Analysing the potential of some selected microbes in de-toxifying sewage waste water

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Abstract

The microorganisms especially certain bacteria have tremendous potential of degrading and detoxifying harmful organic components present in water, contaminated with sewage waste. In the proposed work, six species of micro-organisms were used to analyse their impact on various physico-chemical parameters of sewage waste water. The actual physico-chemical parameters of the collected sample water were noted down (fresh sample parameters). Following this, the sample water was treated with selected micro-organisms (one at a time). The growth of the microbes was observed carefully over a period of 72 hours after inoculation. The physico-chemical parameters were recorded again and were compared with the fresh sample parameters. The results were analysed for any change and on this basis, an impact factor was developed to analyse the extent of bio-remediation effect.

The study reveals that all the microbes selected have great power of degrading and oxidizing the chemicals present in sewage waste. Out of the selected microbes, Rhodobacter sphaeroides has shown the most effective potential in detoxifying pollutants and improving water quality.

Key Words

Microbes, bioremediation, BOD, sewage waste water, pollutants.

Introduction

Water is one of the prime necessities of life. Millions of deaths occur every year worldwide, due to the consumption of contaminated water. High levels of pollutants mainly organic ones cause great damage to the receiving water bodies and their fauna.

Bioremediation is an effective strategy to degrade and detoxify harmful pollutants in the water bodies. This approach uses simple micro-organisms that consume and degrade various organic pollutants. Bioremediation is a cost effective and efficient approach to reduce environmental pollution.

The proposed work was carried out in 2018, at Mathura (India), which has a great religious importance, being the birth place of Lord Krishna and holy river Yamuna. Due to religious

importance, millions of pilgrims from all over the world visit this place and therefore the place severely suffers with the garbage and sewage disposal problem. More than a dozen wide drains pour the excreta and sewage waste directly into the Holy river Yamuna.

The main aim of this work was to investigate the effectiveness of the use of some common microbes in improving the quality of waste water taken from selected sewage sources.

Materials and methods

Water samples were collected, each month in pre sterilized cleaned, dry, polyethylene bottles which have been previously washed with 20 % nitric acid and subsequently with demineralized water. Samples were collected from two wide drains, which directly receive industrial outlets. The contents from both the sites were mixed together, soon after collection. This mixture was used as the sample for laboratory work. One part of the sample was analysed for physico-chemical parameters in the laboratory using APHA (1989) guidelines. The parameters, which were tested include – BOD, ammonia, sulphides, Phosphates and TDS. The other part of the sample was used for bio-remedial treatment.

Following six important microbes were selected for analysing their impact in improving the quality of water. These were – *Rhodobacter sphaeroides, Acinetobacter calcoaceticus, Bacillus subtilis, Pseudomonas aruginosa and Spirulina platensis, Aspergillus fumigatus.* Pure cultures of these species were obtained from the various sources.

A stirred tank glass bioreactor was used for analysing bioremediation impact. One litre of sample water was used in the bioreactor and it was added with inoculum and growth media. The inoculum contained one test organism at a time. The growth was allowed for 72 hours. At different intervals i.e., at 24 hours, 48 hours and 72 hours, the change in physico-chemical parameters of the sample water was recorded and compared with the original sample (fresh sample). For each micro-organism, three samples were analysed (one each month) and an average of the three was finally considered.

Results and Discussion

The observations have been summarized in following table -1.

Table - 1

(All values in mg/l)

Microbes	Sample	**BOD**	**Ammonia**	**Sulphides**	**Nitrates**	**Sulphates**	**TDS**
Rhodobacter sphaeroides	Fresh sample	42	19.6	5.26	3.58	2.5	624
	72 Hour	12	3.5	2.14	9.54	6.57	714
Acinetobacter calcoaceticus	Fresh sample	42	19	5.26	3.58	2.5	624
	72 Hour	29	12.5	4.15	2.41	1.25	415

Bacillus subtilis	Fresh sample	42	19	5.26	3.58	2.5	624
	72 Hour	21	15	5.14	2.05	1.05	514
Pseudomonas aeruginosa	Fresh sample	42	19	5.26	3.58	2.5	624
	72 Hour	30	16	5.08	2.41	1.9	
Spirulina platensis	Fresh sample	42	19	5.26	3.58	2.50	624
	72 Hour	15	07	2.45	3.98	2.89	514
Aspergillus fumigatus	Fresh sample	42	19	5.26	3.58	2.5	624
	72 Hour	31	14	5.14	2.78	2.0	415

Rhodobacter sphaeroides is a purple eubacterium with an extensive metabolic repertoire. *Rhodobacter* exhibited a negative impact factor on sulphate, nitrate and TDS. The rise in the sulphate value is an indicator of increasing BOD values, since the organism is a good producer of oxygen by photosynthesis (B B Nepple 2000). The oxygen then causes oxidation of various organic sulphides and sulphites to sulphates (S. Kalpan, 2005). The rise in the nitrate values also indicates increasing oxygen contents which in turn promotes the oxidation of various reduced forms of nitrogen including ammonia, urea and nitrites (Young S. Do, 2003, M. J. K. Ellington, 2003). The rise in the T.D.S. should not be taken as increase in the pollution load. This is mainly because of increasing number of nitrates and sulphates in the mixture due to increasing oxidation of nitrogen and sulphur compounds. *Rhodobacter* has shown a positive impact on phosphates i.e., it decreased the values of phosphate during experiment.

