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Decontamination of Wastewater by Biofiltration using Invasive Bivalves

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Abstract - *Wastewater disposing into the water bodies is the main cause of water pollution. The effluents which are disposed to the water bodies from different sources contain a high concentration of contaminants, effluents from household contains mainly biological waste, industrial wastes contain chemical wastes, etc. Pollution of water is measured by various parameters, the parameters like BOD, COD, Nutrients (N, P & K), and pathogens are considered in this study. In physical treatment methods decontamination is done by using biological activities like biofiltration and bioaccumulation. In this study physical method (biofiltration) is adopted using 'invasive bivalves' as micro-organisms. Wastewater can be decontaminated using bivalves. The main type of the bivalves used in this study is* ***Dressina polymorpha, Mytilus edulis, and corbicula flumina****. These bivalves decrease the contamination level and these will encompass nutrient and phosphorus removal for recovery of eutrophic sites. They have also the capacity for removing biological and chemical contaminants from water. The other applications include removal of organic compounds, reducing E-Coli, reducing metallic compounds, etc. The mechanism involved to reduce the contaminant concentration is* ***biofiltration*** *using bivalves.*

Key Words**:** Decontamination1, Bivalves2, Biofiltration3, Nutrients4, pathogens5, COD6.

1. INTRODUCTION.

Usage of water is increasing day by day with the increase in population and their needs. With the increase in needs, water wastage also increases. The wastage in water may be the soap and chemical traces, pathogens and biological waste from residential areas. This wastage is released into the nearby water bodies with partial or no treatment. Due to this disposal, the concentration of the contaminants is increasing with time. With the increased contaminants the effect on the flora and fauna is also increased.

1.1. Effects of water pollution:

- Health effects on human beings and the animals, economic losses to industries which consume the contaminated water.
- Eutrophication due to the presence of nutrients like N&P and health problems to aquatic animals.

The main parameters focused in this study is the removal of eutrophication, COD and BOD and pathogens.

1.1.1. Eutrophication:

Eutrophication means the increase in the nutrient level of the water bodies, the nutrient enrichment of water bodies is due to the disposal of waste which contains nutrients (N, P). Due to these nutrient levels, the growth of phytoplankton is encouraged, which reduces the DO concentration. Due to these lower DO values the survival of aquatic animals is difficult which leads to disturbance in the ecology.

1.1.2. COD and BOD: BOD and COD are the measures of water quality. The higher the COD value the higher the contamination level. If the ratio of BOD and COD is greater than 0.5 then water can be treated biologically.

1.1.3. Pathogens: The pathogens present are tested by using E-Coli tests and their count is done by MPN test, before the treatment the MPN values are higher than the permissible limits. The reason for the high level of E-Coli and pathogens in the selected area is the mixing of the animal excreta into rivers, sites used as dumping stations for the community near the canals and the various domestic uses such as washing clothes, animals, utensils, etc. To determine the pathogens in the water biological tests E-Coli and MPN tests are conducted.

1.2. Objectives: The objectives of the bivalves treatment of wastewater are

- Study of eutrophicated sites recovery.
- Study of COD reducing capacity.
- To determine the MPN reducing capacity.

2. LITERATURE REVIEW:

Joao Gomes, Ana Matos, Rosa M. Quinta Ferreira, Rui C.Martins [1], Environmental applications of invasive bivalves for water and wastewater decontamination.

In this study, they determine that these invasive bivalves threat native species and cause economic issues to the industry. Biofiltration capacity and

tolerance to toxic compounds useful for water treatment. May be used to recover eutrophicated invasive sites. The capacity of removing chemical and biological contaminants from wastewater treatment is an alternative pest management approach for these species.

Ronaldo Sousa Æ Jorge L. Gutie ´rrez Æ David C. Aldridge [2], Non-indigenous invasive bivalves as ecosystem engineers.

