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Epidemic potentials of septic tank sewage systems in Benin-city Edo state, Nigeria

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Abstract:

Background: Avoidable disease epidemics continue to torment developing countries due to poor personal and environmental hygiene.
Objective: To determine the epidemic potentials of septic tank sewage systems in Benin-City, Edo State, Nigeria.
Materials and Methods: Five settled sewage (sludge), and five wastewater samples fortnightly for 3 months were analyzed using standard bacteriological methods.
Results: All the bacterial isolates were isolated and identified using standard techniques/procedures. High coliform counts were obtained in wastewater samples than on sludge samples in all locations. *E. coli* was the most frequent bacterial isolate in both wastewater and sludge samples. Other potential pathogenic bacterial isolates include Proteus species, Klebsiella species, Staphylococcus aureus, and Pseudomonas species.
Conclusion: Poor management of septic tanks and sewage systems in Benin City are a potential source of the epidemic by pathogenic bacteria isolates from the septic tanks when released into the environment. Improving the standard of management of septic tanks in Benin is strongly recommended.
Keywords: septic tanks, sewage system, sludge, Benin City

Introduction:

The disposal of domestic, industrial, and agricultural waste constitutes a major ecological problem in society. A major factor influencing the health of individuals where public sewers are not available is the proper dispersal of human excreta. The discharge of untreated waste into the environment presents two hazards which are the contamination of drinking water by microbial agents of enteric disease such as cholera, dysentery, diarrhea typhoid, etc, and the depletion of dissolved oxygen supply as a result of microbial decomposition of organic matter, leading to the destruction of animal life (1). Human waste can be said to be properly dispersed when they do not cause public health hazard by causing a nuisance (its odor), contaminating any drinking water supply, or being accessible to children, insects, rodents or other agents that can afterward come in contact with drinking water.

In Nigeria septic tank (household sewage disposal system), is very commonly used for waste disposal. Septic tanks should not be located near the source of domestic water supply, to avoid the pollution of groundwater used for this purpose. There are three main functions of a septic tank includes sedimentation of solid materials, Biological degradation of solid materials, and storage of sewage, (2, 3).

Septic tank may fail in its function due to the following factors: Irregular cleaning, leading to the accumulation of sludge or scum which clogs the septic tank system by blocking the outlet device; some chemicals often added to septic tanks to clean it up, may alter the alkalinity of the sludge and interfere with its digestion; roof drains producing a large volume of water being piped into the septic tank increases the content of the tank leading to clogging of the system; and flushing of new or hard-papers, rags and sticks into the septic tank system, which may not decompose in the tank will lead to clogging of the system. When there is a failure of the septic tank system the health of the public is threatened. Mainstream search shows that since the old study of Nkanji (4) was published, the literature is virtually empty about septic tank systems as a potential source of a disease epidemic in Benin City.

This study was designed to determine the epidemic potentials of poor septic tanks systems in Benin City through isolation and identification of bacterial species associated with settled sewage (sludge) and wastewater in septic tank sewage systems, assess the coliform population in sludge and wastewater in five different locations, and to examine the current disposal systems with the hope of recommending better ways of sewage disposal. These are all aimed at minimizing the health hazards resulting from poor sewage treatment and disposal systems in Benin city,

Materials and methods:

Five samples of settled sewage (sludge) and five samples of wastewater (effluents from septic tanks in five different locations), in Benin city Edo State, were used for the study. Sludge samples collected into sterile sampling containers and waste collected into sterile 250ml specimen bottles were sent to the laboratory for analysis. Samples were collected fortnightly for three months.

All media used (Nutrient broth, Peptone water, Nutrient agar, and MacConkey agar, Thiosulphate citrate bile salt sucrose agar, and evaporated milk agar), were prepared according to the manufactures (BIOTEC) instructions. A 1% w/v dilution of sludge in distilled water was made and ten-fold serial dilution of this 1% w/v of sludge/distilled water preparation were also made in 6 sterile test tubes, to get between10^2-10^6 dilutions respectively. Ten-fold serial dilutions of wastewater preparation in distilled water were also made in 6 sterile test tubes, to get between10^2-10^6 dilutions respectively. A pour-plate method was used to prepare plates for the bacterial count. Two ml of each dilution were added into sterile Petri dishes and about twenty ml of sterile molten nutrient agar were poured into each plate.

