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Full Length Research Paper

Prevalence and public health implications of the bacterial load of environmental surfaces of some Secondary Schools in Sokoto, North-western Nigeria

***[1]A.H. Kawo, [2]Y.U. Dabai, [3]S.B. Manga and [4]G.J. Garba**

[1]Microbiology Unit, Department of Biological Sciences, Bayero University, PMB 3011, Kano, Nigeria
[2]Department of Public Health and Preventive Medicine
[3]Department of Microbiology, Usmanu Danfodiyo University, PMB 2346, Sokoto, Nigeria
[4]Livestock Investigation and Breeding Center, Bulasa, Birnin-Kebbi, Kebbi State, Nigeria

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The occurrence of bacteria on contact surfaces of eight randomly-selected secondary schools (coded A-H) in Sokoto metropolis, north-western Nigeria was determined using standard methods. A total of five hundred and sixty (560) samples from the eight (8) study sites (A-H) comprising of ten (10) samples each from the toilets, doors, computers, walls, chairs, tables and hands of students (contact surfaces) were randomly taken and analysed using bilotting and standard plate count techniques respectively. The samples were collected using sterile swab sticks. From the results obtained, the highest bacterial count of 6.91 x 10^7 cfu/ml was obtained from toilets in site A while the least was in sites A, G and H each with 8.57 x 10^6 cfu/ml. The bacteria isolated and identified using cultural, morphological and biochemical methods included *Staphylococcus aureus* (60.0), *Streptococcus faecalis* (5.0), *Escherichia coli* (20.0), *Pseudomonas aeruginosa* (10.0) and the species of *Micrococcus* (3.0) and *Klebsiella* (2.0) The implications of the results in relation to human health have been discussed. Suggestions have been made on how to improve the health conditions of the students in particular and the school environments in general.

Keywords: Bacterial load, Contact surfaces, Secondary schools, Sokoto, Human health.

INTRODUCTION

As a result of the increasing number of students in most secondary schools in rural and semi-urban areas of Sokoto State, north-western Nigeria, available sanitary facilities and staff cannot sustain the population and this leads to contamination of surfaces with faecal and other contaminating materials either directly or indirectly. Calamari *et al* (1994) reported that noticeable problems in metropolis especially in the densely-populated areas of schools are lack of running tap water, bole holes, drainage systems and heaps of domestic waste materials, which increase the chance of contamination. The secondary school students also interact with the surrounding environment and surfaces, among which are materials and humans. Contact surfaces such as doors, toilets, board, computers and furniture are all potential sources of spread of infections (WHO, 1980; Anson *et al*., 1988; Mohammed *et al*., 2005; 2006; Kawo and Rogo, 2008). Thomas and Tillet (1973) reported that enteric pathogens associated with diarrhea in day-care centers, nursery and secondary schools are spread by the faeco-oral route. Contamination by hands or environmental objects may be due to human involvement, which may harbour micro-organisms that increase the risk of illnesses among the students. In view of the problems associated with the level of hygiene in most of the secondary schools in rural and semi-urban areas of Sokoto State, there was the need to determine the type and number of bacterial organisms that are associated with some contact surfaces of some of these secondary

*Correspondence Author E-mail: ahkawo@yahoo.com; Tel: +234-0802-315-3895)

schools. This was with a view to providing baseline information to the general public and health care authorities for awareness and putting appropriate control measure.

MATERIALS AND METHODS

The study sites

The study sites included Government Secondary School Dange-Shuni (Site A) in Dange-Shuni local government area (LGA), Comprehensive Secondary School (Site B), Federal Government Science College (Site C), Sheikh Abubakar Gumi Secondary School (Site D) all in Sokoto-North LGA, Government Secondary School Wammako (Site E) in Wammako LGA, Government Day Secondary School Arkila (Site F), Government Secondary School Kofar-Marke (Site G) and Government Secondary School Runji Sambo (Site H) all in Sokoto-South LGA.

Sample collection and processing

A total of five hundred and sixty (560) samples from the eight (8) study sites (A-H) comprising of ten (10) samples each from the toilet seats, doors, computers, classroom walls, chairs, tables and hands of students (contact surfaces) were randomly collected using commercially-sterile swab sticks (Kawo and Rogo, 2008). The swab sticks were inserted into 10ml of sterile peptone water contained in a sterile test tube and transported to the Microbiology Research Laboratory of the Department of Microbiology, Usmanu Danfodiyo University, Sokoto within 30–60 minutes, stored in a refrigerator at -4°C for immediate bacteriological analysis.

