

Review on Municipal Waste Water Treatment by Bioremediation Techniques of Jayanti Nala, Kolhapur

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ABSTRACT: Bioremediation is a process in which beneficial microbiological agents, such as yeast, fungi or bacteria are used to clean up contaminated soil and water. Biological treatment systems have various applications, such as cleaning of water or sludge contaminated areas. Bioremediation is emerging as an effective and attractive technique to treat and recover the environment, in an eco friendly manner. Bioremediation technology, which leads to degradation of pollutants, may be a effective as well as environmentally friendly alternative. Water pollution is one of the most leading causes of public health issues and mortality. It is mainly the outcome of urbanization and overpopulation and is caused due to over utilization of fertilizers by farmers, sewage from hotels, hospitals and homes and industries in the city. Present paper is a contextual investigation of Kolhapur city. In this paper, an endeavor has been made to comprehend the issue of water contamination of panchaganga waterway because of urbanization and industrialization and its effect on general wellbeing in Kolhapur city. As the greater part the contaminated water originates from the jayanti stream to the panchganga waterway so jayanti stream has been considered as the significant purpose of examination and an imaginative idea is recommended to manage this issue viably. This paper discusses the role of microbes in waste water treatment methods in different areas of Jayanti Nala and puts forward thoughts and scope for further research in this area.

KEYWORDS: Bioremediation, Biodegradation, Environment, Microorganisms, pollutants.

I.INTRODUCTION

Bioremediation is the use of microorganisms to degrade environmental contaminants into less toxic forms (S Commu et al, 2011). Research has demonstrated that bioremediation can be an effective solution to tackle waste water due to the capability of microorganisms to survive, adapt, and thrive within many environments, including wastewater (S Commu et al, 2011). Bioremediation techniques for wastewater are frequently more advantageous than customary systems since it very well may be actualized straightforwardly at the site of the contaminant or in the wastewater treatment plant (Karigar and Rao, 2012). Wastewater is a major issue in numerous nations; thusly, bioremediation for squander water treatment is perhaps the best answer for tackle the issue. Bioremediation is a process in which microbiological agents such as yeast, fungi or bacteria are used to reduce the contamination of soil and water (DivyaAnand et al, 2015). It is defined as the elimination or transformation of polluting or contaminating substances by the application of biological processes (Karigar & Rao, 2012). The first and greatly affected ecosystems in any country are the aquatic ecosystems, affected by either point or non-point source of pollution (Karigar & Rao, 2012). Point wellsprings of contamination happen when the dirtying substance is transmitted straightforwardly into the conduit. The normal point wellsprings of contamination are Municipal, and Industrial wastewater effluents; run-off and leachate from strong removal locales; run-off from modern destinations; run-off and drainage from Industrial locales; release from vessels (Kshirsagar et al, 2013). The non-point sources includes flow of water from agricultural fields and orchards, urban run-off from unsewered areas, etc(Kagalkar&Jagtap et al, 2017). The effects of water pollution are not only devastating to the

aquatic organisms but also to the terrestrial animals and birds (Divya&Anand et al, 2015). More seriously, contaminated water destroys aquatic life and reduces their reproductive ability(Mangalekar&Jadhav et al, 2014). Ultimately, the water becomes unfit for human consumption or domestic usage, at severe cases even a hazard to human health(Divya & Anand et al, 2015). Waste disposal has an environmental cost and a financial cost too, which can be reduced by use of bio remediating agents (Pillay, 1992). To speed up the bioremediation process, seeding of contaminated wastewater with competent microflora that are capable of degrading hazardous waste, is usually practiced in most treatments. The inoculated microorganisms either may be naturally occurring types or prepared in the laboratory to attack the target waste (Dhote&Ingole et al, 2012).More than half of the polluted water comes from the Jayanti Nala to the Panchaganga River. Jayanti Nalaaltogether has been a major source of water pollution. This water has led to the increase in diseases(Mangalekar&Jadhav et al, 2014). Hence, there is a need of proper management and cleaning of the waste coming from the Nala. .Many attempts have been made to minimize the pollution such as setting up of new STPs(Mangalekar&Jadhav et al, 2014).

In this paper we are further going to discuss about the various types of organisms and sources affecting the water quality of Jayanti Nalaand how bioremediation will prove to be an effective and better option for quality control of this water.

