



Pathogenicity and antibiotic resistance of *Enterococcus faecalis* isolated from water used in health-care centers of Ekiti State University and environ

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Abstract

The quality of water samples obtained from the health-care center in the Ekiti State University and three other centers around the campus; Ekiti State University Teaching Hospital (EKSUTH), Iworoko-Ekiti health Centre (IHC) and the State Hospital, Ikole-Ekiti (SHI) were investigated by analyzing the total bacterial count using pour plate method; the incidence and antibiotic resistance of *Enterococcus faecalis* as water quality indicator was enumerated using selective isolation and disk diffusion method respectively. The mean TBC, TCC and TEC of all the water samples ranged from 9.1×10^2 to 17.4×10^3 CFU/ml, 4.1×10^2 to 5.5×10^3 CFU/ml and 0.4×10^2 to 0.4×10^3 CFU/ml respectively. A total of 70 (32.9%) *Enterococcus faecalis* were recovered from the water samples from Iworoko HC, which showed highest distribution in bore-hole and well water samples while least frequency of *E. faecalis* (15.7%) was recovered from EKSU HC. However, no incidence of *E. faecalis* in table water obtained from all the health-care facilities. Just 35% of 20 selected *E. faecalis* were caseinase producers while 80% of the isolates were biofilm producers. All the isolates were resistant to cefuroxime, cefixime, augmentin and ceftazidime while only 10% of them were resistant to ofloxacin. 58.6% of the isolates showed MAR to eight (8) antibiotics with three different resistotypes while only 1.4% of them showed MAR to four (4) antibiotics with just one resistotype (CRX-CXM-AUG-CAZ). Only *E. faecalis* 15 among the selected isolates possessed two plasmids with molecular weight of 1.415bp and 13.535bp. However, consumption of contaminated water traceable to faecal sources and plasmid mediated of the causative microbes would be discussed.

Keywords: Pathogenicity; *Enterococcus Faecalis*; Health-Care Centers; Biofilm.

1. Introduction

Enterococci, which include *Enterococcus faecalis*, *Enterococcus faecium* and their varieties, are commonly found in the feces of humans and other warm blooded animals. Enterococci are members of the intestinal microbiota of healthy humans and animals and can be released into the environment, such as soil and water by human and animal fecal material (Gilmore *et al.*, 2002). Although some strains are ubiquitous and not related to fecal pollution, Enterococci in water are an indication of fecal pollution and the possible presences of enteric pathogens. Knowledge of Enterococci sources, fate and transport can inform the creation of models that predict Enterococci concentrations in various water sources. Measuring Enterococci on hands may be useful for understanding post collection stored water contamination in developing countries, as well as the spread of infectious disease in both developing and developed countries (Pickering *et al.*, 2010). A methods allocates sources of Enterococci found in a surface water would be beneficial to the community of water quality managers (Jin *et al.*, 2004). The treatment of Enterococci infections can be difficult because *Enterococcus* species are intrinsically resistant to many antimicrobial agents, including cephalosporin, clindamycin, semi synthetic penicillinase-stable penicillin, and Aminoglycosides among others, and have the capacity to acquire resistance genes and mutations (Arias and Murray, 2012).

The resistance of biofilm cells formed as a result of activities of *Enterococcus* spp. to antimicrobial agents has serious consequences. When biofilms form on a medical device such as a ship implant, they are difficult to kill and can cause serious illness.

The aim of this project research work was to show if the presence of plasmids in bacteria is the major factor responsible for its resistance to antibiotics and basic objective of this research include: To identify the isolated organism, to determine the virulence factor of the organism, to determine the antibiotic susceptibility of the isolated organisms and the presence of plasmids in selected isolates isolated from water.

2. Material and methods

2.1. Sampling site

Water samples were taken from the health-care facility of the Ekiti State University campus, Ado-Ekiti and other three facilities around the campus which included; Ekiti State University Teaching Hospital, Ado-Ekiti; Iworoko-Ekiti health Centre and State Hospital, Ikole-Ekiti.

2.1. Collection of water samples

Water samples from different sources such as well water, bore-hole water, chlorinated hospital water and bottled water available for use within each of these health-care centers' environments were collected aseptically using 250ml sterile sampling bottles, transported immediately in ice-bag to the Microbiology Laboratory of Ekiti State University, Ado-Ekiti for bacteriological analysis within 2h of sample collection.

