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Assessment of The Microbiological And Physicochemical Quality of Two Rivers Receiving Inorganic Fertilizer Inputs In Ogoniland, Rivers State, Nigeria.

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Abstract: *An investigation was carried out on the microbiological and physicochemical qualities of Rivers Goneewa and Oortee in Yorkwiri-Boue Community in Ogoniland, Rivers State. The Rivers were in proximity with farms applied with inorganic (chemical) fertilizer, Nitrogen-Phosphorus-Potassium (NPK). The qualities of the Rivers were assessed using standard methods for the determination of the level of pollution as well as anthropogenic activities (inorganic fertilizers). Samples taken from the Rivers were subjected to some physicochemical analyses like pH, DO, BOD, Hardness, temperature, sulphate, phosphate, Turbidity, electrical conductivity, Total dissolved solids, nitrate, ammonia, etc.Rivers Goneewa and Oortee had mean bacterial counts of $9.0x10^4$cfu/ml and $5.9x10^4$ cfu/ml respectively. The total coliform counts were higher in River Goneewa with 55 MPN Index/100ml while River Oortee had 33 MPN Index/100ml. The total thermotolerant coliorm for both Rivers was 6 MPN Index/100ml.The total yeast counts for Rivers Goneewa and Oortee were $3.5\ x10^3$ and $3.0\ x10^3$ cfu/ml while the mould counts were $3.0\ x\ 10^3$ and $2.6\ x10^3$cfu/ml for the respective Rivers.The total heterotrophic bacterial, fungal, total and fecal coli form counts were also analyzed and observed to be above WHO and FEPA acceptable limits. The genera of bacteria isolated included Pseudomonas, Corynebacteria, Bacillus, Shigella, E.coli, Enterobacter as well as some pathogens like Klebsiella and Streptococcus. Few species of Fungi isolated included Penicillium, Fusarium solani, Mucor sp., etc. Input of the fertilizers into the Rivers may have contributed to the elevated levels of microorganisms and some physicochemical parameters like ammonia (1.25- 1.39mg/l) (which exceeded FEPA permissible limit of 0.1mg/l in natural water bodies) ,Phosphate(8.23-9.05 mg/l), turbidity (7-9 mg/l), electrical conductivity (5-6.8 mg/l), BOD (3.4mg/l),etc.*

Keywords: *Rivers Goneewa and Oortee, water quality, bacteria, fungi*

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I. Introduction

The impact of fertilizer and hazardous wastes on aquatic life including microorganisms cannot be over-emphasised. Fertilizers are used by home owners to maintain and improve landscape beauty and quality. In recent years, increased use of home lawn and garden fertilizers has caused concern on pollution of lakes and ground water. Proper fertilizer application can enhance plant growth without polluting the environment. Yet, misuse of fertilizer may not only harm the environment especially ground and surface water, but may result in injury to landscape plants as well (Rosen and White, 1999). The use of industrially manufactured nitrogen fertilizers increased rapidly in developing countries between 1960 and 1980. This facilitated a large increase in the production of feed and food grains (Maize, wheat and rice) per unit of cultivated land, but in some regions, it also contributed to enrichment of surface and groundwater with various forms of nitrogen that can cause contamination of surface waters.

Consequently, upon the industrial revolution, many production and manufacturing companies have added toxic and hazardous wastes including synthetic compounds into the aquatic environment due to improper waste management techniques. These wastes are also discharged into water without any treatment as a result of improper or deliberate channeling of the wastes into aquatic environment. The presence of these wastes into the environment causes extensive damage to the water quality characteristics and the ecology of the environment especially when microbial degradation activities fail to remove these pollutants fast enough to prevent environmental degradation (Obire and Odudo, 1997). Inorganic fertilizers can enter aquatic environments via point and non point sources derived from human activities. Non point sources generally are of greater relevance than point sources since they are larger and more difficult to control (Howart *et al*., 2000).

