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EFFECT OF TREATED SEWAGE ON AQUACULTURAL PRACTICE IN THE TROPICS.

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ABSTRACT

Studies were carried out to establish the effect of treated sewage discharge on aquacultural practice. Water samples from a channelled water slot receiving treated sewage were collected weekly for twelve months and physico-chemical characteristics of the samples were monitored. General characteristics of aquatic habitats of the slot were also studied. The results were compared with results of physico-chemical characteristics of water samples monitored over the same period and collected from 500m and 1000m away from the slot.

Tissue analyses results showed no toxicity level of the fish from the three sources, however it was revealed that the fishes in the slot were rich in mineral content than fishes of the same species from the 500m and 1000m distance away from the slot. Other observed features exhibited by the fishes were increased weight and size. Physico-chemical results of the treated sewage were all within acceptable limit for discharge into water body while results of water samples from the slot showed no sign of pollution or distortion in fauna and floral life of the slot. However the dissolved oxygen level was quite low when compared with samples collected from the other two sources. Coliform count and ammonia were also found to be higher in the slot.

Introduction

With the advent of industrialisation and increasing populations, the range of requirements for water has increased with greater demands for higher quality water. Drinking water supplies and specialised industrial production exert the most sophisticated demands on water quality. In line with these uses water has been considered the most suitable medium to clean, disperse, transport and dispose of wastes (4).

Treated sewage has been found to provide good source for domestic water needs, industrial and agricultural purposes, such as culturing of fish and field crops (8). The water content of treated sewage accounts for about 99.9% of the total quantity, while the rest consists of organic and inorganic constituents (1). The common salts present in sewage are ammonium, nitrate and phosphate and these provide excellent and rich nutritive constituents of fish meal (5). From the bulk constituents of treated sewage smaller particles of organic origin found in the treated sewage form direct food source to zooplankton and benthos, the larger particles are directly utilised by fish and soluble organic substances are directly used by phytoplankton for photosynthesis and by zooplankton as a food source (3).

All species of fish that is suitable for fresh-water fish culture are suitable for sewage-fed fish culture (7), however, *Tilapia guineensis,* was used in this research work because of its availability all year round, ease of handling and small size.

In view of the pollution problems associated with sewage handling, a highly efficient biological treatment system was used in this research work. This study was necessitated by the need for construction of biological treatment plant in communities where large volume of sewage is being generated. This research work therefore looks at the effect of treated sewage on the aquatic life of a water course.

Materials and Methods

Sample collection and analysis

Water samples were collected weekly for 12 months from the slot receiving treated sewage and 500m and 1000m distance away from the slot and monitored for physico-chemical characteristics. All analytical procedure using titrimetry, infrared spectroscopy, flame photometry, microscopy proceeded in accordance with the methods of American Public Health Association (2). Dissolved oxygen was determined *in-situ* and later confirmed in the laboratory by Winker's method.

Total microbial count was carried out using standard plate count technique by plating aliquots (0.1 ml) of appropriate dilutions of water samples in standard plate count agar and incubating at 30°C for 48hours. Other specific research and experimental methods employed are defined below.

Extraction of lipids for tissue analyses

10g of the crushed organisms were accurately weighed into a homogeniser flask. $10cm^3$ of dichloromethane and $20cm^3$ methanol were added to the tissue and homogenized for 2mins. $10cm^3$ of dichloromethane was then added and homogenized for 30secs and then, $10cm^3$ of water was added and homogenized for another 30secs. The mixture was filtered through a glass sinter into a separating funnel and transferred into a round bottom flask.

Extract for analyses of heavy metals in tissues were obtained by digesting with appropriate volume of hydrogen peroxide and nitric acid.

Toxicity test

This experiment was aimed at establishing the concentration of the treated sewage at which the fish can conveniently survive and the effect that a given accumulated substance will have on the test organisms.

Raw sewage with pre determined physico-chemical and microbiological parameters was treated by employing the use of a pair of four interconnected aquacell tanks, each measuring 7x3x1m and filled with raw sewage. The raw sewage inoculated with sewage biodegraders was then allowed to flow through the interconnected tanks to act in synergism with inoculated water hyacinth plants. The results of the physico-chemical analyses after seven weeks were compared with the controls, which was fresh-water from the surrounding slot.

Fish was made to grow in 5%, 10%, 15% and 20% concentration of the treated sewage to natural fresh-water for 28days. The concentration at which no 'fish kill' was recorded after 56days was used in a ratio 1:3 of natural water of the fish to grow the test organisms. Tissue analyses were done after 84days.

In order to prevent the test organisms from being stressed by instantaneous change in water quality, temperature or other characteristics that may be associated with the natural habitat conditions and the culture environment, they were allowed to acclimatize for a minimum of ten days prior to commencement of any test.

Results

Table 1 shows proximate and mineral analysis results of *Tilapia guineensis* from the channelled slot, 500m and 1000m away from the slot. Higher concentrations of mineral content were recorded in the slot than the 500m and 1000m distance from the slot.

The temperature of the raw sewage was observed to be very high and this could be due to the naturally high temperature of feaces, heat generated during microbial activities and domestic warm water use. High levels of Total suspended solids, Dissolved solids, anions and metals were also observed in treated sewage in the water slot when compared with the 500m and 1000m distance from the slot.

Tissue analysis results in table 3 showed absorption and bioaccumulation of certain mineral nutrient in the test organism. However no toxicity level was recorded.