II.TYPES OF ORGANISMS USED IN BIOREMEDIATION

Examples of microorganisms studied and strategically used in Bioremediation treatments for heavy metals include the following,

- 1) **Bacteria:** Arthrobacter spp., Pseudomonas veronii, Burkholderia spp., Kocuriaflava, Bacillus cereus, and Sporosarcinaginsengisoli.
- 2) **Fungi:** Penicilliumcanescens, Aspergillus versicolor , and Aspergillus fumigatus.
- 3) **Algae:**Cladophorafascicularis, Spirogyra spp. and Cladophora spp. and Spirogyra spp. andSpirullinaspp.
- 4) **Yeast:** Saccharomyces cerevisiae and Candida utilis.

* The way in which microorganisms interact withheavy metal ions is partially dependent on whetherthey are eukaryotes or prokaryotes,wherein eukaryotes are more sensitive to metal toxicity thanprokaryotes.

* The possible modes of interaction are (a) active extrusion of metal, (b) intracellular chelation (ineukaryotes)by various metal-binding peptides, and (c) transformation into other chemical species with reduced toxicity.

* For Bioremediation to be effective microorganisms must enzymatically attack the pollutants and convert them to harmless products.

* Most of Bioremediation systems are run under aerobic conditions.

* Choice of the organisms employed depends on the chemical nature of the polluting agents, and needs to be selected carefully as they only survive in the presence of a limited range of chemical contaminants.

*The productivity of the degradation procedure is identified with the capability of the specific microorganism to bring molecular oxygen into the hydrocarbon and to create the intermediates that in this manner enter the general vitality yielding metabolic pathway of the cell.

III.STATUS OF WASTE WATER IN KOLHAPUR

Expanded development exercises because of urbanization and industrialization are enormously liable for water contamination in Kolhapur city. Panchaganga is one of the dirtiest waterways on the planet. Every day 90 million litres/day waste water produce in Kolhapur (Thorvat&Sonje, et al, 2012). It's capacity is only 25 million litres/day. The assessed civil wastewater is to the tune of 90 Million Liters for each Day (MLD) which arrives at the stream Panchaganga through two regular nallahs, to be specific Jayanti nallah and Dudhali nallah. The release areas are around 500 m upstream the Bawada water works which supplies in excess of 50 percent of metropolitan water to the city. (MPCB Report; 2005-06, S. K. Deshmukh et al.; 2001). Because of the water contamination, there is an issue of satisfactory flexibly of consumable water. Water contamination has made genuine effect on human life because of different water borne infections.The present drainage system is 30 years old and it should be modified (Dhote&Ingole et al, 2012). Industrial waste waterof JayantiNala and dudhalinalas, domestic waste water are the main sources of the Panchaganga river pollution. Due to huge amount of waste water Kolhapur MunicipalCorporation got 131 time notices (Mohite et al, 2020). Every day 165 metric ton/day solid waste produces. These solid waste legitimately go to the waterway in light of the fact that there is no solid waste administration office appropriately working at present in the city. Other than panchaganga waterway eight MIDCs, seven sugar processing plants and 174 gram panchayat towns produce squander water which goes to the stream (Dhote and Ingole et al, 2012).In the year 2012, more than 500 cases



of Jaundice and many deaths were reported in the textile area of Ichalkaranji, Kolhapur (Aurthor& Sandeep et al, 2019). This is also main cause of contaminated water from the Panchagangariver.

Description of Jayanti Nala:

Jayanti Nalastart from Kalmba Lake and having length of 9km. At Hutatma Park, Gomati Nala mixes with the Jayanti Nala and form a big Nala Basin. This accounts for more than 60% of the total sewage generated in the city. This water is then pumped to the pumping station and is eventually sent to the STP located at KasabaBawada, Kolhapur (MPCB report 2009).

Source	Flow rate (million litres per hr)			Flow rate (MLD)	Flow rate (MLD) as reported by KMC for 2003-04
	8am-10am	1pm-3pm	5pm-7pm		
Jayanti Nala	0.8	1.5	1.4	24	70.1

Table (1):Flows and Characteristics in Nala Basin in Kolhapur Report.

Public health issues in Kolhapur city :

The causes of Jayanti Nalapollution are industrial waste water, domestic waste water, solid waste, over utilization of the fertilizers, hospitals, hotels,small industries and businesses are responsible for increase in public health issues.

Total Population of Kolhapur City (2001 Census)	Water Usage (per day)	Waste water without treatment (per day)
4.93 Lakhs	120 Million Litres	100 Million Litres

Total No. of Industries	Total waste water without Treatment
2953	18.59302 Million Litre per day

Table (2): MPCB report 2009.

