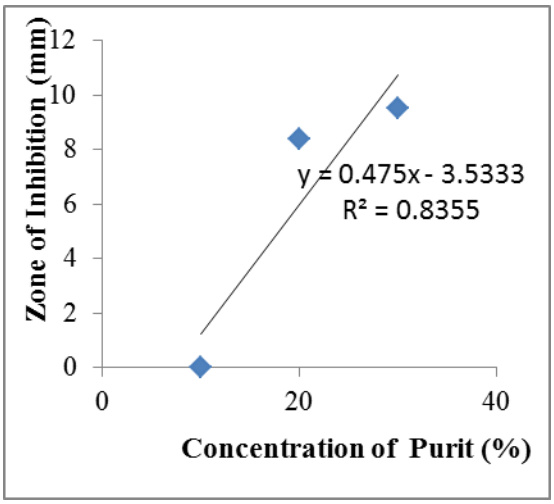

Fig VII: Relationship between Conc. of Purit and Inhibitory Zones as exhibited by SS16

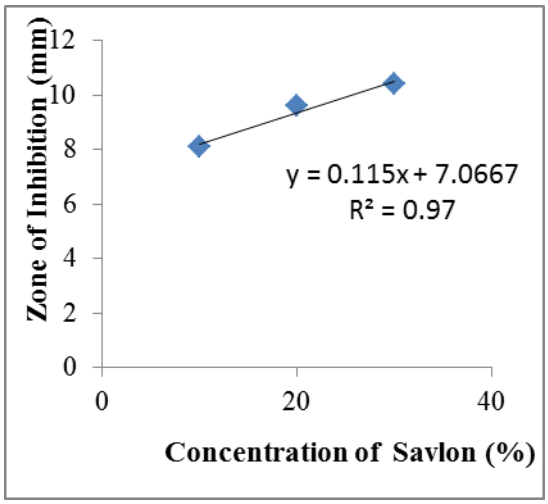

Fig VIII: Relationship between Conc. of Savlon and Inhibitory Zones as exhibited by SS02

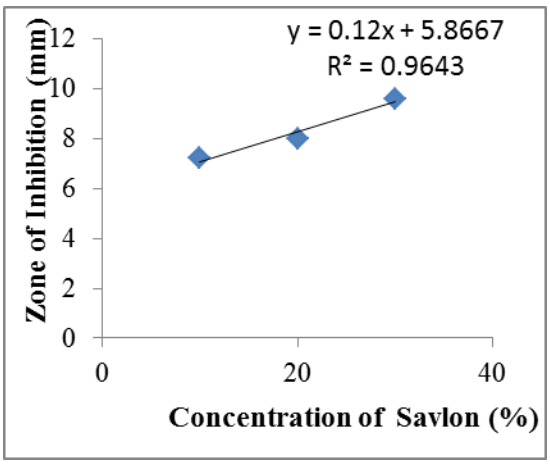

Fig IX: Relationship between Conc. of Savlon and Inhibitory Zones as exhibited by KP15

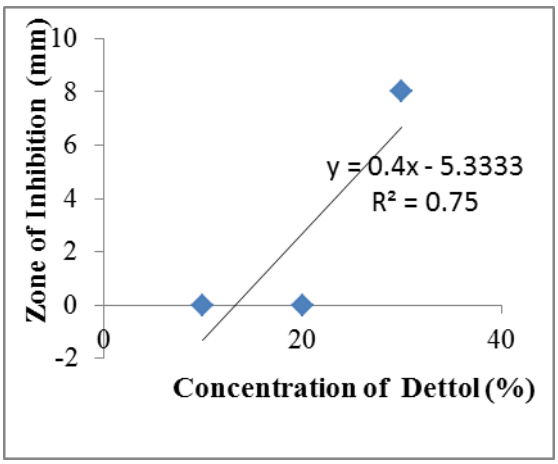

Fig X: Relationship between Conc. of Dettol and Inhibitory Zones as exhibited by PA06

