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Full Length Research Article

Distribution Pattern of Enteric Organisms in the Lagos Lagoon, Nigeria

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Abstract
A wide range of organisms was encountered in the 24 sampled sites of the Lagos Lagoon. The enteric gram-negative shortrods, Lactose fermenting organisms such as *Klebsiella spp, Enterobacter spp* and *Escherichia coli* were prevalent in most of the Lagoon sites studied. The *in vitro* antibiotic sensitivity profile of the isolates revealed that high proportion of the bacteria isolate showed multiple antibiotic resistance. This is epidemiologically significant in the event of human infections. Since these organisms are widely distributed in the surface water they are likely to contaminate marine organisms which if consumed by people in the area may result in disease spread which could also be complicated by the antibiotic resistant nature of the organisms involved.

Key words: Distribution, Enteric, Lagoon, Lagos, Organisms, Pattern

INTRODUCTION

The Lagos Lagoon is a great expance of bw – lying salt and brackish water covering an area of about 208 km^2. In most places the Lagoon is usually less than 1.5 meters deep (Akpata and Ekundayo, 1978). The total range is small, 0.3-1.3 meters. The interconnecting creeks are very shallow. They are sites of active sedimentation and deposition of mud (Ajao and Fagade 1990).

The increase in population and industrialization of the city of Lagos which is a commercial nerve center of this country, Nigeria, has resulted into proportional generation of various types of wastes or contaminants into the Lagoon. The contaminants and the diverse nature of the marine Lagoon environment result in succession of various species of microorganisms which may be potential sources of health hazard. The discharge of raw sewage into the Lagoon has important health implication (Akpata & Ekundaayo, 1978;Halasi-Kun, 1981). The occurrence of the enteric organisms and other microorganisms in the Lagos Lagoon may lead to contamination of aquatic life and other food products, thereby causing possible health hazard to those products. In the food chain consumption of hazardous wastes or infectious agents can adversely affect the consumers and organisms of the high trophic level (Prescott *et al*., 2002).

The infiltrations of various forms of contaminants into the Lagoon necessitate the routine monitoring of this coastal water body. In order to appreciate the level of pollution and environmental degradation of the area, an environmental impact assessment (E.I.A) study of the area should be carried out. Munn (1979), identified E.I.A as an activity designed to identified and predict the impact of project on the biogeophysical programmes, operational procedures and to interprete and finally communicate the impact. The conservation of the biogeophysical component of the ecosystem is desirable for man's co-existence, hence the need to monitor it's dynamics.

Microorganisms like other life forms are, an integral and important components of the ecosystem (Prescott *et. al*., 2002). There is a wide variety of microorganisms in nature and they are versatile in the use of diverse nutrients in the environment. The specificity for nutrients or succession of certain organisms in an environment may serve as bioindicators of the presence of pollutants in such an environment (Baker, 1976). This study will help to determine some polluted zones of the Lagos Lagoon based on the presence of specific enteric organisms in certain areas of the study site. The occurrence of such organisms are potential threat to the ecological area, thus possible health remedy can be made from the study for sustainable economic development.

MATERIALS AND METHODS

Sampling Technique

Twenty-four stations were mapped out on the Lagos Lagoon for the month of February and June study periods. The Nigerian Institute for Oceanography and Marine Research (NIOMR) assisted in the research with the aid of NIOMR field assistants that routinely used the designated map to locate sampling points from where water samples were collected for analysis (Fig. 1).

Surface water was collected within a depth of one foot into sterile plastic container employing a Ruthner standard water sampler, (8cm diameter and 50cm long, capacity 500ml). Approximately about a litre of water was collected from each sampling point. The samples were labelled and sealed, and immediately kept in a cooler containing ice on board the boat for preservation. The water samples were analyzed within 36 hours of sample collection. The coliform counts were determined employing Millipore membrane filters (Satorious, GmbH). On incubation of the serially diluted sampled water in Nutrient agar plates at 37°C overnight, the organisms were counted by enumerating the colony forming units of the sample sources cultured.