Effluent from other sources:

There are about 49 servicing stations in the city which generates 49,000 litres of waste water. The waste from slaughter houses and fish markets are having high organic load. This water is directly discharged into the Nala which add to the pollution. Other sources of Pollution are the hotels, restaurants, hawkers, etc.

Sources	Total No.	Total amount of waste generated
Servicing Stations	41	2,00,000 litres/ day
Hotels, Restaurants &Hawkers	1044	1,49,400 litres/ day
Slaughter houses waste	02	800 Kg/ day
Meat shops and Fish	76	1000 Kg/ day

Table (3): MPCB Report 2009



Agro chemicals used in the fields:

Table (4): MPCB Report 2009

Sr. No	Type of Agro - chemical	Solid State (per year)	Liquid State (per year)
1	Chemical fertilizers	78,244 Tones	
2	Pesticides	1,41,764 Tones	22,068 Litres
3	Weedicides	34,995 Tones	21,664 Litres
4	Fungicides	6771 Tones	1828 Litres

Effect of water pollutants:

- Copper (Cu):** Excess Cu in human body is toxic, may cause hypertension, sporadic fever, uremia, coma, causes pathological issue in brain tissue.
- Zinc (Zn):** Causes vomiting, renal damage, cramps etc
- Barium (Ba):** Excessive Salivation, colic, vomiting, diarrhea, tremors, paralysis of muscles, nervous system, damage to heart and blood vessels
- Iron (Fe):** Causes quick breath and heartbeat rates, blockage of veins, hypertension and laziness
- Cadmium (Cd):** It might cause lessening of red platelets, weakness of bone marrow, amble torments, aggravation in calcium digestion, mellowing of bones, cracks, skeletal twisting, harm of kidney, hypertension, tumor development, heart ailments, debilitated conceptive capacity, hereditary change.
- Mercury (Hg):** Causes headache, abdominal pain, diarrhea, destruction of haemoglobin, damage of renal tissues, mimamata diseases
- Lead (Pb):** Causes brain damage, vomiting, loss of appetite, convulsions, uncoordinated body movements, helplessly amazed state,
- Radioactive materials/metals/substances:** It causes severe mental retardation and leukaemia in infants. Radioactive metals like heavy metals are nephrotoxic and damage kidneys.
- Fluoride:** Results in progressive crippling scourge (sponging)/ fluorosis of bones, teeth. May cause metabolic alternations in soft tissues and their functional mechanism.
- Chromium (Cr):** It causes cancer, anuria, nephritis, gastrointestinal ulceration, perforation in partition of nose
- Manganese :** Causes growth retardation, fever, sexual impotence, muscles fatigue, eye blindness
- Cobalt (Co):** Causes paralysis, diarrhea, low blood pressure, lung irritation, bone effects
- Nickel (Ni):** Changes in muscle, brain, lungs, liver, kidney and can also cause cancer, tremor, paralysis and even death
- Alkalinity and Acidity:** Permissible range of pH value if violated may cause health problem to human and animals and loss of productivity in agriculture
- Chlorine (Cl):** Destroys plants and aquatic life and is biocide
- Sulphide :** Gives bad odour, toxic to many aquatic organisms and animals
- Pesticides/Insecticides:** Highly poisonous for humans and animals. Also they lower seed germination, plays a role in development of Parkinson’s disease, destruction of nerve cells in certain regions of brain resulting in loss of dopamine which is used by nerve cells to communicate with brain. Some of these are physical poisons, some are protoplasmic poisons causing liver damage, some are respiratory poisons and some are nerve poisons.
- Nitrogen:** can produce a serious condition in fish called "brown blood disease." Causes a condition known as methemoglobinemia or "blue baby" disease.

Need of water treatment:

Wastewater treatment includes breakdown of complex natural mixes in the wastewater into more straightforward intensifies that are steady and irritation free, either physico-chemically and additionally by utilizing miniaturized scale life forms (organic treatment). The unfriendly natural effect of permitting untreated wastewater to be released in groundwater, or surface water bodies as well as terrains are as per the following:

- The decay of the natural materials contained in wastewater can prompt the creation of enormous amounts of malodorous gases.

2. Untreated wastewater (sewage) containing a lot of natural issue, whenever released into a waterway/stream, will expend the disintegrated oxygen for fulfilling the Biochemical Oxygen Demand (BOD) of wastewater and along these lines exhaust the broke up oxygen of the stream, consequently causing fish slaughters and other unfortunate impacts.