Concentrations of inorganic nitrogenous compounds (NH^{4-}, NO_2^-, NO^{3-}) in ground and surface waters are increasing around the world, causing significant effects on the degradation of freshwater, estuarine and coastal marine environment (Smith *et al*., 1999; Howart *et al*., 2000; Philips *et al*., 2002).
This study was carried out to determine the level of pollution in two rivers in Ogoni land due to excess influx of inorganic fertilizers

II. Materials And Methods

Water samples were collected with sterile one (1) litre plastic containers from two Rivers in Yorkwiri Boue community in Ogoniland, Rivers state. These rivers are located in proximity to farms where application of inorganic fertilizers [NPK] was the norm; hence the rivers were covered with algal bloom. As a result of the algal bloom on the surface of the water, the water was rendered useless (no desired species of fish, swimming activities ceased and non-potable for drinking).Samples were transported immediately to the Microbiology Laboratory of Rivers State University, Port Harcourt, Nigeria for microbiological and physicochemical analyses.

Physicochemical Parameters of the Samples

The physicochemical parameters were measured using standard analytical procedures (AOAC, 2000). The pH meter used was pocket-sized HANA pHep + HI 98108 with automatic temperature compensation. Total organic carbon was determined by dichromate wet oxidation method of Walkley and Black as modified by Dhyan *et al*., (1999). Nitrate content was determined using the macro Kjeldahl digestion method of Brady and Weil (1999) and available phosphorus was determined using the method reported by Olsen and Sommers (1982). Sulphate was determined using the turbidometric method. Standard methods were used for the determination of Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand(COD), turbidity, electrical conductivity, ammonia, total dissolved solid (AOAC,2000).

Enumeration and Identification of bacteria and fungi

Sampling from each polluted river was carried out for the enumeration of total Heterotrophic Bacteria (THB). Samples were serially diluted and an aliquot from each sample was placed on nutrient agar medium (Oxoid) for isolation of THB with the addition of 50µg/ml nystatin to suppress the growth of fungi. Plates were incubated at 30°C for 24 hours before the colonies were counted. The bacterial isolates were characterized using microscopic techniques (Gram staining) and biochemical tests.
Acidified potato dextrose agar plates containing streptomycin (1mg/100ml) were used to obtain fungal isolates. The plates were incubated at 30◦c and observed after 48 hours for yeasts and 96 hours for mould, after this, isolation of pure isolates was done.

Estimation of Coliform and Faecal Coliform Bacteria in the River water samples

Coliform bacteria in the River water samples were estimated using the Most Probable Number (MPN) technique. Reactions to MPN technique and thermo tolerant coliform bacteria MPN index/100ml of each water sample was done using double strength Mac Conkey broth for 10ml of sample and single strength Mac Conkey broth for 1ml and 0.1ml of the sample . The test for the estimation of coliforms involves the following steps: Presumptive, confirmatory and completed test. It was performed as described by Verma *et al*., (1999).

Identification and Characterization of isolates

The methods described in Cheesebrough (2000) were adopted in characterization of isolates. Isolates were identified by standard methods (Williams and Odokuma, 2014).

III. Statistical Analysis

Results were analyzed using analysis of variance (ANOVA) and means were compared for significance at $p \leq 0.05$ using Duncan's multiple range analysis.

Results of the physicochemical analysis

The baseline physicochemical properties of Rivers Goneewa and Oortee in Yorkwiri Boue community in Ogoniland, Rivers state are shown in Table 1 below:

Table 1: Baseline Physicochemical parameters of Rivers Goneewa and Oortee

Parameter	River Goneewa	River Oortee
pH	4.19	5.23
Temperature (°c)	28	25
Turbidity (NTU)	7	9
Electrical conductivity (µ/cm)	67.8	67.5
Total Dissolved Solids (mg/l)	47.5	46.9
Phosphate (mg/l)	8.23	9.05
Dissolved oxygen (mg/l)	3.2	3.3
Biochemical Oxygen Demand (mg/l)	3.4	3.4
Total acidity (mg/l)	68	95
Total Hardness (mg/l)	518.4	614.4
Nitrate-Nitrogen (mg/l)	0.32	0.69
Ammonia (mg/l)	1.39	1.25

The mean values of the total heterotrophic bacterial counts obtained ranged from 5.9 – 9.0 x 10^4 cfu/ml. River Goneewa had a higher mean bacterial count of 9.0 x 10^4 cfu/ml while River Oortee had a mean count of 5.9x 10^4 cfu/ml.

The reaction of the River water samples to MPN techniques to total coliform counts showed that River Goneewa recorded a higher coliform count of 55 MPN Index/100ml while River Oortee had 33 MPN Index/100ml.

