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Research Article

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Remediation of Yamuna River water in city of Taj by Bacterial Consortium

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ABSTRACT

Perceiving bacteria as dangerous is now turning towards greater awareness of the microbial world as a fundamental element of life. The present research work has been carried out to analyze the physico-chemical characteristics of Yamuna river water and to reduce the load BOD, COD, hardness, alkalinity, acidity, dissolved solids, suspended solids, total solids by the process of bioremediation using bacterial consortium. The bacterial consortium treated water sample showed a sharp reduction in BOD i.e. 89% and 84% in COD. The result of the study indicates that Effective bacterial consortium helps in the reduction of water impurities.

Keywords*: Bacterial consortium; Yamuna River water; Bioremediation.*

Abbreviations: *EM: Effective Microbes; DO: Dissolved Oxygen; COD: Chemical Oxygen Demand; BOD: Biological Oxygen Demand; TDS: Total Dissolved Solids; TSS: Total Suspended Solids; TS: Total Solids; mg L-1: milligrams per Litre; g: grams; APHA: American Public Health Association.*

INTRODUCTION

Environmental contamination owing to the anthropogenic activities and the natural resources is increasing progressively on account of an unabated increment in population, industrialization and urbanization[1]. The world is facing a global water quality crisis. Continuing population growth and urbanization, rapid industrialization, and expanding and intensifying food production are all putting pressure on water resources and increasing the unregulated or illegal discharge of contaminated water within and beyond national borders. Purity of water is one of the most important felt needs in public health in developing countries in the twenty first century[2].

Rivers are the lifeline of any civilization. Rivers are water ways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes[3]. Rivers play a major role in integrating and organizing the landscape and moulding the ecological setting of a basin. They are prime factors controlling the global water cycle and in the hydrologic cycle, they are the most dynamic agents of transport[4].

River pollution in India has now reached to a point of crisis due to unplanned urbanization and rapid growth of industrialization. The entire array of life in water is affected due to pollution in water. The problem of water quality deterioration is mainly due to human activities such as disposal of dead bodies, discharge of industrial and sewage wastes and agricultural runoff which are major cause of ecological damage and pose serious health hazards[5]. The degree of pollution is generally assessed by studying physical and chemical characteristics of the water bodies[6].

Yamuna River is one of the important rivers of India originating from Himalayas. The status of the Yamuna river water is very much useful as it determine the physiological life cycle of plants, animals and human kingdom. In Agra (city of Taj) the Yamuna River has always been the most important freshwater resources. However the Yamuna water is used in every sector of development like agriculture, industry, transportation, aquaculture, public water supply etc. Huge load of wastes from industries, domestic sewage and agriculture practices find their way into the Yamuna, resulting in large scale

deterioration of the water quality and affect the physico- chemical parameters of water. The growing problem of degradation of our ecosystem has necessitated the monitoring of water quality of various rivers all over the country to evaluate their production capacity and utility potential and to plan restorative measures[7]. An idyllic process for pollution abatement is 'bioremediation'. The term bioremediation has been introduced to describe the process of exploiting biological agents to eliminate toxic waste from environment. At present, bioremediation is the most effective management tool to manage the polluted environment and recover contaminated environment[8]. In other words Bioremediation is a new treatment technology to clean up contaminated environments through the use of microorganisms. Microorganisms cleaned the Earth in its early stages when it was polluted, helped create the oceans, rivers, and soil, and helped maintain an environment in which living things could thrive.

New technologies are being produced to assist in the treatment and disposal of waste water, conforming to strict environmental regulations. One of these new technologies are Effective microbes (EM) technology.

The concept of Effective microorganisms was developed by Japanese horticulturist Teuro higa from the University of Ryukyus in Japan. He reported in the 1970s that a combination of approximately 80 different microorganisms is capable of positively influencing decomposing organic matter such that it reverts into a life promoting process[9]. The Studies have shown that EM may have a number of applications, including agriculture, livestock, gardening landscaping, composting, bioremediation, cleaning septic tanks, algal control and household uses[10]. Relevant researchers are concerned about the non hazardous, environmental friendly and sustainable technique to achieve a healthy, non pollutant environment through bioconservation i.e. biological based treatment of waste dimension[11,12,13]. Hence in present investigation an attempt has been made to remedify the Yamuna waste water by bacterial consortium.