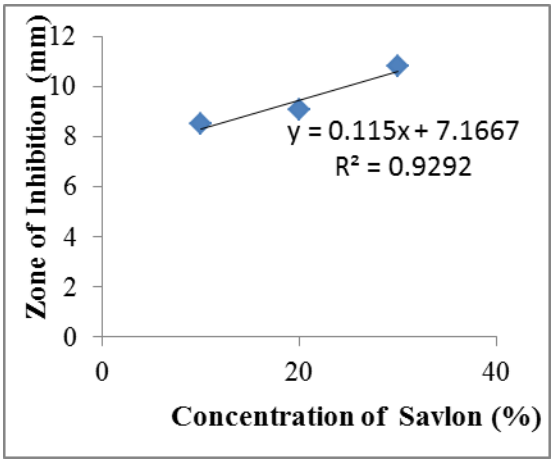

Fig XI: Relationship between Conc. of Savlon and Inhibitory Zones as exhibited by PA23

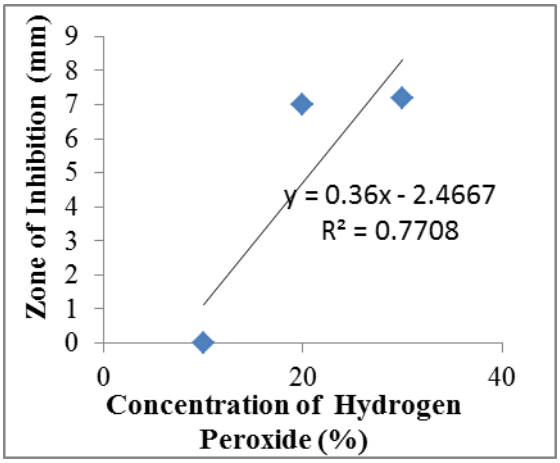

Fig XII: Relationship between Conc. of H_2O_2 and Inhibitory Zones as exhibited by KP01

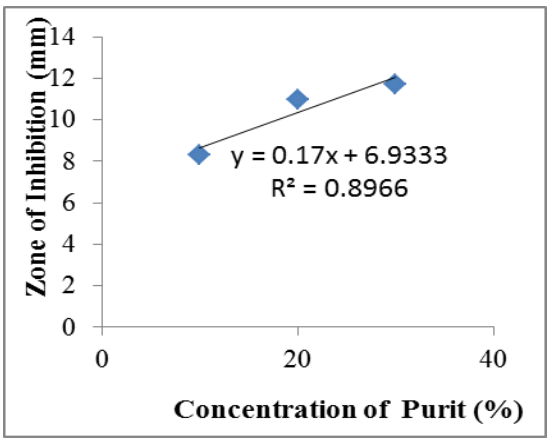

Fig XIII: Relationship between Conc. of Purit Inhibitory Zones as exhibited by PS11

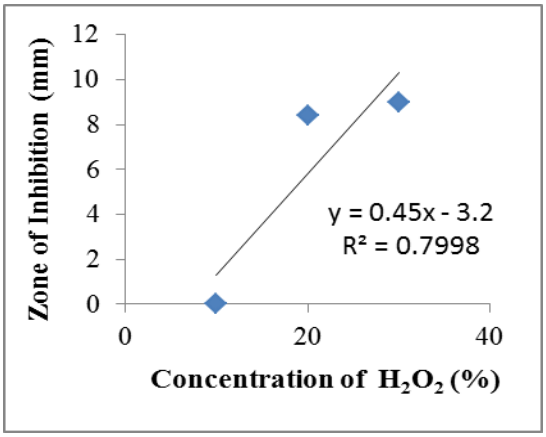

Fig X1V: Relationship between Conc. of H_2O_2 and Inhibitory Zones as exhibited by EC28

