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Review on Pseudomonas Strutzeri: A Potential Pradator for the Spilled Oils in the Niger Delta Rivers of Nigeria

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Abstract—*Environmental pollution has become a global issue due to the ever increasing self abuse of the earth we live in. This is as a result of the growing world population and increase in human activities.*
Nigeria is a West African country with large deposits of crude petroleum. This is a boost to the strength of the economy of the largest populated black nation. However, oil spillage has posed a serious threat to the aquatic ecosystem, particularly along the areas where crude oil explorations take place. Most of the rivers affected are nursery and breeding grounds for a large variety of fishes. Dead fishes could be seen floating on the water in the ocean, shore, creeks and rivers of the coastal communities in the Niger Delta area of Nigeria. Gloomy, dark coloured pollutants have always been seen spreading on the surface of the ocean and have been impacting seriously on the people and the coastal shoreline.
This review put together all the available literatures on various technologies; involving bio - augmentation, bio - stimulation, bio - venting and bio - adsorption with particular reference to the use of the bacterium; Pseudomonas stutzeri.
The review has the objectives of (1) To list the cost effective remediation methods using the bacterium (2) To highlight the methods used in applying pseudomonas stutzeri for bioremediation of crude oil polluted environments.

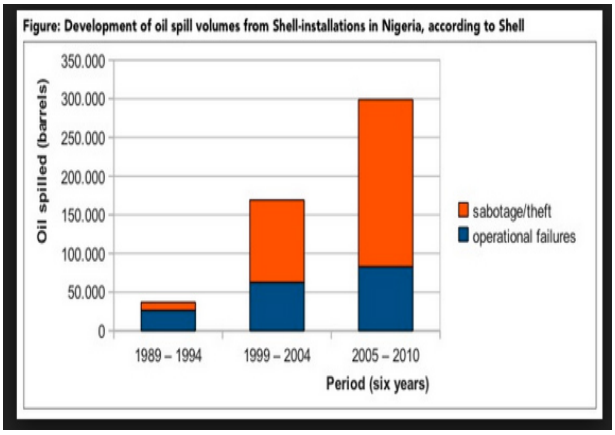
Keywords: *Niger Delta, Nigeria, Oil Spillage, Pseudomonas stutzeri, Pollution*

1. INTRODUCTION

First described by Burri and Stutzer in (1895), *Pseudomonas stutzeri* is a versatile bacterium that has been isolated in a vast majority of environments. Recently, it has gained attention in the remediation of polluted environments, with wastewater treatment and hydrocarbon degradation of oil polluted environments being the two most widely used applications.

Crude oil extraction in the Niger Delta has led to wide-scale contamination of the environment. This has gone on for decades, with little or no attempt to repair the affected contaminated environments, in spite of the United Nations Environment Programme (UNEP) Ogoni environmental assessment report (UNEP, 2011). This is unbelievable despite the huge wealth returns from crude petroleum business in the world. Habitats affected are the water bodies because all pollutants end up there through run – offs. Fisheries, a lucrative and sustainable source of income in Nigeria is seriously challenged and threatened in the Niger Delta region. Fishing in the region is now under jeopardy as fishermen get little or no catches. All the fish in the polluted waters are either dead or migrated to cleaner waters thus, fishermen need to cover long distances to cast their nets.

Among the most recent happenings of this menace of water pollution from oil spillage is in Kouama area in the creeks of the oil rich Niger Delta region of Nigeria (Abowei and Ogamba).



Courtesy: Royal dutch Shell.

A wide variety of technologies are available today for the bioremediation of polluted environments.

Pseudomonas stutzeri is a soil bacterium that is motile and has a single flagellum at one pole. It is a gram – negative that was first isolated from human spinal fluid. It belongs to the genus "Pseudomonas" the members of the genus demonstrate a great deal of metabolic diversity, and consequently are able to colonize a wide range of niches (Madigan, 2005).

Microorganisms that degrade hydrocarbons are adapted to grow and thrive in oil-containing environments (Eliora and Eugene, 2002). They have an important role in the biological treatment of this pollution.

Pseudomonas stutzeri has been isolated from soil contaminated with crude oil (Ewa et al, 2011). Wilfred et al, (2004) also identified it in a one year old oil buried site.

An interesting approach for a sustainable bio remediation project in Nigeria will be the application of the available technologies "in – situ" in soils. Once the situation is curtailed on soils, water pollution concerns will be minimal.

Plate 1: Hydrocarbon polluted river.
Courtesy: Deutsche welle T.V

Methods of Bioremediation of oil spilled environments, applicable to the Niger Delta.

2. BIOSTIMULATION

This involves certain adjustments on the environment to stimulate existing bacteria capable of bioremediation. It is achieved by the addition of rate limiting nutrients and electron acceptors, such as phosphorus, nitrogen, oxygen, or carbon.