In this paper, the ecosystem engineering attributes of non-indigenous invasive bivalves (i.e., the capacities of these organisms to directly or indirectly have an effect on the supply of resources to alternative species by physically modifying the environment have been studied. By reviewing the ecology of several invasive bivalves the author identifies a variety of mechanisms via which they modify, maintain and/or create habitats. Given the sometimes high densities and broad spatial distributions of such bivalves, their engineering activities will significantly alter ecosystem structure and performance (e.g., changes in sediment chemistry, grain size, and organic matter content via bioturbation, exaggerated light penetration into the water column due to filter feeding, changes in close to bed flows and shear stress due to the presence of shells, provision of colonisable substrate and refuges by shells). In addition, changes in ecosystem structure and functioning due to engineering by invasive bivalves usually have terribly massive economic impacts. Given the worldwide unfold of no indigenous bivalves and the varied ways in which they physically modify habitats, their engineering effects ought to receive a lot of serious thought in restoration and management initiatives.

3. METHODOLOGY:

Biofiltration technique is used for the treatment of wastewater. In this study, the treatment is done by making a model of the filtration unit. In this filtration unit, bivalves are introduced as macro-organism for decontamination. These selected bivalves have the capacity for treatment of wastewater. The selected bivalves intake nutrients, substrate, and phytoplankton as food and stabilize the chemicals in their mollusks. For the treatment, the bivalves harvesting have been done for a period of 4 months. The alive bivalves are collected from the seashore into a clean and sterilized bottle. These are transported to the laboratory for harvesting. The favorable conditions for their survival are provided and their growth in terms of weight and shell height is observed. The three common types of bivalves used in the study are ***Dressina polymorpha (Quagga mussel), Mytilus edulis (zebra mussels) and corbicula flumina (blue mussels)***

3.1 study Area: Samples are collected from canals and from the industrial area in and near Kakinada.

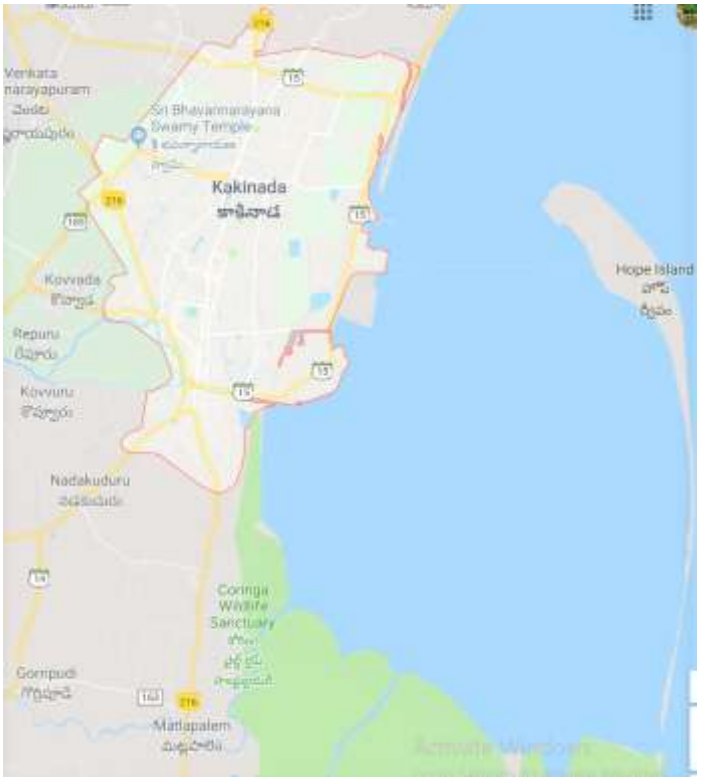

Fig -1.: Map of study area (Kakinada)

Three samples are collected from canals and two number of samples are collected from the industrial area where high contamination is expected due to the actions performed. Samples are collected from Matlapalem canal, Indrapalem canal, and industrial areas. Matlapalem water will merge into the Bay of Bengal through Coringa wildlife Estuary. Indrapalem canal water is very rich in nutrients so it is highly eutrophicated. The reason is the waste disposal and the actions performed near the canal.