Enumeration of aerobic mesophilic bacteria

The enumeration of the aerobic mesophilic bacterial count was carried out according to the methods described by Chesebrough (2000) as well as Kawo and Rogo (2008) using standard plate count techniques. Here, serial dilution of the sample was aseptically carried out by pipetting 1ml from the inoculated peptone water into a test tube (10^{-1}) containing 9ml of sterile distilled water. A quantity (1ml) from the diluent was aseptically pipetted and transferred into the second test tube (10^{-2}) containing 9ml of sterile distilled water. The process was repeated until a dilution of 10^{-6} was obtained. A quantity (0.1ml) of 10^{-6} dilution was aseptically introduced into prepared nutrient agar plates (in duplicates) and spread uniformly over the agar plate using a bent glass rod. The plates were incubated at 37°C for 24-48 hours. Colonies were counted and the mean counts were recorded and expressed in colony forming units per milliliter of the sample (cfu/ml) analysed.

Isolation and identification of the bacterial isolates

This was carried out using cultural, morphological and biochemical methods (Chesebrough, 2000). A distinct colony was picked using sterile wire loop and transferred into prepared nutrient agar (oxoid) plates using streaking method and incubated at 37°C for 24-48 hours. A loopful of the culture was picked and inoculated into sterilized slant bottles containing nutrient agar (oxoid) medium using streaking technique. The slants were incubated at 37°C for 24-48 hrs after which Gram's and spore staining as well as biochemical tests (catalase, coagulase, sugar fermentation, H_2S production, oxidase, urease and IMViC) were carried out to authenticate the identity of the bacterial isolates.

RESULTS AND DISCUSSION

Environmental (contact) surfaces became an issue of health concern particularly in recent years as they have been reported as potential carriers and transmitters of disease-causing microorganisms (Mohammed *et al*., 2005; 2006; Rogo and Kawo, 2005; Kawo and Rogo, 2008). In addition, computer keyboards have been reported as agents of cross contamination (Michael, 2002), a phenomenon that occurs when individuals spread germs from one surface to another by simple touch (Mohammed *et al*., 2005; 2006; Rogo and Kawo, 2005). Diseases commonly spread by means of environmental surfaces such as computers, classroom walls, toilets, chairs, etc, include the common cold, cold sores, conjunctivitis, giardiasis, impetigo, meningitis, pin worm disease, diarrhea and pneumonia, to mention but a few (WHO, 1980). Bacteria such as *Escherichia coli*, *Shigella dysentriae*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae* and *Staphylococcus aureus* as well as *Corynebacterium diphtheriae* cause diarrhea, dysentery, pneumonia, food poisoning and intoxication as well as whooping cough respectively (FAO, 1979; WHO, 1980; CDCP, 1992). Generally, all the sample sites had viable counts higher than 10^6 cfu/ml (Table 1). This is in excess of the WHO (1980) accepted limit for microbial contamination for any surface sample who reported that contact surfaces should not exceed 1.20 x 10^6 cfu/ml. The results obtained in this study are also contrary to the findings of Olayemi and Adebayo (1991) in Ilorin who reported a contamination rate of 2.60 x 10^6 cfu/ml. Of particular importance in the present study is the toilet facility that had the highest overall mean count of 3.36 x 10^7 cfu/ml (Table 1). The reason for the high counts obtained from the toilets might be that they were probably more frequently patronized than the other contact surfaces, which could have a restricted patronization. Thus, the higher counts generally obtained in this study might be related to the poor habit of sanitation and/or cleanliness. On the other hand, samples from the hands

Table 1. Bacteriological characteristics (cfu/ml x 10^7) of the contact surfaces of some secondary schools in Sokoto, north-western Nigeria

Item/Site	A	B	C	D	E	F	G	H	Overall Mean
Toilet	6.91	3.05	2.69	1.86	2.79	5.63	2.89	1.06	3.36
Door	2.86	2.24	3.57	1.57	2.86	4.34	1.57	1.70	2.59
Computer	2.21	1.70	2.71	1.31	1.89	2.86	1.70	1.70	2.01
Wall	5.63	2.31	1.91	2.89	3.29	3.21	1.97	0.89	2.76
Chair	4.34	1.80	5.12	1.97	1.31	2.21	1.80	0.86	2.43
Table	3.29	2.14	1.89	1.89	1.97	1.57	1.31	0.88	1.87
Hands	0.86	1.60	1.06	0.89	0.89	0.89	0.86	0.86	0.99
Overall Mean	3.73	2.16	2.71	1.77	2.14	2.96	1.73	1.14	

Table 2. Morphological and biochemical characteristics of the bacteria isolated from the contact surfaces of some secondary schools in Sokoto, Nigeria (figures in parentheses are prevalence rates)