The River water samples' reaction to MPN technique of Thermo tolerant Coli form count showed that both rivers recorded the same value (6 MPN Index/100ml).

The mean values of the total Yeast counts obtained from Rivers Goneewa and Ortee were 3.5 x 10^3 and 3.0 x 10^3 cfu/ml respectively while the mean values of the total Mould counts were 3.0 x 10^3 and 2.6 x 10^3 cfu/ml from both rivers.

Figures 1a and 1b below show the microbiological characteristics of Rivers Goneewa and Oortee.

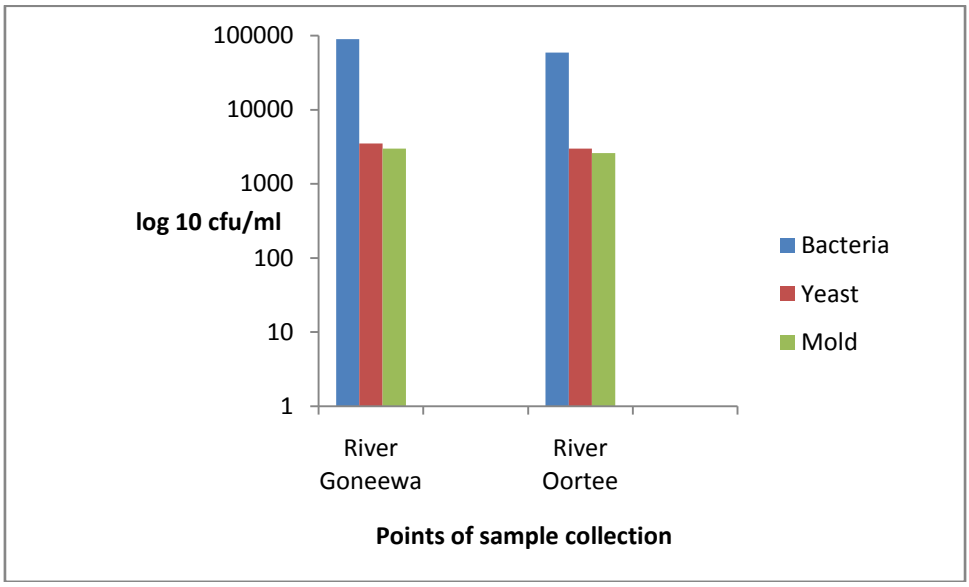

Fig 1a: Bacterial and fungal counts in Rivers Goneewa and Oortee

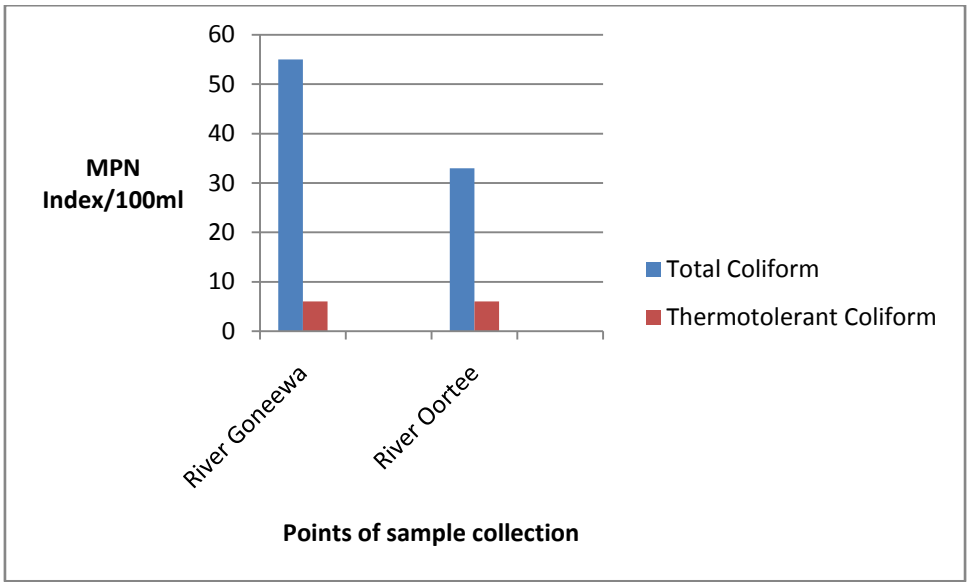

Fig 1b: Total and Thermo tolerant Coliform Bacterial counts in Rivers Goneewa and Oortee

Analysis of variance (ANOVA) using Student T-test on the data obtained showed that there was no significant difference at $p \geq 0.05$ between the microbiological (bacteria, yeast, mould, total and thermo tolerant coli form bacteria) characteristics in the two river water samples. Using ANOVA, there was no significant difference in the physicochemical characteristics in Rivers Goneewa and Ortee.