Wilfred et al, (2004) biostimulated the native bacteria population in oil, buried site on shore line by adding liquid fertilizer treatments. They monitored oil degradation by measuring the rate of carbon dioxide evolution and oil chemical analysis.

Sequence analysis pin pointed *Pseudomonas stutzeri* to be the dominant specie at the initial phase of the oil breakdown.

Similarly, Ojo (2006) reported the capability of native bacterial population to mineralize petroleum hydrocarbons in wastewater. Okoh, (2003) equally demonstrated the degradation rates of different strains of *Pseudomonas stutzeri* on crude oil with evidence of significant reduction of major peak components of the oil.

3. BIOAUGMENTATION

Actively growing, specialized microbial strains are added into the contaminated soils or water bodies to augment the native microbial community.

Commercial cultures of *Pseudomonas stutzeri* are available for a wide range of bioremediation purposes including wastewater treatment.

Since *Pseudomonas stutzeri* is among the native flora found in most oil polluted environments, it is convenient to isolate and mass produce them for augmentation purpose.

Ebrahimi, et al, (2012), from an oil contaminated field, isolated 19 bacteria (PDB 1-19) from different genus and species. *Pseudomonas stutzeri and Chryseobacterium sp.* were among the dominated species. Bacteria were cultured by enrichment technique in Carbon Free Minimal Medium, containing 1% Gas oil. The composition of the Carbon Free Minimal Medium (CFMM):(g/L): NH4NO3 3.0, CaCl2.7H2O 0.005, KH2PO4 0.8, Na2HPO4 2.2, MgSO4.7H2O 0.01. The initial pH was adjusted to 7.

Similarly, Bola, et al, (2006) demonstrated the degradation of crude petroleum components (kerosene, diesel and naphthalene) in mineral salts medium. Escraros blend crude oil, petroleum feedstock was used as the substrate.

4. RESULTS AND DISCURSION

In a research carried out by Wilfred, et al, (2004), buried oil was degraded to a significantly greater extent in fertilized plots. This was due to the stimulation of the resident bacteria community by adding more nutrients.

The key players!

In the same experiment by Wilfred, et al, (2004) on a one year buried oil site, bacterial community structure was in treated plots were profiled by:

- Denaturing gradient electrophoresis (DGE)
- Analysis of PCR amplified genes (16s rRNA) gene fragments

Result showed *Pseudomonas stutzeri* sequences to be the dominant in the initial phase of oil degradation in plots treated with slow release fertilizer.

Table 1: Some hydrocarbon biodegrading microorganisms.

Crude Oil component	Microorganism
Saturates	Arthrobacter sp., Acinetobacter sp., Candida sp., Pseudomonas sp., Rhodococcus sp., Streptomyces sp., Bacillus sp., Aspergillus sp.
Monocyclic aromatic hydrocarbons	Pseudomonas sp., Bacillus sp., Bacillus stereothermophilus, Vibrio sp., Achromobacter sp.

Polycyclic aromatic hydrocarbons	Arthrobacter sp., Bacillus sp., Burkholderia cepacia, Pseudomonas sp., Mycobacterium sp., Xanthomonas sp., Phanerochaete chrysosporium,Anabaena sp., Alcaligenes.
Resins	Pseudomonas sp., Members of vibrionaceae, Enterobacteriaceae.

Courtesy: Subhash, et al, (2012).

As reported by Subhas, et al, (2012), Pseudomonas sp, was observed to be associated with all crude oil component biodegradation. This owes to the versatility of the Pseudomonas genus.

Some factors make hydrocarbon biodegradation favourable for microorganisms. To achieve maximum results, adjustments and manipulations are key to success of any bioremediation technology.

Nilanaja and Preethy, (2010), mentioned among the factors:

- The composition and inherent biodegradability of the petroleum hydrocarbon pollutant
- Temperature: affects chemistry of pollutants, viscosity, and physiology of
- Nutrients: are very important ingredients for successful biodegradation of hydrocarbon pollutants especially nitrogen, phosphorus, and in some cases iron.

Other factors are pH, as pointed out by Darin, et al, 2013, in a study they conducted on microbial degradation of oil hydrocarbons. They observed maximum diesel oil degradation by Bacillus cereus A (85.99% and 83.84% of aliphatic and aromatic hydrocarbon) was at pH 7.Therefore pH 7 was selected for further experimentation. Higher or lower pH values showed inferior results; metabolic processes are highly susceptible to even slight changes in pH (Wang et al., 2012).

In the same vein, Bola et al, (2006), reported the growth of all isolates on crude petroleum as the sole source of carbon and energy.