2.3. Bacteriological analysis

Ten-fold serial dilution was carried out on the water samples collected and 1ml of the water sample were inoculated on Nutrient agar, MacConkey agar and Bile Esculin agar using pour plating technique and incubated at 37°C in an incubator for 24 h invertedly according to Olutiola *et al.*, 2000. Pure bacterial strains were isolated by streaking on freshly prepared media. Pathogenic factors of the isolated microbes were also determined through biofilm and caseinase production according to Jamal and David (2007).

2.3.1. Antibiotics susceptibility test

The bacterial suspension was incubated at ambient temperature until the turbidity of the suspensions was corresponding with McFarland Turbidity Standard of 0.5, which is equivalent of 10^8 CFU/ml. They were subjected to antibiotic sensitivity tests using the disc diffusion method for each of the isolate as described by Cheesbrough (2006). The antibiotics used were ceftazidime (CAZ, 30µg), Cefuroxime (CRX, 30µg), Gentamicin (GEN, 10µg), Cefixime (CXM, 5µg), Augmentin (AUG 30µg), Ciprofloxacin (CPR, 5µg), Ofloxacin (OFL, 5µg), Erythromycin (ERY, 5µg). The diameter of zone of the clearance/inhibition including the diameter of the disk was measured to the nearest whole millimeter and interpreted on the basis of CLSI (2005) guidelines.

2.3.2. Plasmid extraction and profiling

TENS (Tris- 25mM, Ethyl-dimethyl tetra-amine; EDTA-10mM, Sodium hydroxide; NaOH 0.1N and Sodium dodecyl sulphate; SDS 0.5%) protocol described by Liu *et al.*, (1995) was employed in plasmid extraction. The extracted plasmid DNA was electrophoresed on 0.8% agarose gel stained with ethidium bromide and visualized by UV-transillumination according to Robins-Browne *et al.*, (2004).

3. Results

The mean total bacterial count (TBC), total coliform count (TCC) and total Enterococcus count (TEC) of water obtained from EKSU health centre (EKSU HC) ranged from 12.4×10^2

to 7.5×10^3 CFU/ml, 4.3×10^2 to 3.3×10^3 CFU/ml and 0.7×10^2 to 0.4×10^3 CFU/ml respectively. The same mean estimations (TBC, TCC and TEC) obtained for Iworoko health centre (IHC) ranged from 9.1×10^2 to 6.4×10^3 CFU/ml, 8.9×10^2 to 5.5×10^3 CFU/ml and 0.6×10^2 to 0.3×10^3 CFU/ml respectively. The mean values (TBC, TCC and TEC) obtained for Ekiti State teaching hospital (EKSUTH) ranged from 20.1×10^2 to 17.4×10^3 CFU/ml, 4.1×10^2 to 3.1×10^3 CFU/ml and 0.7×10^2 to 0.3×10^3 CFU/ml respectively. While mean TBC, TCC and TEC obtained for State hospital Ikole (SH.I) ranged from 11.1×10^2 to 9.5×10^3 CFU/ml, 6.1×10^2 to 3.2×10^3 CFU/ml and 0.4×10^2 to 0.2×10^3 CFU/ml respectively (Table 1).

A total of 70 species of *Enterococcus faecalis* were recovered from the water samples with the highest frequency (32.9%) obtained from Iworoko health centre (IHC), with highest distribution in bore-hole and well water samples. EKSUTH and SH.I comprised the same frequency of *E. faecalis* (25.7%) with highest distribution from well water at State Hospital, Ikole. Meanwhile, least frequency of *E. faecalis* (15.7%) was obtained from EKSU HC. There was no incidence of *E. faecalis* in table water obtained from all the health-care facilities (Table 2).

Among 20 selected *Enterococcus faecalis* isolated from water samples of the health-care facilities 35% were revealed to be caseinase producers while 80% of the isolates showed ability to produce biofilm (Table 3).

About 10% of isolated *Enterococcus faecalis* were able to resist the effect of ofloxacin. All the isolates (100%) were resistant to cefuroxime, cefixime, augmentin and ceftazidime while very high percent (significantly above average) of the test *E. faecalis* showed resistance to gentamycin (70%), ciprofloxacin (99%) and erythromycin (80%) (Table 4).

All the isolates exhibited multiple antibiotics resistance to at least four (4) of the test antibiotic with varying resistotype (combination). Highest percentage (58.6%) of the isolates showed resistance to 8 antibiotics with 3 different resistotypes; followed by 22.9% of the isolates which were resistant to six (6) antibiotics with two (2) resistotypes. About 11.4% and 7.1% of the isolates were separately resistant to five (5) and eight (8) antibiotics with one resistotype each; and only 1.4% of the isolated *E. faecalis* showed resistance to four (4) antibiotics with just one resistotype (CRX-CXM-AUG-CAZ) (Table 5).