Identification and antibiotic sensitivity pattern of isolates

Each bacterial isolates was identified based on their morphological characteristics, colour, arrangement of vegetative cell and possession of spores and other biochemical characteristics (Robert *et al.*, 1984), The *in vitro* antibiotic susceptibility testing of bacterial isolates was performed using the standardized disc agar diffusion method described by Bauer *et al* (1966). Paper disc medium (PDM), Antibiotic sensitivity agar (AB BIODISK, Solna, Sweden) was the plating medium used. The antibiotic discs (AB BIODISK, Solna , Sweden) that were placed on the culture medium and used for this test included Gentamicin, Nalidixic acid, Tetracycline, Spectinomycin, chloramphenicol and streptomycin with 30µg/disc each in quantity. Others were Trimethoprim sulfamethoxazole 1-2+23.8µg/disc Trimethoprim 1.2µg/disc, Ampicillin 10µg/dsic and sufamethoxazole 23.8µg/disc.

RESULTS

Various species of microorganisms encountered in the Lagos Lagoon were identified by standard microbiological techniques as shown in Table 1. The occurrence of microbial species encountered in different designated sampling sites of the Lagoon was also studied (Table 2).

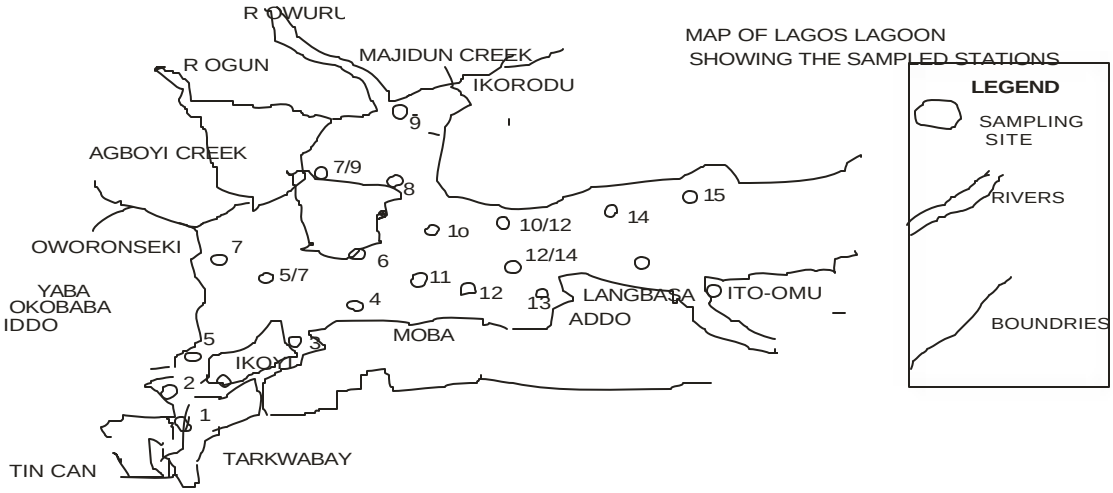

Fig. 1: Map of Lagos Lagoon

Table 1:
Morphological and Cultural Characteristics of Bacteria Isolates From The Lagoon