Biochemical test	Bacterial isolates 1(60.0)	2(5.0)	3(3.0)	4(20.0)	5(10.0)	6(2.0)
Gram's reaction	+	+	-	-	-	-
Catalase	+	-	-	+	+	+
Coagulase	+	-	+	-	-	-
Lactose	+	-	-	+	-	+
Glucose	+	-	+	+	-	-
Mannitol	+	-	+	+	-	-
Sucrose	+	+	-	+	-	-
H_2S	-	+	-	+	+	+
Oxidase	-	+	-	-	+	-
Urease	-	+	-	+	-	-
Spore	-	+	-	-	-	-
Methyl-red	-	+	-	-	-	+
VP	-	+	+	+	+	-
Indole	-	+	-	+	-	+
Total No.						

Key: 1 = *Staphylococcus aureus*; 2 = *Streptococcus faecalis*; 3 = *Micrococcus* species; 4 = *Escherichia coli*; 5= *Pseudomonas aeruginosa*; 6 = *Klebsiella* species.

of students Table 1 had the least overall mean bacterial count (0.99 x 10^7 cfu/ml). This might be associated with the level of hygienic habit by the students. This agrees with the findings of Ferson (1997) where the highest value of bacterial contamination from the samples tested was 1.64 x 10^6 cfu/ml while the least of 1.04 x 10^6 cfu/ml was obtained from the hands of students. These high numbers of bacteria count could cause health hazards. The high bacterial count obtained from site A Table 1 could be due to poor sanitary condition of the school environment. This might also be related to the fact the school is located in a rural area of the State where personal and environmental hygiene is generally poor due to illiteracy and socio-economic factors among others (Ferson, 1997). These observations could explain the reason for the low counts generally obtained from the other sample sites, which are located within the metropolitan Sokoto. Table 2 shows that a total of 100 bacterial isolates was obtained from the eight sample sites. The cultural, morphological and biochemical properties of these isolates showed that they belonged to six genera namely *Escherichia coli*, *Klebsiella* species, *Micrococcus* species, *Pseudomonas aeruginosa, Staphylococcus aureus* and *Streptococcus faecalis*. The

presence of these microorganisms is a cause for serious concern mainly because these microorganisms are opportunistic human pathogens and even though may not infect healthy humans but may infect immune-compromised individuals (Baid, 1985; Antai and Ogbonna, 1988). These microorganisms have been variously reported as responsible for respiratory and skin infections, enteritis, meningitis, stomach disorders and sinusis (Cruickshank *et al*., 1980; Garba, 2002; Collen, 2005). Thus, their occurrence on these environmental surfaces may pose serious health hazards to the students attending these schools. Ferson (1997) has shown that students in most secondary schools are significantly more likely to be household index cases of enteric infections than those not in schools. These students can therefore serve as transmitters of enteric infections to the community at large because of the poor hygienic habit of the students especially among low-income earners as earlier reported by Thomas and Tillet (1973). Generally, *S. aureus* and *E. coli* were the most isolated while the species of *Micrococcus* and *Klebsiella* were the least Table 2. The high occurrence of *S. aureus* could be associated with the fact that it is abundant in human body especially as a normal flora of the skin. It has also been reported as a contributor of 40-45% nasal carriers in humans (Ogbini and Omu, 1986; Uabol-Egbenni, 2003; Onukwubiri, 2005; Abdulhadi *et al*., 2008). In addition, *S. aureus* could elaborate toxins in foods, which are dangerous to human and other animal health (FAO, 1979; Wieneke *et al*., 1993; Uabol-Egbenni, 2003). On the other hand, the low occurrence of *Klebsiella* species might be associated with the fact that this bacterium is present in respiratory tract and faeces of about only 5% of normal individuals (Chesebrough, 2000). Thus, these microorganisms could have come in contact with the contact surfaces through the soil, clothing, food remnants and/or hands of users (Uabol-Egbenni, 2003; Mohammed *et al*., 2005; 2006; Kawo and Rogo, 2008). In conclusion, contact surfaces could act as vehicles for harboring and transmission of bacterial diseases and infections (Thomas and Tillet, 1973; Baid, 1985; Olayemi and Adebayo, 1991; Ferson, 1997; Yusha'u *et al*., 2008; Kawo *et al*., 2009).

CONCLUSIONS AND RECOMMENDATIONS

In view of the high level of bacterial contamination as well as the isolation and identification of some potential bacterial pathogens from the contact surfaces of some secondary schools in Sokoto metropolis, it shows that the students in these schools may easily contact these micro-organisms and thus become infected. It is therefore strongly recommended that public awareness and enlightenment campaigns on proper environmental and personal hygiene be intensified within the school environments in particular and the general public.

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