IV. Discussion

This study revealed that the ammonium levels from the two rivers (1.25-1.39mg/l) exceeded the permissible limit (0.1mg/l) found in natural water bodies (McNeely *et al*., 1979, WHO, 1993, EPA,1993). The decomposition of nitrogenous organic matter, that is, microbial reduction of nitrate to nitrite under anaerobic condition might account for this observation. The discharge of ammonia is frequently associated with reduction of Dissolved Oxygen Concentration in the water bodies. The phosphate level was quite high due to the run-off of these inorganic fertilizers from the farms.

The Total alkalinity level was low indicating a high acidic level of the water samples. This indicates high levels of carbonates, bicarbonates and hydroxides. The turbidity of the water was high (7 - 9 NTU). This is due to the presence of the algal bloom on the surface of the water making it to be too cloudy. The Electrical Conductivity (EC) was high. This high EC value indicates the presence of high concentration of total dissolved solid from industrial effluents and in the case of this study, the inorganic fertilizer (McNeely *et al*., 1979).
The total hardness level of the water was high (518.4 – 614.4mg/l), hence, the River water bodies are classified as hard water. The Biochemical Oxygen Demand obtained from this study was 3.4mg/l. This value is indicative of influx of contaminants into the water bodies. This can be attributed to the influx of biodegradable materials from external sources possibly due to run-off from the farms and anthropogenic factors (Williams and Odokuma, 2013).

This investigation showed the presence of total heterotrophic bacteria, Yeast, Mould, total Coliform and Thermotolerant Coliform bacteria counts in the two River water samples obtained from Yorkwiri-Boue Community in Ogoni land, Rivers State. The faecal coliform count obtained was far above recommended standards. The detection of faecal coliform indicates faecal pollution of drinking water. The presence of faecal indicators showed the presence *Escherichia coli* and *Shigella* sp. Other enteric pathogens such as *Enterobacter* indicated that the water sources were heavily polluted with faecal matter. Other pathogens such as *Klebsiella*, *Proteus* and *Streptococcus* were isolated.

On the standard plate count, the number of colonies isolated was not quite high due to toxicity of the algal bloom on the surface of the water. The presence of eutrophication eliminated most of the microflora and the only species that remained were those that could thrive in the harsh environment. Environmental bacteria like *Corynebacteria* and *Bacillus* species were also recovered indicating no treatment of the water bodies. The international standards for drinking water states that potable water should not contain 100 cells of Total Heterotrophic Bacteria per 100ml of water, but unfortunately, the bacterial counts obtained in this study superceeded the standard (EPA,1993, WHO,1993). If the water is used for drinking, it would pose threat to public health causing gastrointestinal diseases and blue baby syndrome in infants. The presence of *Pseudomonas*

was common and its presence is of significance in determining the extent of the water pollution. The study revealed few species of fungi and they include *Penicillium* sp., *Fusarium solani*, *Saccharomyces cerevisiae*, *Mucor* sp. and *Rhizopus* sp. These are group of fungi that invade the superficial layer of the skin and degrade the keratinized tissues of skin, hair and nails in living animals including man, causing skin diseases.

V. Conclusion

The microbiological and physicochemical characteristics of the two Rivers in Yorkwiri Boue community in Ogoni land, Rivers State revealed the presence of pathogenic microorganisms. The impact of fertilizer on microbiological water quality cannot be overemphasized since they lead to death of aquatic invertebrates and fishes, pollution of water and excessive supply of nutrients into the aquatic bodies.

There are management practices that may help to reduce nutrients in these water bodies and they include prevention of leaching of fertilizer after rainy season by covering the ground with vegetation and qualitative assessment of the trophic state of water bodies.

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