Samples are collected by grab sampling method and transported to the laboratory for within two hours.

3.2. WHAT ARE INVASIVE BIVALVES? Invasive bivalves are the type of aquatic mollusks which doesn't have a head. These bivalves have a compressed body enclosed within a hinged shell. Some of the examples of bivalves are oysters, mussels and scallops. These bivalves' lives both in freshwater and marine waters and the majority of the bivalve are filter feeders. They breathe and feed through the gills. Most bivalves burry the soil and live under the soil and some bivalves attach to the hard surfaces like rocks.

Table 1 Scientific classification of bivalves

Kingdom	Animalia
Phylum	Mollusca
Class	Bivalvia

Table 2 Bivalves types, with scientific names, diet and life span

Name	Scientific name	Diet	Life span
Quagga mussel	Dreissena rostriformis bugensis	Phytoplankton-zooplankton algae	3-5 years
Zebra mussels	Dreissena polymorpha	substrate	4-5 years
Blue mussel	Mytilus edulis	Bacteria and toxins	4-5 years

3.3. Size of bivalves: these organisms have a life period of 4-5 years. Actually, young bivalves of one year age have high filtering capacity compared to older ones. The collected bivalves are harvested to observe the growth in terms of their shell height and gross weight.

3.4. Why Bivalves in Pollution control: The main considered phenomenon for usage in the pollution control is their diet, and it is the mechanism involved in the pollutants removal. The pollutants they intake as their food are Algae, substrate, and nutrients. As these are some of the pollutants which cause the contamination. In most of the kinds of literature, it was observed that most of the variety of bivalves metal reducing capacity.

4.TEST RESULTS:

The samples collected from the study area are tested for nutrients (N&P), MPN, COD, and E-Coli presence. The testing in the laboratory is done by using UV spectroscopy for determining nutrients and COD levels.

Table 2: The initial tests results for the selected 5 samples.

parameter(ppm)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
COD	305	280	706.2	220	200
Total Nitrogen as N	150	108.25	105	165	175
Nitrate Nitrogen	18	15	24.2	27.8	25
Phosphorus	8.8	7.6	15.32	9.8	8.7
MPN	150	120	76	95	540
E-Coli	present	present	present	present	present
pH	7.38	7.18	7.26	7.32	7.52
Alkalinity	240	200	230	450	850
Hardness	780	660	650	580	985
TSS	513	246	520	625	650

From the initial test results of samples, it was observed that most of the sample values are above the permissible limits as per CPCB, which means the selected water bodies are highly polluted and need treatment for decontamination. For this purpose, wastewater is treated with bivalves.

Biofiltration model:

The treatment is done by introducing the bivalves in biofiltration model. The biofiltration model is prepared by a transparent type bottle with inlet and outlet. The gravel media of size 4-12mm is placed to a height of one fourth from the bottom in the model, the role of media make bivalves to attach the media. And the bivalves are placed above the media. The number of bivalves provided to the wastewater is one of each type (***Dressina polymorpha, Mytilus edulis, and corbicula flumina***) for one liter of wastewater allowed to treat, so the bivalves number depends upon the quantity of wastewater and the concentration of wastewater. As the bivalves are marine ones so it is necessary to maintain the ocean water salinity for effective removal. If freshwater bivalves are used then there is no need for maintaining the salinity.

Fig -2: Biofiltration Model

The samples are treated by allowing them through an inlet and collecting them through the outlet. The water is collected through an outlet because of the hydraulic head. The collected water after treatment for day1 to day7 is tested for the considered parameters. The test results after 7 days of treatment are as follows:

Parameter (mg/l)	Sample1	Sample2	Sample3	Sample 4	Sample5
DO	4.1	8	4	4	5.7
COD	20	25	87	27.9	22
BOD	25	10	2	0.25	15
total nitrogen as N	15	5	15	32	71

nitrate nitrogen	2	1	9	7.65	8.2
Phosphorus	2.1	1	2	0.256	1
MPN per 100ml	20	10	4	5	15
E-Coli	8.1	8	nil	8.5	nil
pH	12	nil	8	nil	8
hardness	60	18	23	65	80
TSS	35	12		56	60