Isolate Code	Cultural characteristics and pigments on solid media	Shape	Gram Stain	Blood Heamolysis	Catalase	O-F Glucose	Nitrate Reduction	Mannitol	Glucose	Fructose	Lac-tose	Suc-rose	Raffi-nose	Arabi-nose	Citrate utiliza-tion	EMB Agar (Lactose Formation)	Mannitol Salt Agar	Identification
1	Lobate,raised, yellow Colony.	Rod	-	ß- Heam-olysis	+	O/F	+	+g	+g	+	+	-	-	-	-	Green metallic sheen	ND	Escherichia coli
1b	Undulate, rough,raised,yellow Colony	Cocci in chain	+	a- Heam-olysis	-	O/F	+	+g	+	+g	+g	+g	+g	+g	-	ND	ND	Streptococcus spp.
2	Entire edge, Smooth,convex, yellow colony	Rod	-	a- Heam-olysis	+	O/F	+	+g	+g	+g	+g	+g	+g	+g	-	Mucoid	ND	Enterobacter spp.
2c	Flat,mucoid, luxuriant, white colony	Rod	+	ß- Heam-olysis	+	O/F	+	+	+g	-	+g	+g	+g	+g	-	Mucoid	ND	Bacillus polymyxa
5	Entire edge, Smooth,convex, yellow colony	Rod	+	ß- Heam-olysis	-	-/F	+	+g	+	+	-	-	-	-	-	-	Growth mannitol fermented	Bacillus spp.
6	Entire edge, Smooth,convex, white colony	Rod	+	ß- Heam-olysis	+	O/F	+	+g	+	-	+	-	+g	+g	+	-	Growth mannitol fermented	Bacillus spp.
9MJR(1)	Lobate,Translusce nt,Mucoid,golden yellow.	Cocci in cluster	+	ß- Heam-olysis	+	O/F	-	+g	+	+	-	+	+g	+	+	ND	Growth mannitol fermented	Micrococcus spp.
OGR (1)	Lobate,smooth,um bonate pink colony.	Rod	-	ß- Heam-olysis	+	O/F	+	+g	+g	+g	+g	+g	+g	+g	+	Mucoid	-	Klebsiella spp.
OGR (2)	Lobate,rough,raise d,green to purple Colony.	Rod	-	ß- Heam-olysis	+	O/-	+	+g	+g	+	-	-	+g	+g	+	-	ND	Pseudomonas aeroginosa
10a	Lobate,,raised,tan white Colony.	Cocci in cluster	-	a- Heam-olysis	-	O/F	-	+	+g	+g	+g	+g	+g	+g	-	-	No growth	Veillonella spp.
10/11	Lobate,raised, yellow Colony.	Rod	-	ß- Heam-olysis	+	O/F	+	+g	+	+	+	+	-	-	-	Green metallic sheen	-	Escherichia coli
15	Lobate,,raised,tan white Colony.	Large rod	+	ß- Heam-olysis	+	O/F	-	+	+	+	-	+	-	-	+	-	Growth mannitol Not, fermented	Bacillus megaterium

Table 2a:
Distribution pattern of Bacterial isolates cultured from the Lagos Lagoon.

Isolates	Sampling stations (surface water)																		
	1	2	2sp.	3	4	5	6	7	8	9	9MJR	10	11	12	13	14	AGR	15	OGR
Bacillus spp.																			
Bacillus megaterium																			
Micrococcus spp																			
Klebsiella spp.																			
Enterobacter spp.																			
Escherichia coli.																			
Bacillus polymyxa																			
Veillonella spp.																			
Streptococcus spp.																			
Pseudomonas spp.																			

Legend: Present: + ; Absent : -

Table 2b:
Distribution Pattern of Enteric Organism in The Lagos Lagoon.

Stations	**February**	**June**
	Coliform Count Cfu X 10^3	Coliform Count Cfu X 10^3
1	2.5	0.21
2	7.1	0.35
2 Special	2.8	0.67
3	0.50	2.4
4	0.10	1.8
5	0.30	0.37
6	0.10	0.70
7	0.40	0.19
5/7	1.7	1.00
7/9	0.48	0.37
8	0.50	1.10
9	1.5	0.80
10	0	0.28
11	0.20	1.7
12	0	1.4
12/10	0.70	1.7
12/14	0.40	3.2
9MJR	3.0	0.50
AGR	7.0	0.20
OGR	0.30	-
13	0	0.80
14	0.20	0.60
15	0.30	0.15

Legend: *N.D – Not Determined*

Here the enteric Gram negative rods organisms such as *Klebsiella* spp. *Enterobacter* spp. and *Escherichia coli* were found to be widely distributed in the Lagos Lagoon. The organisms recovered in the Lagoon ranged from a high of 7.1 X 10^3 cfu/ml recorded in station 2 and Agboyi creek respectively to low coliform counts of zero (0) in each of the stations 10,12 and 13 for the month of February. In June, the total coliform count also ranged from a high of 3.2 x 10^3 cfu/ml in station 12/14 to a lows coliform count of 0.15 X10^3 cfu/ml observed in station 15. The individual coliform count varied from station to station. (Table 2).