MATERIALS AND METHODS

Isolation of bacteria

Water samples were collected in sterilized BOD bottles, from the river Yamuna situated in the city of Taj-Agra, India, receiving the huge loads of industrial, agricultural and domestic wastes resulting in large scale deterioration of the water quality and affects the physico-chemical parameters of water. The water samples were analyzed to determine their physical, biological and chemical characteristics. For the selected isolation bacteria Nutrient agar mediawereused. Nutrient Agar medium was prepared by mixing Peptone-5 g, Beef extract-3 g, Sodium chloride-5 g, Agar-20 g, pH-7 in 1000 ml distilled water.

The Yamuna water sample directly streaked on Nutrient media and incubated at 37°C for 24 h. After the incubation period the plates were observed for growth on the media[14]. When the colonies appear on agar plates, each one was subcultured on a new agar plate until pure strains were obtained.

Identification of bacteria by BD-BBL crystal autoreader

The BBL CRYSTAL Rapid Gram-Positive (RGP) Identification System (ID) is a miniaturized identification method employing modified conventional, fluorogenic and chromogenic substrates[15]. Pure cultures of bacteria were identified by BD-BBL crystal autoreader. The identified bacterial isolates were stored on the Nutrient agar medium at 4°C for further studies.

Physico-chemical analysis of Yamuna waste water

The analysis of initial physico-chemical parameters such as DO, BOD, COD, TDS, TSS, TS, acidity, alkalinity and hardness of collected Yamuna water samples were carried out by standard methods[16].

Bacterial Consortium Preparation

Bacterial cultures (*Rhodopseudomonas palustris, Rhodobacter spheroides, Escherichia coli, Bacillus subtilis, B. cereus, B. thuringiensis, B. fusiformis, Lactobacillus* sp) were inoculated individually in pre-sterilized 100ml Nutrient broth. The flask was kept in a shaker at 120 rpm for 16 to 18 h at 30°C. The culture broth was centrifuged at 10000 rpm for 20 min. Cell suspension was prepared using sterile distilled water and adjusted to 0.5 OD using UV-visible spectrophotometer[17]. 5% of the above stock solution of Effective Microorganisms was added in Jaggary Solution (Jaggary-100g, Yeast extract-10g,

Distilled water- 1000ml pH-6.5. Dissolve all the ingredients in distilled water and autoclaved at 121˚C at 15 lbs for 15 min.). The inoculated Jaggary medium was incubated at 37˚C temperature for 5 days.

Efficiency of bacterial consortium with respect to the reduction of physico-chemical properties of Yamuna waste water

The efficiency of the bacterial consortium was evaluated with respect to changes in physico- chemical parameters of the wastewater samples after treatment by following the standard method of APHA (1998). For bacterial consortium treatment 5% of EM solution containing bacterial consortium was inoculated into the water samples and incubated in an incubator. After incubation the samples were analyzed for different physico-chemical parameters.

RESULTS AND DISCUSSION

In present study for remediation purpose eight indigenous bacterial strains were isolated from Yamuna water and were tentatively identified as *Rhodopseudomonas palustris, Rhodobacter spheroides, Escherichia coli, Bacillus subtilis, B. cereus, B. thuringiensis, B. fusiformis, Lactobacillus* sp by BD-BBL crystal autoreader. The physico-chemical characteristics of Yamuna waste water before and after treatment are presented in Table 1.