Out of five selected MAR *Enterococcus faecalis* recovered from the water samples, only *E. faecalis* 15 possessed two plasmids with molecular weights of 1.415bp and 13.535bp as depicted in Figure 1.

Table 1: Microbial Load of Water Samples from Health-Care Facilities

Sources of samples	Total bacteria counts					
	TBC 10 ³		TCC 10 ³		TEC 10 ³	
	10 ³	10 ⁴	10 ³	10 ⁴	10 ³	10 ⁴
EKSU HC						
A	37	30	24	20	3	2
B	25	19	29	18	5	3
C	5	3	2	0	0	0
D	180	98	30	28	5	3
Mean	123.5	75	42.5	33	6.5	4
IWOROKO HC						
A	53	41	70	60	3	2
B	24	16	80	30	4	2
C	2	0	3	1	0	0
D	103	71	25	18	5	2
Mean	91	64	89	54.5	6	3
EKSUTH						
A	16	51	20	16	3	2
B	205	165	30	25	2	1
C	1	0	3	1	0	0
D	180	132	29	20	8	3
Mean	201	174	41	31	6.5	3
SH.I						
A	45	31	10	4	3	1
B	49	38	30	20	3	2
C	2	1	1	0	0	0
D	126	119	80	40	2	1
Mean	111	94.5	60.5	32	4	2

Keys: TBC= Total Bacteria Count

TCC= Total Coliform Count

TEC= Total Enterococcus Count

SH.I= State Hospital, Ikole

IWOROKO HC= Iworoko-Ekiti, Health center

EKSU HC= Ekiti State University, Health center

EKSUTH= Ekiti State Teaching Hospital

Table 2: Distribution of Enterococcus Faecalis in Water Samples from Water Samples in Health-Care Facilities

Sources of sample	Number of distribution per water samples				Total Distribution	Percentage Distribution
	Bore-Hole	Well water	Chlorinated HW	Bottle water		
EKSU HC	3	5	3	ND	11	15.7%
IWOROKO HC	10	10	3	ND	23	32.9%
EKSUTH	7	7	4	ND	18	25.7%
SH.I	4	12	2	ND	18	25.7%
Total					70	100%

Keys: HW= Hospital water

SH.I= State Hospital, Ikole

IWOROKO HC= Iworoko-Ekiti, Health center

EKSU HC= Ekiti State University, Health center

EKSUTH= Ekiti State Teaching Hospital

ND=Not Detected

Table 3: Biofilm and Caseinase Production by *E. Faecalis* Isolated from Water Samples in Health-Care Facilities

S/N	Isolates	Pathogenic factors	
		Caseinaseproduction	Biofilm production
1	<i>E.feacalis</i> 18	+	+
2	<i>E.feacalis</i> 37	-	+
3	<i>E.feacalis</i> 19	-	+
4	<i>E.feacalis</i> 16	-	+
5	<i>E.feacalis</i> 17	+	+
6	<i>E.feacalis</i> 36	+	+
7	<i>E.feacalis</i> 9	+	+
8	<i>E.feacalis</i> 10	-	+
9	<i>E.feacalis</i> 6	-	+
10	<i>E.feacalis</i> 60	+	+
11	<i>E.feacalis</i> 70	+	+
12	<i>E.feacalis</i> 11	+	-
13	<i>E.feacalis</i> 35	-	+
14	<i>E.feacalis</i> 14	-	+
15	<i>E.feacalis</i> 41	-	-
16	<i>E.feacalis</i> 55	-	+
17	<i>E.feacalis</i> 49	-	+
18	<i>E.feacalis</i> 43	-	+
19	<i>E.feacalis</i> 45	-	-
20	<i>E.feacalis</i> 47	-	-
	Number of positive isolates (%)	7 (35)	16 (80)

Keys: + means Positive Production of biofilm and caseinase.

- means Negative Production of biofilm and caseinase.