Each sampled site constituted different type of bacterial species apart from the coliform groups of organism. Table 2 shows that though there were more coliform organisms in February but there were some dominant species in the sampled site. Thus the enteric organisms were encountered in less frequency for February than June when there was more widespread of the enteric organisms in most of the designated station probably due to their dispersal by rainfall and tide. . The enteric organisms identified as *Escherichia coli*, *Enterobacter spp.* and *Klebsiella spp.* were found in many areas of the Lagos Lagoon as shown in Tables 1 and 2. The *in vitro* antibiotic sensitivity test performed for bacterial isolates revealed that 6(60%) of the selected strains tested showed multiple antibiotic resistance (Table 3).

Table 3:
Antibiotic Sensitivity Profile of selected Bacterial strains encountered in the Lagos Lagoon.

Isolate Code	Bacterial Species	GM	NA	TS	TC	TR	AM	SM	SC	SX	CL
1	*Escherichia coli*	18R	15R	18R	18R	17S	0R	16R	12R	0R	22R
2	*Enterobacter spp*	22S	18R	25S	22R	20S	9R	20S	8R	0R	18R
5	*Bacillus spp*	28S	25R	28S	25R	0R	40S	15R	10R	23S	35S
6	*Bacillus spp*	26S	30S	40S	36S	24S	35S	16R	16S	33S	38S
9MJR(1)	*Micrococcus spp.*	26S	32S	38S	38S	25S	28S	24S	16S	22S	31S
OGR (1)	*Klebsiella spp.*	18R	17R	25S	17R	19S	8R	22S	14R	7R	22R
OGR (2)	*Pseudomonas aeroginosa*	26S	40S	36S	24R	42S	35S	20S	16S	34S	36S
7/9	*Klebsiella spp*	18R	17R	26S	17R	19S	8R	22S	14R	7R	22R
10/11	*Escherichia coli*	18R	15R	17R	18R	17S	0R	16R	12R	7R	22R
15	*Bacillus megatarium*	28S	10R	18R	28S	0R	0R	0R	13R	21S	26S

Legend:
S – Sensitivity, R – Resistant, GM – Gentamicin, AM – Ampicillin, SM - Streptomycin, NA – Nalidixic acid, TS – Trimethoprim + Sulfamethoxazole , SC – Spectinomycin, TR – Trimethoprim, TC – Tetracycline, SX – Sulfamethoxazole, CL – Chloromphenicol

The presence of this kind of organisms is of epidemiological significance because the multiple antibiotic resistant enteric organisms may be difficult to treat in case of human infections. The site of occurrence of the enteric organisms may help in proper monitoring of the Lagoon for sustainable ecological development.

DISCUSSION

This study shows that contamination of the Lagoon with coliform bacteria occurred in all the stations that were sampled except one (Table 1& 2).The study of Akpata and Ekundayo (1978) also confirmed the presence of coliform bacteria relevant areas of the Lagoon. These suggest that the Lagoon is relatively unsafe for swimming and other recreational purposes. It may also indicate that individuals with open sores or skin abrasions may be at the risk of getting infected with these organisms, more so if such individuals are also immunocompromised.

Enteric Gram negative short rods, lactose fermenters, such as *klebsiella spp, Enterobacteria spp* and *Escherichia coli* constituted high percentage of the entire organism cultured from the Lagos Lagoon samples suggesting recent contamination of this body of water with human sewage. According to Ajao and Fagade (1990), since the later part of 19th century, the Lagoon has served as the ultimate sink for the disposal of untreated domestic sewage. This may have serious health implications. Various wastes and contaminants discharged into the Lagoon contribute to a large extent to the metabolic activity of microorganisms (UNESCO, 1981;Webb, 1958). *Bacillus* species are equally widely encountered in the Lagoon. This may be due to inherent nature of this organism which is associated with its ability to survive in hostile environment. The *in vitro* antibiotic sensitivity profile of the isolates was determined. 6(60%) of these microorganisms tested showed multiple antibiotic resistance. These include the enteric gram negative short rods such as *klebsiella spp., Enterobacter spp.*, and *Escherichia coli* (Table 3).

In conclusion, this study shows that the entire organisms found in most areas showed multiple antibiotic resistance which if consumed by marine organisms and humans could spread within food chain. This is significant healthwise and also indicates the prevalence of multiple antibiotic resistant bacterial isolates in our natural water as shown in this study through contamination with human wastes. The results obtained in the study would be helpful to ecologists and health-care administrators in the proper monitoring of our natural waters for proper health care management.

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