When screened for hydrocarbon utilization, *Pseudomonas stutzeri* grows wild in naphthalene under aerobic condition.

5. CONCLUSION

Bioremediation is a popular and promising technology for remediating environments contaminated with petroleum hydrocarbons from spillages.

Pseudomonas stutzeri can grow sporadically even in minimal, chemically defined media, with ammonia ions or nitrate and a single organic molecule as the sole source of carbon and energy (Jorge, et al, 2006).These qualities qualify this bacterium as a candidate to eat up the oil spills in the Niger Delta rivers of Nigeria.

6. RECOMMENDATIONS

There is an urgent need for promt actions to be taken by the government to save the livelihood of the people and the environment from the adverse impacts of hydrocarbon pollution. This is to prevent further episodes and happening. The following recommendations are made:

- The government should set out modalities of operation for the oil companies to operate. A good environmental management plan should be put in place
- Oil companies should be made to comply with international best practices in oil explorations
- Available technologies for oil spill control should be put in place. An example here is the use of GIS (geographical information system) to track illegal oil refineries and thefts in the region.
- Stiff penalties should be set for oil companies that do not comply with laws, legislations and regulations
- Environmental conservation laws should be reviewed.
- Available technologies to be adopted in repairing polluted environments on a continuous system.

REFERENCES

[1] Bola, O.O., Mathew, O.I., Joseph, O.A. and Sunday, A.A. (2006). Hydrocarbon degrading potentials of bacteria isolated from a Nigerian bitumen. (Tarsand deposit). *Nature and Science. 4(3).*

[2] Darin, M., Zakia, O. and Hanafy, H. (2013). Environmental studies on the microbial degradation of oil hydrocarbons and its applications in Lebanese oil polluted coastal and marine ecosystem. *intn. Journal of current microbiology and applied sciences.*

[3] Ebrahimi. M., Sarikhani. M.R. and Fallah, R. (2012). Assessment of biodegradation efficiency of some isolated bacteria from oil contaminated sites in solid and liquid media containing oil – compounds. *Int. Res. Journal of Applied and basic Sciences. Vol 3(1). Pp: 138 – 147.*

[4] Eliora, Z.R. and Eugene, R. (2002). Biosurfactants and oil remediation. *Current opinion on biotechnology. Vol 13(1). Pp: 249 – 252.*

[5] Karthika, R., Gopinath, L.R., Achaya, S. and Bhuvaneswari, R. (2014). Isolation of dieseldegrading bacteria, identification of catechol gene and its biogas production. Jounal. Environmental science, toxicology and food technology. Volume 8. Pp 2319 – 2399.

[6] Lehman, K.B. and Neuman, R. (1986). Atlas and Grundriss der Bakterilogie und Lehburch der speziellen bakteriologischen diagnostic. 1st edi. J.F Lehman, Munchen.

[7] Madigan, M., Martinko, J. (2005). Brock biology of microorganisms. (11th edition). Prentice Hall ISBN 0 – 13 – 144329 -1.
[8] Nilanaja, D. and Preethy C. (2010). Microbial degradation of petroleum hydrocarbon contaminants. An overview. *Biotechnology research international. Volume 2011*.
[9] Ojo, O.A. (2006). Petroleum-hydrocarbon utilization by native bacterial population from a wastewater canal Southwest Nigeria. *Afr J Biotechnology 2006;5(4): 333-337.*
[10] Okoh, A.I. (2003). Biodegradation of Bonny light crude oil in soil microcosms by some bacterial strains isolated from crude oil flow stations saver pits in Nigeria. *Afr J Biotechnol (2003);2(5):104-108.*
[11] Sellers, Kathleen. (1999). Fundamentals of Hazardous Waste Site Remediation. Lewis Publishers, New York.
[12] Subhash, C., Richa, S., Kriti, S. and Anima, S. (2012). Application of bioremediation technology in the environment contaminated with petroleum hydrocarbon. *Ann Microbiology. Vol 63. Pp: 417 – 431.*
[13] United Nations Environmental Programme, (2011). Environmental Assesement of Ogoniland. Nigeria. UNEP; 2011. Pp: 8 -17.
[14] Wang, Q., Zhang, Y.L. and Klassen, W. (2011). Potential Approaches to Improving Biodegradation of Hydrocarbons for Bioremediation of Crude Oil Pollution. *Environ. Protection J. 2: 47-55.*
[15] Wilfred, F., Rolling, M., Michael, G., Milner, G., Martin, J., Francesco, F., Richard, P., Swannell, J., Fabian, D. and Ian, M. (2004). Bacterial community Dynamics and hydrocarbon degradation during a field scale Evaluation of bioremediation on mudflat Beach contaminated with buried oil. *App. Env. Microbiology. Vol 7(5). Pp: 2603 – 2613.*