Table 4: Antibiotics Susceptibility among Enterococcus Faecalis Isolated from Water Samples in Health-Care Facilities

Isolates	Antibiotics								Phenotype of resistant pattern
	GEN	CPR	CRX	ERY	CXM	OFL	AUG	CAZ	
1	R	R	R	R	R	R	R	R	GEN,CPR,CRX,ERY,CXC,OFL,AUG,CAZ
2	R	R	R	S	R	I	R	R	GEN,CPR,CRX,CXM,AUG,CAZ
3	I	I	R	I	R	S	R	R	CRX,CXM,AUG,CAZ
4	R	R	R	R	R	R	R	R	GEN,CPR,CRX,ERY,CXM,OFL,AUG,CAZ
5	R	R	R	I	R	R	R	R	GEN,CPR,CRX,CXM,OFL,AUG,CAZ
6	R	R	R	I	R	I	R	R	GEN,CPR,CRX,CXM,AUG,CAZ
7	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
8	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
9	I	R	R	R	R	I	R	R	CPR,CRX,CXM,AUG,CAZ
10	I	R	R	I	R	S	R	R	CPR,CRX,CXM,AUG,CAZ
11	R	R	R	I	R	R	R	R	GEN,CPR,CRX,CXM,OFL,AUG,CAZ
12	I	R	R	R	R	I	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
13	R	R	R	R	R	I	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
14	R	R	R	S	R	R	R	R	GEN,CPR,CRX,CXM,OFL,AUG,CAZ
15	R	R	R	R	R	R	R	R	GEN,CPR,CRX,ERY,CXM,OFL,AUG,CAZ
16	S	R	R	I	R	S	R	R	CPR,CXR,CXM,AUG,CAZ
17	R	R	R	R	R	I	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
18	R	R	R	R	R	R	R	R	GEN,CPR,CRX,ERY,CXM,OFL,AUG,CAZ
19	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
20	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
21	R	R	R	R	R	R	R	R	GEN,CPR,CRX,ERY,CXM,OFL,AUG,CAZ
22	R	R	R	R	R	I	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
23	I	R	R	I	R	S	R	R	CPR,CRX,CXM,AUG,CAZ
24	R	R	R	R	R	I	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
25	R	R	R	I	R	S	R	R	GEN,CPR,CRX,CXM,AUG,CAZ
26	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
27	I	R	R	I	R	S	R	R	CPR,CRX,CXC,AUG,CAZ
28	S	R	R	I	R	S	R	R	CPR,CRX,ERY,CXM,AUD,CAZ
29	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
30	R	R	R	R	R	I	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
31	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
32	I	R	R	I	R	S	R	R	CPR,CRX,CXM,AUG,CAZ
33	S	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
34	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
35	I	R	R	I	R	S	R	R	CPR,CRX,CXM,AUG,CAZ
36	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
37	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
38	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
39	I	R	R	I	R	S	R	R	CPR,CRX,CXM,AUG,CAZ
40	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
41	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
42	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
43	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
44	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
45	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
46	S	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
47	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
48	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
49	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
50	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
51	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
52	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
53	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
54	R	R	R	S	R	S	R	R	GEN,CPR,CRX,CXM,AUG,CAZ
55	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
56	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
57	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
58	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
59	R	R	R	I	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
60	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
61	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
62	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
63	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
64	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
65	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
66	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
67	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
68	I	R	R	R	R	S	R	R	CPR,CRX,ERY,CXM,AUG,CAZ
69	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
70	R	R	R	R	R	S	R	R	GEN,CPR,CRX,ERY,CXM,AUG,CAZ
Percentage Resistance	70%	99%	100%	80%	100%	10%	100%	100%	

Keys:R- Resistance, S- Suceptibility, I- Intermediate, GEN- Gentamicin, CPR-Ciprofloxacin, CRX- Cefuroxime, ERY- Erythromycin, CXM- Cefixime, OFL- Ofloxacin, AUG- Augmentin, CAZ- Ceftazidime

Table 5: Multiple Antibiotic Resistance Patterns of *Enterococcus Faecalis* Isolated from Water Samples in Health-Care Facilities