Acinetobacter calcoaceticus are strictly aerobic, non fermentative, gram negative bacilli. *Acinetobacter* exhibited a positive impact on the sulphates, nitrates and TDS. The fall is observed probably because the organism respires aerobically (Desouky Abdel-El- Haleem, 2003) and consumes oxygen quickly, so, deriving its oxygen from sulphate ions. The value of nitrates was also decreased from 3.58 mg/l to 2.41 mg/l probably for the same reason. However, the fall in ammonia and sulphides values were improved only marginally. A considerable fall in the BOD values was observed which shows the importance of this species in the bioremediation of waste water.

Bacillus subtilis is a bacterium, which live mainly as saprophytes. They are well known for their antibiotic properties. *Bacillus subtilis* exhibited a strong positive impact on the sulphates and nitrates. The sulphates values improved from 2.5 mg/l to 1.01 mg/l. This indicates that organism uses the sulphates ions for its metabolic requirements. Similarly, the nitrate values decreased from 3.58 to 2.05 mg/l. TDS and BOD values also exhibited an improvement, but no significant improvement in the ammonia and sulphides values was observed.

Pseudomonas aeruginosa can catabolise a wide range of organic molecules. The value of sulphate was decreased from 2.5 mg/l to 1.96 mg/l. Similarly, a positive impact was noted on

nitrate values also. The values decreased from 3.58 to 2.41 mg/l. This fall in values indicates that this species can greatly metabolise the nitrates and sulphate contents, showing its diversified metabolism (Kliushnikova, 1992). *Pseudomonas* also exhibited a significant improvement in BOD values. But the reduction in ammonia and sulphides values was only marginal.

Spirulina platensis is a blue green alga, obligatory photoautotrophic microbe. It showed a tremendous positive impact on the BOD values. The BOD values fall from 42 mg/l to 15 mg/l. This was mainly because of the oxygen producing metabolic reactions (Chojnacka K, 2007). Similar to BOD, the bacterium greatly decreased the ammonia and sulphides values. This indicates the great oxidizing capacity of this organism. But on the other hand, a slight negative impact of sulphates and nitrate values was observed. The values of nitrates were increased from 3.58 to 3.98 mg/l and the values of sulphates were increased from 2.50 to 2.89. A small reduction in TDS values was also observed.

Aspergillus fumigatus is a fungal saprotroph, which degrades a wide variety of organic compounds and it is also a very good metal absorbent (Amini M, Younesi H. 2009). *Aspergillus* exhibited a positive impact on the sulphates, nitrates and TDS values. A significant reduction in BOD values was also noted. The BOD values fall from 42 mg/l to 31 mg/l. The reduction in the values of ammonia and sulphides was very small.

Conclusion

From the above discussion and analysis, it can be concluded that all the selected microbes have a natural tendency to degrade complex compounds into simpler ones. Majority of them have a diversified metabolism. When used, *in situ* bioremediation, their capabilities get enhanced and accelerated. If microbial digesters are used to treat industrial waste water before its disposal, not only we can save our rivers and other natural water bodies from contamination but also can utilize this water for drinking and other purposes.

The most significant reduction in BOD, ammonia and sulphides values was carried out by *Rhodobacter sphaeroides*. So, out of the six selected microbes, the *Rhodobacter sphaeroides* emerged out as champion.

References

Al Garni S, Ghanem K M, Bahobail A S (2009). Biosorption characteristics of Aspergillus fumigatus in removal of cadmium from an aqueous solution. African Journal of Biotechnology 8, 4163-4172.

Amini M, Younesi H (2009). Biosorption of Cd (II), Ni (II) and Pb(II) from aqueous solution by dried biomass of Aspergillus niger : Application of response surface methodology to the optimization of process parameters. Clean-Soil, Air, Water 37, 776-786.

APHA 1989. Standard methods for the examination of water and waste water. 17th Ed. Washington D.C., U.S.A. pp. 10-203.

B B Nepple, J Kessi, R Bachofen (2000), Chromate reduction by Rhodobacter sphaeroides; Journal of industrial Microbiology and Biotechnology October 2000, Volume 25, Issue 4, pp 198-203.

Bo Shi, Pete Lortscher, Doris Palfery (2012), Algal biomass anaerobic biodegradability. Journal of Applied phycology, Volume 25, Issue 3, pp 757-761

Chojnacka K (2007). Bioaccumulation of Cr (III) ions by blue green alga Spirulina sp. Part 1. A comparison with biosorption. American journal of Agricultural and Biological Science 2, 218-223.

Desouky Abdel-El- Haleem (2003); Acinetobacter : Environmental and biotechnological applications: African journal of Biotechnology. Vol. 2 (4).P.P. 71-74.

Focht, D D (1997). Hurst. C J Kundsen, G R, Mclnernchy, MJ Stetzenback. L D, and Walter M V, Aerobic botransformation of polychlorinated biphenyls, Manual of Environmental Microbiology. ASM press, Washington DC, 811-814.

Gorbi G, Zanni C, Corradi M G, (2007); Sulfur starvation and chromium tolerance in Scendesmus acutus: a possible ink between metal tolerance and the regulation of sulfur uptake/ assimilation processes. Aquat Toxicol. 2007 Oct 30; 84(4): 457- 64. 2007 Jul 22.

Kliushnikova T M, Chernyshenko DV, Kasatkina T P (1992): The sulphate-reducing capacity of bacteria in the genus Pseudomonas, Mikrobiol Zh. 1992 Mar- Apr; 54(2): 49-54.

S Kalpan, J Eraso and J H Roh. (2005). Interacting regulatory networks in the facultative photosynthetic bacterium, Rhodobacter sphaeroides 2.4.1. Biochemical society Transaction; 33 (1), 51-55.

Tanya Kruitz and peter Wolk (1995). Use of filamentous cyanobacteria for Biodegradation of organic pollutants ; Applied and Environmental microbiology; Vol.61(1). 234-238.