DISCUSSION

Door handles are important reservoir of microorganisms and this study has revealed the level of bacterial contaminants on the surfaces of door handles of offices, toilets, hostels, laboratories and classrooms in the University of Uyo. Although, most skin flora bacteria are Gram positive, and could account for their predominance on fomites especially the door handles, but in this study the Gram negative bacteria were found to occur more than Gram positive bacteria. All the door samples obtained from offices, laboratories, hostels, laboratories and classrooms showed bacterial contamination. The high level of contamination of the door handles in this study is in agreement with the reports of Nworie *et al*.(2012), who observed 86.7% bacterial contamination of door handles and also the reports of Otter and French (2009) who observed 95% positive cultures. The variation in the number of positive samples from one place to the other may be connected with differences in hygiene and sanitary conditions in the environment. The high level of bacterial contamination of toilets, hostels and classrooms door handles could be attributed to the fact that they are being used frequently by a very high population of students and staff, and this is in agreement with the findings of Boone and Gerba (2010) and Nworie *et al*., (2012) who reported that the levels of contamination varied, depending on the exposure and environment.

The microorganisms isolated from the door handles in the study were *S. aureus*, *Streptococcus* spp, *Bacillus* spp, *E. coli*, *Proteus* spp, *E. faecalis*, *K. pneumoniae* and *P. aeruginosa*. In this study, the most frequently isolated bacteria pathogens was *S. aureus* which may be due to the fact that it is a major component of the normal flora of the skin and nostrils, which probably explains its high prevalence as a contaminant, as it can easily be discharged by several human activities. This observation is in agreement with the findings of Brooks *et al.* (2007) and Nworie *et al*. (2012). The isolation of *S. aureus*, *K. pneumoniae*, *E. coli* and *Proteus* spp from the door handles is in conformity with the previous reports of Lynn *et al*. (2013). The occurrence of *Bacillus* spp, *P. aureginosa* and *E. feacalis* on the surface of the toilet door handles also corroborated the previous work of Opere *et al*. (2013) who reported the isolation of *Bacillus* spp, *S. aureus*, *P. aureginosa* and *E. feacalis* from the toilets. Each of these organisms has been implicated either as a major contaminant or as the most pathogenic bacteria recovered. The occurrence of *Bacillus* spp in the door handles was very low and this is in disagreement with the Brooks *et al*. (2007) who reported that *Bacillus* spp as one of the predominant organisms isolated from door handles. The occurrence of *Bacillus* spp in the door handles in this research could be explained by the fact that *Bacillus* spp are ubiquitous in nature with their spores able to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods.

Dettol and Savlon are widely used for various purposes including disinfection of skin, objects and equipment, as well as environmental surfaces (Saha *et al*., 2009). The antimicrobial properties of disinfectants on some bacteria have also been reported (Akinjogunla and Divine-Anthony, 2015). The results show that different types of microorganisms vary in their response to different types of disinfectants. Savlon was the most effective against all the bacteria isolated from door handles in this study because of the wider inhibitory zones obtained compared to the other disinfectants evaluated. The sensitivity of *P. aureginosa* to Savlon in this research corroborates the earlier reports of Olowe *et al*. (2005). The mechanism of action of disinfectant is by production of destructive chemicals that attacks membrane lipids, DNA and other essential cell components of various pathogenic bacteria. Microorganisms are continuously acquiring resistance to new disinfectants; as a result, no single disinfectant will be appropriate for all pathogens. The results also showed that some of the bacteria were sensitive to H_2O_2 and this agrees with the reports of Tortora *et al.* (1998). Russell (1996) reported that Gram-negative bacteria are generally more resistant to disinfectants than are the non-sporulating, non-mycobacterial Gram-positive bacteria but the results of this experiment showed no remarkable difference in resistance between Gram-positive and Gram-negative bacteria.

The student and staff regularly have access to offices, classrooms, laboratories for different purposes and since the door handles are not routinely disinfected, the possibility of transmission of pathogenic bacteria among the staff and students may be great. However, Savlon could be first choice of disinfectant for the cleansing/disinfecting of the doors handles.

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