The molten agar/sample dilutions were mixed by careful and gentle swirling of the Petri-dishes and they were allowed to set. A loop full of an aliquot from the tubes containing the 1%preperations were inoculated into McConkey agar nutrient agar, thiosulphate citrate bile salt sucrose agar, and evaporated milk agar for identification of significant bacteria. All the media used were controlled using standard techniques and by the guidelines reported by Cheesbrough (5). All isolates were identified using the schemes of Barrow and Feltham (6), and Holt (7).

Gram's staining techniques were performed on all isolates using the method reported by Raphael (7). Spore staining (using 5% malachite green as primary stain and 0.5% aqueous safranin stain) as outlined by Barron et al (6), was carried out on all isolates suspected to be spore formers.

Peptone water sugars (sucrose, mannitol, maltose, glucose, galactose, rhamnose, lactose, and fructose) with bromothymol blue indicator were prepared using the method reported by Cheesbrough (5). A loop full of the 1% w/v preparation was inoculated into the bijoux bottles containing these sugar preparations and incubated at 37^{0}C for 24hrs. Dunham tubes were added to bottles containing glucose for acid and gas production and no tubes were added to other bottles for acid production.

Other tests carried out for further identification of isolates include urease, catalase, oxidase, indole, coagulase, methyl red, citrate utilization, hydrogen sulfide production, and Voges-Proskauer test respectively. Standard procedures and techniques reported by Barrow & Feltham (6), and Cruickshank et al (8), were followed in performing all the above mention tests used for the identification of all the isolates.

Results:

The total bacterial counts from water samples and sludge samples, from five different locations in Benin City, are as shown in (Tables 1 and 2) below. The total bacterial count for the period of the study showed that the bacterial densities of sludge samples were higher than those of the wastewater samples. The isolates and their percentage occurrence s have been outlined in (Tables 3 and 4) below.

Table 1: Fortnight total bacterial count from wastewater samples.

Sampling location	Bacterial count (CFU/ml x 10^7)					
	1	3	5	7	9	11
Icemen	1.82	1.93	1.53	1.97	2.00	2.10
Ehen Eden	2.14	2.42	2.58	2.36	2.23	2.65
New Benin	2.33	2.04	1.97	1.93	2.98	2.27
Ekosodin	1.95	2.56	2.02	1.87	2.56	1.90
Oguola	2.25	2.30	2.28	2.60	2.26	2.03

Sampling locations labeled A to D are as follows: A. (Icemen), B (When Eden), C. (New Benin), D. (Ekosodin), and E. (Oguola). The sampling period in weeks has been numbered from 1 to 11 as shown above (Table 1).

Table 2:
Fortnight total bacterial count from sludge samples.

Sampling location	Bacterial count (CFU/ml x 10^7)					
	1	3	5	7	9	11
A	1.26	2.28	2.30	2.34	3.38	3.47
B	1.56	2.26	2.84	2.88	2.32	2.75
C	2.44	2.87	2.90	2.95	3.67	2.32
D	1.33	1.28	2.37	2.22	2.34	2.25
E	1.32	2.44	2.52	2.30	3.60	2.46

Sampling locations labeled A to D are as follows: A. (Iwehen), B (Eheneden), C. (New Benin), D. (Ekosodin), and E. (Oguola). The sampling period in weeks has been numbered from 1 to 11 as shown above (Table 1).

Table 3:
Bacterial isolates from wastewater samples:

Isolates	Number (%) of total bacterial isolates
Escherichia coli	12 (14.45)
Proteus species	11 (13.25)
Klebsiella species	9 (10.84)
Staphylococcus aureus	9 (10.84)
Pseudomonas species	7 (8.40)
Micrococcus species	7 (8.40)
Shigella species	5 (6.02)
Enterobacter	5 (6.02)
Streptococcus species	5 (6.02)
Bacillus species	5 (6.02)
Salmonella species	4 (4.82)
Serratia species	2 (2.4)
Vibro cholera	5 (6.02)

Table 4:
Bacterial isolates from sludge samples:

Isolates	Number (%) of total bacterial isolates
Escherichia coli	11 (15.28)
Proteus species	10 (13.89)
Klebsiella species	10 (13.89)
Bacillus species	7 (9.72)
Clostridium species	6 (8.33)
Salmonella species	5 (6.94)
Micrococcus species	5 (6.94)
Shigella species	5 (6.94)
Streptococcus species	4 (5.56)
Serratia species	4 (5.56)
Streptococcus species	3 (4.17)
Pseudomonas species	2 (2.78)