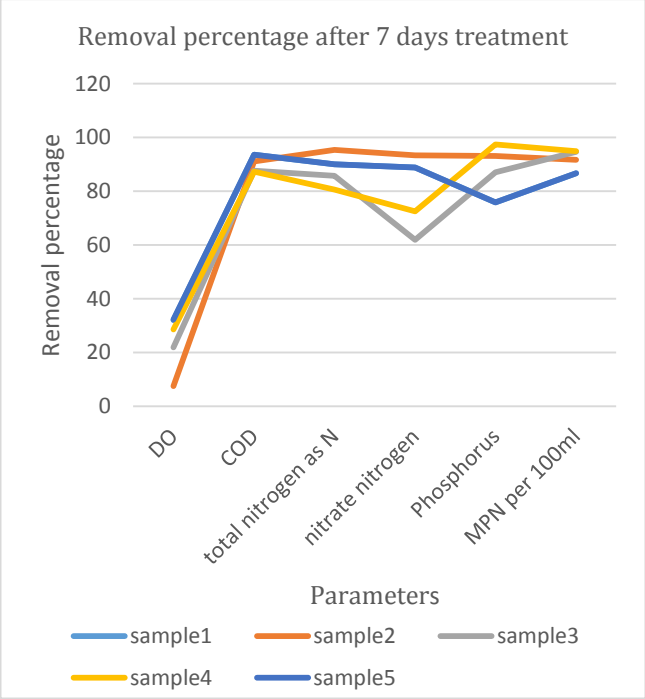

Chart -1: Removal percentage of parameters of samples After 7 days of treatment.

Results and Analysis:

Bivalves can treat wastewater with nutrients, high COD and pathogens. As the experimental setup is free to the atmosphere it is an aerobic process. The Dissolved Oxygen levels are checked to maintain DO levels for the organism to live and the minimum DO levels for the organism to sustain in the water is 4.0mg/l. All the water samples contain more than the minimum level throughout the duration of the experiment. COD removal percentage is near to 80% for 3 days treatment and 90% for 7days treatment, the COD level after 7 days treatment are less than the disposal limits i.e. 250ppm. Nitrates and phosphorus removal capacity is varying between 70-90% for sample1, sample2, sample3, sample4, and sample5. The reason for the difference in the removal percentage of nutrients is the fecal matter of the bivalves is rich in nutrients. E-Coli is tested after incubated for 24hours at 37^0C and E-Coli is nil in the treated sample. MPN is calculated after the test tubes with serially diluted samples (10ml, 1ml, 0.1ml) are incubated for 48 hours at 37^0C. For all 5 samples, 10ml dilution test tubes are positive. The removal percentage of MPN is about 80-90%. Expect sample 5 all the samples MPN values are below 150. For sample 5 MPN is high.

6. CONCLUSION:

By Bivalves treatment nutrient levels are reduced, so these can be used for recovery of eutrophicated sites. For this purpose, bivalves should be harvested in the water bodies which are invaded eutrophicated. The Bivalves spread faster the spreading of the bivalves should be controlled in the water bodies for effective removal. As the bivalves take the contaminants like algae, the substrate as their food the contamination level decreases with increase in time of treatment. The selected type of Bivalves (*Dreissena rostriformis bugensis, Dreissena polymorpha, and Mytilus edulis)* can treat this type of wastewater after 7 days of treatment. These type of bivalves can remove COD up to 80%, and the nitrates and phosphorus levels are reduced up to 70%, bivalves can reduce pathogens up to 90-95%.so these Animalia kingdom organisms can be used for treating the wastewater. These bivalves can treat polluted water bodies by simply harvesting in them, they can be also be used in industrial treatment plants as the substitute of microorganisms in biological treatment. The only drawback is their growth should be controlled otherwise they will take control over the other aquatic animals in the water bodies.

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