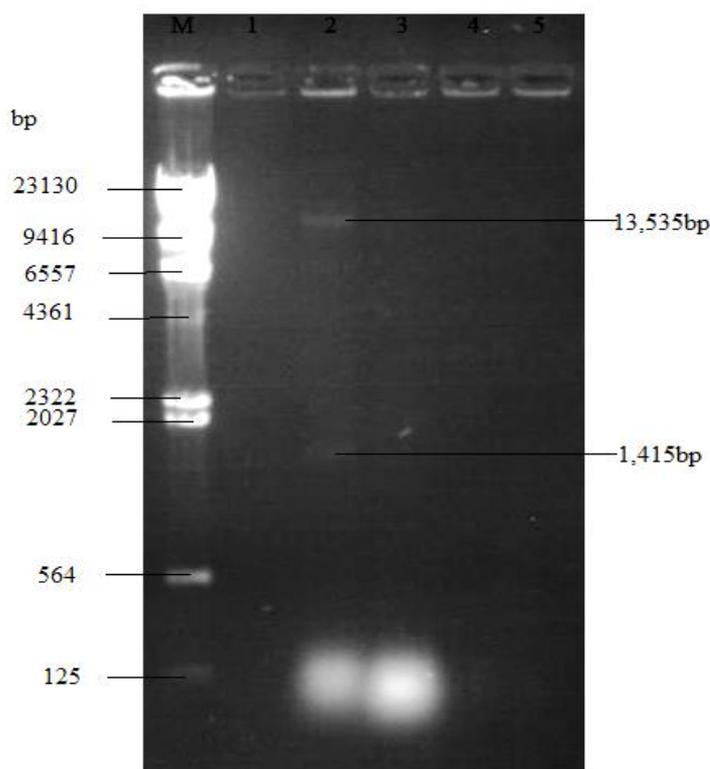
Number of antibiotics	Resistotypes	Number of Occurrences (%)
4	CRX-CXM-AUG-CAZ	1
	Total	1 (1.4)
5	CPR-CRX-CXM-AUG-CAZ	8
	Total	8 (11.4)
6	GEN-CPR-CRX-CXM-AUG-CAZ	4
	CPR-CRX-ERY-CXM-AUG-CAZ	12
7	Total	16 (22.9)
	GEN-CPR-CRX-CXM-OFL-AUG-CAZ	2
	GEN-CPR-CRX-CXM-OFL-AUG-CAZ	3
	GEN-CPR-CRX-ERY-CXM-AUG-CAZ	35
8	Total	40 (58.6)
	GEN-CPR-CRX-ERY-CXM-OFL-AUG-CAZ	5
	Total	5 (7.1)
	Total (%)	70 (100)

Keys: GEN- Gentamicin, CPR-Ciprofloxacin, CRX- Cefuroxime, ERY- Erythromycin, CXM- Cefixime, OFL- Ofloxacin, AUG- Augmentin, CAZ- Ceftazidime

Table 6: Plasmid Profile of Selected MAR Isolates from Water Samples in Health-Care Facilities

Isolates	Number of plasmids	Molecular weight of plasmid (bp)	Antibiotics to which isolates were resistant	
			Number	Combination
<i>E. faecalis</i> 1	-	-	5	GEN-CPR-CRX-ERY-CXM-AUG-CAZ
<i>E. faecalis</i> 15	2	13,535, 1,415	5	GEN-CPR-CRX-ERY-CXM-AUG-CAZ
<i>E. faecalis</i> 21	-	-	5	GEN-CPR-CRX-ERY-CXM-AUG-CAZ
<i>E. faecalis</i> 4	-	-	5	GEN-CPR-CRX-ERY-CXM-AUG-CAZ
<i>E. faecalis</i> 5	-	-	5	GEN-CPR-CRX-ERY-CXM-AUG-CAZ

Keys: GEN- Gentamicin, CPR-Ciprofloxacin, CRX- Cefuroxime, ERY- Erythromycin, CXM- Cefixime, OFL- Ofloxacin, AUG- Augmentin, CAZ- Ceftazidime

**Fig. 1:** Plasmid Profile of MAR *Enterococcus faecalis* Isolated from Water Samples in Health-Care Facilities.

4. Discussion

The most effective way to protect the quality of drinking water is through consistent and constant monitoring of the water supply (WHO, 2010). The quality of water is determined bacteriologically and physicochemically to ensure safe and portable water free from pathogenic microorganisms and chemical substances that are harmful to health (Shittu *et al.*, 2008).

The mean of the total bacterial, total coliform and total enterococcal counts of the water samples were higher than the specified limit advocated by WHO, 2006. This is an indication of high microbial load which may be due to poor hygiene and sanitary condi-

tions (Okonko *et al.*, 2008). More so, Roohul-Amin *et al.*, (2012) attributed microbial contamination of drinkable water to leakage in pipes, cross contamination with wastewater, poorly constructed well head, short distance between water supply network and sewage supply; construction of septic tanks near wells and drinking water supply lines; run-offs; infiltration of wastes and direct deposition of waste water through leakage. This evident the high microbial load encountered for the well and bore-hole water analyzed in present study.