Discussion:

The highest values of total bacterial counts ($2.98x10^7$ and $3.67x10^7$ ^{CFU}/ml) from both wastewater and sludge samples respectively in June may be due to increased nutrient load from surface water runoff, soil erosion as the rainy season persisted [8]. The low values of bacterial count from both surface water and sludge samples in locations B and D may be attributed to environmental factors such as pH and toxic elements. The high values of bacterial count from both surface water and sludge samples agree with the known fact that the natural habitat of bacteria (coliforms) is the intestinal tract of humans and is thus excreted normally in the feces (10).

The total microbial densities of the sludge samples were generally higher than those of the wastewater samples. This observation is consistent with the reports of Apkata and Ekundayo (11) who reported that bottom samples would have a higher number of bacteria than surface samples, as a result of bacterial sedimentation due to gravitational pull, and that sedimentation will be enhanced by the richer organic matter available at the bottom (sludge) samples. Higher values are only recorded in surface (wastewater) samples than in bottom (sludge) samples, due to resuspension of bacteria.

E. coli is a coliform that has been indicated as a good indicator of shellfish quality (12), and the presence or absence of *E. coli* in water has been used as an index of recent or heavy fecal pollution (11). The low number of salmonella species and Streptococcus species recorded maybe because they are mostly pathogenic and pathogenic bacteria are found to survive less outside their host than non-pathogenic organisms (13).

Vibro cholera isolated in locations C (Eheneden) and D (New Benin), could be attributed to the high nutritional concentration of the samples from these locations since the organism needs a high nutrient concentration for growth (14). The presence of Pseudomonas species was expected because it is a normal flora of the soil, (some species may be found in the intestinal tract) from where it could have its way to the septic tank sewage system through floods. *Entero bacteria* and *Proteus species* are also parts of the normal flora of the intestinal tract and may have found their way into the septic tank through fecal samples.

The *Staphylococcus species*, normal flora of the skin (although can also be a pathogen depending on the site) may have found its way to the tank through bathing and laundry water allowed to flow into the tank from the house. *Bacillus species* occurrence may be due to washing offs from soil and vegetation. The presence of *Clostridium perfringens* in sludge at the sampling location indicated fecal pollution of remote origin.

The result of this study has supported previous works that domestic sewage contains intestinal microflora and microorganisms that inhabit the soil and vegetation. The bacterial load was far higher than that of the international standard of 500 cells per 100ml. Septic tank sewage systems contain many pathogenic and non-pathogenic organisms and so improper disposal leads often to the epidemic. Thus proper dispersal of septic tank wastewater and sludge is necessary to reduce contact with man, vectors that transmit them, and objects useful to man.

We observed in the course of this study that sewages are not properly disposed of and due to poor maintenance culture, the poor economic situation of the country, broken sewages are allowed to flow out to the neighborhood thereby contaminating the air, the fields, and the roads and also being exposed to the vectors that transmit diseases. Signs of a failed septic tank soakaway may include but not limited to Septic tank effluent surfacing on your land; Strong or bad odors coming from the septic tank or drains; Pollution of nearby ditches or streams with effluent; Slow flushing of toilets; Gurgling in the drains; Ground movement (dips) near the septic tank or soakaway drain field; Toilet overflowing; Overflow at washing machine hookup; Overflows into shower or bath when the sink is discharged; Drain inspection chambers have standing effluent in them when it should be empty WTE (15).

Nine simple reasons why septic tank and sewage systems may fail include but not limited to: poor maintenance when not emptied at least once a year; more than one-meter depth of the septic tank not constructed in the aerobic soil layer; nature of the soil and its effect on the soakaway performance; high water table and its effect on the septic tank soakaway; deterioration of the septic tanks; Sodium Binding in the soil; another house joining the septic tank system; heavy Rain and its effect on the septic tank system and more people using the septic tank system. Since this happens in the city, the situation in the villages is even worst because open latrines and indiscriminate dumping of fecal materials are very common WTE (2016).

In conclusion, Septic tank sewage systems contain potentially pathogenic bacteria which possess public health challenge when the septic tank content leaks into the environment. Proper sewage disposal and maintenance to prevent pathogens from causing epidemic is strongly recommended in the study location.

Conflict of interest: None

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