Table 1:Proximate and mineral analysis results of *Tilapia guineensis* from the channelled slot, 500m and 1000m away from the slot

Nutrients %	slot	500m	1000m
Kjeldahl nitrogen	4.2	0.2	0.2
Crude protein	24	1.45	1.60
Crude fibre	32	1.2	1.1
Carbohydrate	28	2.9	2.6
Sulphur	2.18	ND	ND
Phosphorous	2.3	0.01	0.01
Magnesium	3.5	1.5	1.3
Sodium	1.4	0.02	0.01

Values are means of 3 composite test organisms collected over a period of 12 months.

Table 2: Physico-chemical analyses of samples from the slot, 500m and 1000m distance

Parameters	slot	500m	1000m
Colour	Non-objectionable	Non-objectionable	Non-objectionable
Odour	Nil	Nil	Nil
Temp. (^{0}C)	30.20	29.80	29.70
pH	7.80	7.40	7.20
Turbidity (NTU)	40	38	30
Conductivity (ohms)	935	745	820
Total Solids (mg/l)	90	29	24
Suspended Solids(mg/l)	52	25	23
Dissolved Solids(mg/l)	265	168	124
Dissolved Oxygen(mg/l)	1.2	8.4	8.5
BOD_5(mg/l)	24	12	12
Ammonia(mg/l)	14	8	7
Nitrates(mg/l)	4	2	2
Sulphates(mg/l)	120	124	122
Phosphates(mg/l)	6	2	2
Carbonates(mg/l)	260	280	275
Bicarbonates(mg/l)	160	98	73
Potassium(mg/l)	14	8	9
Sodium(mg/l)	28	16	12
Magnesium(mg/l)	42	26	23
Calcium(mg/l)	520	445	23
Zinc(mg/l)	0.06	0.05	0.03
Copper(mg/l)	0.1	0.07	0.02
Iron(mg/l)	0.2	0.1	0.10
Manganese(mg/l)	0.05	0.01	0.02
Coliform (MPN) counts/100ml	120-106	64-106	63-106
Total bacterial counts/ml	110-102	72-102	62-102

The values are mean of 3 composite samples collected over a period of 12 months.

Table 3: Result of tissue analyses

Nutrients %	slot	500m	1000m
Cadnium	ND	ND	ND
Chromium	ND	ND	ND
Copper	0.002	0.001	ND
Lead	0.001	0.01	0.003
Iron	0.01	0.002	0.001
Zinc	0.02	0.01	0.01
Arsenic	ND	ND	ND
Nickel	0.001	ND	ND
Cobolt	ND	ND	ND

ND = Not Detected
The values are mean of 3 composite samples collected over a period of 12 months.

Discussion

It is expected that if sewage is not properly treated before discharge into a watercourse, the suspended solids tend to settle out in the slack water and behind weirs, forming banks of sludge. The organic portion of the sludge tends to denude the stream of dissolved oxygen and finally undergoes putrefaction, especially in warm weather, resulting in portions of the sludge being buoyed to the surface by the gas produced (11). The organic portion of the sludge can also help to destroy animal and plant life in the stream and the organic matter in colloidal dispersion and true solution also play its part in reducing the dissolved oxygen content (12). Available oxygen, adequate nutrients and absence of toxic substance are essential factors for growth and reproduction of aquatic life.

The nature and composition of sewage was investigated by Sridhar (1980) and Mara & Oragui (1983) and their findings revealed that sewage exhibits a characteristic high load of physico-chemical and microbiological pollution. This observation is in agreement with the results of this study where higher levels of physico-chemical indices such as Total Solid, conductivity and turbidity were observed in the slot compared with the 500m and 1000m distance.

The dissolved oxygen of the 500m and 1000m distance was observed to be higher when compared with level obtained in the slot. This could be attributed to the fact that clean natural water in a watercourse is normally well oxygenated and contains large and varied number of life forms, including protozoa, bacteria and aquatic plants and animals, which are interdependent, forming a complex system and keeping the stream in a healthy condition. The water obtains its dissolved oxygen mainly from the atmosphere by surface aeration and this process is assisted by the turbulence of the stream caused by the velocity of its flow and its passage over rocks, stones and weirs. The increasing levels of phosphates and nitrates were also recorded in the slot.

The temperature of the slot was also observed to be high and this could be due to the naturally high temperature of feaces, heat generated during microbial activities and domestic warm water use. High levels of Total suspended solids, Dissolved solids, anions and metals were also observed in slot when compared with 500m and 1000m distance.

Heavy metal concentration in domestic raw sewage has been found to be high (7). The concentrations of other ions have also been found to be always higher than the maximum permissible regulatory levels high (14). At such high concentration heavy metals are frequently toxic to man as a result of bioaccumulation. The observed increase in hardness of the watercourse (500m and 1000m) may be due to high levels of Mg and Ca often associated with coastal environment, which is associated with the study area. However the average chloride, sulphate, Ca and Mg ion concentrations in the watercourse were within the acceptable limits (10).

The pH is an important variable in water quality assessment as it influences many biological and chemical processes associated with water supply and treatment (9). Change in pH can indicate the presence of certain effluents, particular when continuously measured and recorded, together with the conductivity of a water body. Water bodies display temperatures variations along with normal climatic fluctuations which may be seasonal, or in some water bodies, daily (3).

Suspended solids in form of visible sludge create unsightly condition and destroy the use of

water for drinking purposes. The type and concentration of suspended matter controls the turbidity and transparency of the water (6). Suspended matter consists of clay, silt, and fine particles of organic and inorganic matter, soluble organic compounds, plankton and other microscope organisms.

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