As noted earlier, fecal indicator bacteria have been used over the years back, to assess water quality and protect humans from the myriad of enteric pathogens that are transmitted through the water

borne route by acting as fecal indicator (Harwood *et al.*, 2004). Fecal indicator are generally commensal inhabitants of the gastrointestinal tracts of many warm blooded animals and are shed in feces at high densities, thus are easily detected in contaminated water. A study had advocated that isolation of *Enterococcus faecalis* in water sources would be a significant factor for water quality managements (Jin *et al.*, 2004).

Present study showed that water can serve as potential sources of health related risk factors for the consumers, simply by the presence of virulent bacterial isolates with antibiotics resistance attributes. Perhaps, *Enterococci faecalis* may have contaminated the water from various sources in the health-care center through different sources, as reported by Center for Environmental Health (2005). Incidence of *Enterococcus faecalis* in these water samples is an indication of contamination relatively of fecal origin, this is in agreement with Mathur *et al.* (2003) who reported that water may contain a wide range of organisms which include indigenous species, saprophytic species as well as human pathogen such as *Enterococcus faecalis*, *Enterococcus faecium*, *Enterococcus durans*, *Enterococcus avium* and other species of *Enterococcus*. Most of the drinking water samples collected from various hospital sources was positive for *Enterococcus*. This could be due to many reasons. The enterococcal Strains may be more resistant to chlorination (Tree *et al.*, 2003) or the sources of water supply to hospitals may be more polluted than open wells and bore wells. A hospital water tank has been reported as the reservoir of bacteria (Mossel and Struijk, 2002). The ubiquitous nature of the organism and its resistance to adverse environmental conditions is partly responsible for its ability to colonize different habitats and also its ability to spread easily through the water chain (Aparecida *et al.*, 2007).

Production of pathogenic factors like biofilm by the *E. faecalis* isolated from water sources in health-care centers in this study is in accordance with the study of Guiton *et al.* (2010), which reported that biofilm production is one of the virulence factor notable of *Enterococcus faecalis* that contribute to its pathogenicity. Furthermore, the result obtained from this study shows that *Enterococcus faecalis* are multiple antibiotics resistance and the resistance to these antibiotics may be due to increase clinical use of these antibiotics and this corresponded to (Clark *et al.*, 2011). Acquire the resistance in enterococci can occur through sporadic mutations or through acquisition of foreign genetics material. Horizontal gene exchange among *Enterococci* occurs through the transfer of pheromones sensitive or broad host range plasmids, or through the movement of transposons, with few exceptions, multiple plasmids and transposons can be identified in clinical strains. The result shows the presence of bacterial plasmid in *Enterococci* as one of the causes of their resistance to multidrug in correlation with (Hagstad *et al.*, 2010). Factors that might lead to selection of particular groups of antibiotic resistant *Enterococci* in the environment are (1) antibiotic consumption by humans and animals that results in excretion of resistant bacteria, mostly in form of feces and (2) the presence of antibiotics in water that can create or maintain the selective pressure (WHO, 2004). Resistance to Erythromycin, Ciprofloxacin, Augmentin, Cefixime, Ceftazidime, Cefuroxime can be mostly explained by the presence of the classical erm(B) gene alone or combined with the efflux *mef(A)* gene and this correlated with (Arias *et al.*, 2012).

According to the report of (Odeyemi *et al.*, 2010) which stated *Enterococcus* have a remarkable capacity of expressing resistance to several groups of antimicrobial, thus posing a daunting challenge to the word of clinical practice as the number of therapeutic options for medical interventions are significantly reduced. *Enterococci* are not pathogenic organisms in nature, they are part of the microbiota of the body, but there is infection in the body or immunocompromise patient create an opportunity of becoming harmful to the host.

Conclusion and recommendations

Present study has shown that the water samples from the health-care facilities in the Ekiti State University and Environ are not safe for drinking due to contaminations that are traceable to faecal sources. Incidence of a noble water quality indicator, *Enterococcus faecalis* especially in high frequency in these water sources is however a potential health hazard. Moreover, *Enterococcus faecalis* recovered from this study showed the ability to develop resistance to essentially every antibiotic used against them, serving as a great threat to the community.

This study therefore recommends that future studies should further dissect the mechanism by which *Enterococcus faecalis* could colonize water body and should then focus on ways to reduce or prevent this colonization. Strategies, including immunological approaches, to prevent infection in the face of colonization should be explored. In addition, the elucidation of mechanisms of resistance to the newer anti-enterococcal antibiotics should yield important insights for the development of future therapeutic options. Additional new strategies, perhaps phage-based or a combined therapeutic-immunological approach should also be considered.

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