3. Wastewater may likewise contain supplements, which can invigorate the development of amphibian plants and algal blossoms, hence prompting eutrophication of the lakes and streams.

4. Untreated wastewater for the most part contains various pathogenic, or infection-causing microorganisms and poisonous aggravates, that stay in the human intestinal tract or might be available in certain modern waste. These may defile the land or the water body, where such sewage is arranged.

For the above mentioned reasons the treatment and removal of wastewater aren't just attractive yet in addition fundamental.

V. PRINCIPLE OF BIOREMEDIATION

- * The key players in bioremediation are bacteria microscopic organisms.
- * The goal in bioremediation is to stimulate microorganisms with nutrients and other chemicals.
- * Microbes degrade contaminants - organic as well as inorganic.
- * Microbes gain energy that allows them to grow and reproduce.

Objective

- 1) To analyse the quality of water before bioremediation.
- 2) To identify the microbes present in the water.
- 3) To Remove unwanted pathogens and give proper growing culture to the bacteria,
- 4) To Increase its potential of biodegrading waste.
- 5) To analyse the quality of water after bioremediation.
- 6) To prove its capacity of detoxifying large amount of water without generating any kind of toxic residues.

VI. METHODOLOGY

- 1) Collection of waste water samples from different sites of Jayanti Nala. It will be collected monthly for one year from different sites of Jayanti Nala (Ramanand Nagar, Hutatma Park, SiddhivinayakMandir, RenukaMandir, Pumping Station) of Kolhapur in pre sterilized bottles (1 L capacity).
- 2) Isolation and Identification of Bacteria from collected water samples Serial Dilution technique would be used for the isolation of bacteria from the Jayanti Nalawater samples on nutrient agar medium. The isolated bacterial strains would be recognized based on their morphological, physiological, and biochemical qualities includes by Bergey's Manual of Efficient Bacteriology (Claus and Berkeley, 1986). Isolated bacterial cultures would be cross examined by the BD-BBL Crystal Identification Autoreader for the identification surety. Non-Culturable bacteria would be identified using PCR (Ultee et al., 2004).
- 3) Determination of physico-chemical parameters (BOD, COD, Hardness, pH, TS), heavy metals and pesticides from water samples. The initial physicochemical parameters (colour, pH, TDS, BOD, COD, Hardness) of collected water samples would be determined by following the methodology given by Ambasht, (1990) and APHA, (1998). The heavy metals concentration and pesticides residue in the collected water samples would be determined by Atomic Absorption Spectroscopy (AAS) and Gas Chromatography-Mass Spectroscopy (GC-MS) respectively.
- 4) Optimization of bacterial isolates at different pH, temperature and media Optimization of selected bacterial isolates for growth profile at different pH, media and temperature would be carried out by, Saini, (2008).
- 5) Bacterial treatment (monocultures and consortium) for removal of heavy metal ions and pesticides residue.

The efficiency of bacterial monocultures and consortium with respect to reduction in physico-chemical parameters would be carried out following the methodology of APHA (1998) and removal of heavy metals and pesticides residue by Atomic Absorption Spectroscopy (AAS) and Gas Chromatography-Mass Spectroscopy (GC-MS) respectively.

VII. SEASON WISE TEST RESULTS

1) Rainy Season:

Sample	Name of Stations	pH	DO	BOD	COD	TDS	CC	Oil & Grease
1	Kalamba Lake	7.0	3.2	75	112	88	30.81	0.1
2	Near Kalamba Jail	7.3	3.0	80	120	93	106.5	0.38
3	Ramanand Nagar	7.2	2.8	82	124	89	84.47	0.37
4	Shenda Park	7.6	3.1	91	136	99	92.3	0.34
5	Aadhar Hospital	7.1	3	97	146	103	80.94	0.29
6	Gokhale College	6.9	2.8	95	142	120	71	0.31
7	Titan Showroom	6.8	1.9	100	150	134	81.79	0.15
8	Jayanti Bandhara	7.3	1.5	103	154	128	75.26	0.31

Sample	Name of Stations	pH	DO	BOD	COD	TDS	CC	Hardness mg/lit	Turbidity NTU
9	Shingnapur	7.1	4.5	2.6	12	69.5	24.94	80	1.5
10	KasabaBawda	7.1	3.5	4.7	16	72.4	35.99	85	1.7

Table (6)

2) Winter Season:

Sample	Name of Stations	pH	DO	BOD	COD	TDS	CC	Oil & Grease
1	Kalamba Lake	6.8	1.9	90	222	239	36.92	0.17
2	Near Kalamba Jail	7.59	1.6	109	312	454	91.7	0.96
3	Ramanand Nagar	7.68	0	107	366	478	88.78	1.9
4	Shenda Park	7.35	0	103	316	465	99.8	2.2
5	Aadhar Hospital	7.32	1.3	115	374	353	93.4	2.4
6	Gokhale College	7.6	1.0	108	308	342	85.1	1.9
7	Titan Showroom	7.39	1.3	121	326	449	86.1	2.7
8	Jayanti Bandhara	7.47	0.09	116	340	463	101.77	2.19

Sample	Name of Stations	pH	DO	BOD	COD	TDS	CC	Hardness mg/lit	Turbidity NTU
9	Shingnapur	7.36	4.5	3.2	16	140	42	85	1.9
10	KasabaBawda	7.90	3.2	3.4	22	181	45	90	2.2

Table (7)

3) Summer Season:

Sample	Name of Stations	pH	DO	BOD	COD	TDS	CC	Oil & Grease
1	Kalamba Lake	7.9	3.1	140	208	350	45	0.2
2	Near Kalamba Jail	8.1	2.5	149	222	356	49	0.34
3	Ramanand Nagar	7.5	2.4	146	248	378	57	0.37
4	Shenda Park	7.2	2.8	178	298	415	54	0.33
5	Aadhar Hospital	8.3	2.1	201	336	427	78	0.36
6	Gokhale College	7.9	1.7	197	354	418	92	0.41
7	Titan Showroom	7.7	1.8	193	286	471	89	0.43
8	Jayanti Bandhara	8.2	1.3	210	314	480	102	0.44

Sample	Name of Stations	pH	DO	BOD	COD	TDS	CC	Hardness mg/lit	Turbidity NTU
9	Shingnapur	7.5	4	3.5	18	185	49	88	2.1
10	KasabaBawda	7.8	2.7	3.9	54	24	196	110	2.9

Table (8)



Parameters / Seasons	Average Reading		
	Rainy	Winter	Summer
pH	7	7.44	6.60
DO (mg/litre)	2.6	0.8	2.21
BOD (mg/litre)	90.37	108.6	176.8
COD (mg/litre)	135.5	320.5	283.2
Chloride Content (mg/litre)	77.88	85.4	70.75
Total Dissolved Solids (mg/litre)	106.8	405.8	411.8
Oil & Grease (mg/litre)	0.28	1.8	0.36

Table (9)

Table No. (6), (7), (8) & (9) data from (IJIRSET)(A Study of Physico-Chemical Characteristics of Jayanti Nalla Water along with it’s Tributaries with Special Emphasis on Quality of PanchgangaRiver, Jan 2020, Nitish A. Mohite, Vinayak B. Patil, N. S.Misal)

VIII. CONCLUSION

This paper relates to the case study of Jayanti Nala of Kolhapur city. Panchganga river is the main source of water in Kolhapur. As the Nala finally converges in the Panchganga river it poses a threat to the human, animal and aquatic life. Increased industrial as well as domestic activities are responsible for water pollution in Kolhapur city. This paper discusses the role of microbes in waste water treatment methods in different areas of Jayanti Nala and puts forward some thoughts and scope for further research in this area. Bioremediation gives a strategy to decrease of contamination by improving the regular biodegradation forms. Thus we need to develop a better understanding of microbial communities and how they react to the natural environment and pollutants. Identifying the right microbe from the waste to be biodegraded is the major task and conducting field trials with these identified microbes for bioremediation techniques would definitely provide cost effective technologies and offer potential for significant advances in the Jayanti Nala field. Every microbe has different metabolism, it requires different physicochemical parameters for its growth (temperature, pH and nutrients). Hence our main objective over here is to give proper culture to these microbes in the lab. Use of genetically engineered microorganisms is not necessary as in most cases there is a wide diversity of naturally occurring microbial strains. As natural resources are major assets to humans, bioremediation of contaminated sites and ecosystems will be the best ecofriendly approach to preserve the scarce resource and also ensure efficient recycling of wastes. Bioremediation is a vast & an emerging field. It helps to overcome nutrient deficiency in soil as well as water, improves composting of industrial waste, removal of toxic chemicals etc. There is scope for developing new products and new organisms within the contaminated sites. These microbes are the main pillar of this process. It is not only a feasible but also one of the best pollution free method that could assist in our goal of cleaning up Jayanti Nala environment.

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