Table 1- Physico-chemical characteristics of Yamuna water before and after treatment with bacterial consortium

Physico-chemical parameters	Untreated*	Treated*	Percentage reduction (%)
Colour	Brown	Colourless	-
Odour	Foul smell	Odourless	-
pH	8.9	7.1	-
Acidity (mg L^{-1})	498.7	79.3	84
Alkalinity (mg L^{-1})	1197	124	90
Hardness (mg L^{-1})	1834	524	71
TS (mg L^{-1})	56.8	7.0	88
TSS (mg L^{-1})	32.9	4.9	85
TDS (mg L^{-1})	23.9	2.1	91
DO (mg L^{-1})	5.6	78.9	93
BOD (mg L^{-1})	29.9	3.3	89
COD (mg L^{-1})	152.9	24.3	84

*mean from three replicates

All the physico- chemical parameters except DO showed maximum values in untreated Yamuna water sample but the bacterial consortium treated showed much reduction in the physical and chemical parameters to the way of improvement. These findings can serve as an important contribution towards an economic and simplified the biological methods for the waste water treatment using bacterial consortium. Synergistic association of specific aerobic and facultative bacteria able to use a wide range of organic contaminants reduced the physico-chemical parameters of waste water.

Saini *et al* [18] reported that the physico-chemical parameters of untreated domestic waste water were beyond the tolerance limit but after treatment with bacterial consortium all the parameters were sharply reduced, below the tolerance limit. The results are similar with the report of Chandra revealed[19] that the efficiency of active bacterial consortia (*Pseudomonas putida, Rhodophseudomonas, Citrobacter, Enterobacter,* & *Rhodobacter*) in removal of the colour and reduction of BOD, COD, TDS, TS and hardness.

Ganguli and Maiti[20] observed that the dark yellow colour of the water affects the gas solubility and transparency of the water, which becomes light yellow after bacterial treatment. The results are similar with the findings of Mishra and Tripathi[21] reported a significant variation in values of DO, BOD, and COD between untreated and treated sewage waste water. The treated sewage water showed a sharp reduction in BOD (84.9%) and COD (79.9%) and DO content of treated sewage increased by 62.4%. DO, BOD and COD are important parameters which should be determined to perform the sewage quality analysis.

The present findings are supported with the observations of Joshi and Sharma[22] they performed bioremediation of sewage through bacterial inoculation under *in vitro* and reported a reduction in BOD and COD after 24, 48 and 72 h. Maximum reduction (79.45% in BOD and 72.25% in COD) was observed after inoculation period of 72 h with bacterial cultures.

Shrivastava *et* al [23] reported that the microbes used in EM technology are non-harmful, non- pathogenic, non-genetically engineered or modified and non-chemically synthesized. The bacterial consortium used has *B.subtilis*, *Cellulomonas* sp, *Lactobacillus* sp, *Rhodobacter spheroides*, *Rhodopseudomonas palustris.* Microbes originated from their own environment previously exposed to organic substances have greater degradation ability of related waste in biodegradation process.

Ayyasamy[24] supported the present findings. They used different combinations of bacterial and fungal cultures and observed that consortium of five bacterial strains (*Alcaligenes* sp, *Corynebacterium* sp, *Micococcus* sp, *Bacillus* sp, *Pseudomonas* sp.) showed the maximum percentage reduction in BOD, COD and other parameters of effluent in comparison to single and dual bacterial cultures.

Kumar and Bhoopathi[25] also supported the present result and reported that the consortium of different bacterial species (*Pseudomonas* sp, *Cellulomonas* sp, *Alcaligenes* sp) showed the significant reduction in different parameters of sago factory industry. Shrivastava *et al* [26] revealed that the EM technology was effective in the reduction of water impurities and chemical pollutants and biological pollutants to the permissible limits. Among effective microbes *Rhodopseudomonas palustris* and *Rhodobacter spheroids* were more effective in reducing physico-chemical characteristics of waste water.

CONCLUSION

In the growing awareness of relationships between human health and water pollution, it is essential to undertake regular monitoring and surveillance of important aquatic ecosystems. The results of present study indicate that EM technology helps in the reduction of water impurities. The observation revealed that the inoculation of bacterial consortium in water may release the nutrients through biodegradation of the organic/inorganic matter of water sources, which promote the plant growth. Moreover, the regular monitoring of water pollution level of river basin, appropriate purification treatment and community participation in water resources management will certainly help managers in taking informed decisions for water resources sustainability and management.

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