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*Article*

# Bioremediation of Wastewater by Using Bacteria: An Experimental Study at Tigris River

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**Abstract:** The Tigris River holds great importance in the Middle East, as it traverses multiple nations and has played a crucial part in shaping the region's history and progress. The presence of trace elements in water bodies, such as the Tigris River, can substantially impact the bacteria in the environment. Bacteria are essential for nutrient cycling, organic matter decomposition, and the overall health of ecosystems. Bacteria are essential in wastewater treatment, particularly domestic waste, due to their ability to perform bioremediation. Bacterial samples from dirty water were gathered to study bacterial potential function in wastewater treatment. Hydrogenophaga pseudoflava and Pseudomonas aeruginosa cultures, two of the most abundant and pollution-resistant bacteria, were isolated from these samples and put to use in the BBM. Sewage effluent samples from untreated sewage water facilities were taken from the Tigris River for this research. Both (i) wastewater treated with a culture of H. pseudoflava and P. aeruginosa and (ii) wastewater treated without a culture of H. pseudoflava and P. aeruginosa (Control) were used to investigate the impact of bacteria on wastewater. Every fifth day, samples were taken and tested by accepted procedures to determine physicochemical parameters such pH, phosphate, nitrate, BOD and COD. Nitrate and COD are most effectively removed by H. pseudoflava, whereas P. aeruginosa reduces BOD and phosphate. The bacterial bioremediation of wastewater is the subject of the current study.

**Keywords:** Bioremediation, Wastewater, Bacteria, Physico-chemical parameters

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## 1. Introduction

A presence of trace elements in water bodies, such as the Tigris River, can substantially impact the bacteria within the ecosystem. Bacteria are essential for nutrient cycling, decomposition of organic materials, and the overall maintenance of ecosystem health. Contamination can disrupt these processes and lead to various ecological and health-related consequences. Here are some potential effects of trace element contamination on bacteria in the Tigris River. Pollutants and contaminants of all kinds, the byproducts of human progress, are wreaking havoc on our planet. As the world's population has grown, so has the amount of water that has been contaminated. Recently, there has been a growing awareness of the importance of diversifying approaches to water quality problems in

response to rising concerns about The quantity and quality of waste generated and released into natural waters. Wastewater nitrogen removal can be accomplished by bioremediation by employing naturally existing microorganisms and other elements of the natural environment. Cleaning up hazardous waste with bioremediation may end up costing less than with other approaches (Vidali, 2001). Bacteria have been shown to aid in the natural cleaning of water (Han et al., 2000; Olguin, 2003). The purpose of this research was to analyze bacterial strains for their ability to remove inorganic nutrients from wastewater from the Tigris River. The cultivation of H. pseudoflava with P. aeruginosa is being studied for its potential utility in bioremediating wastewater.

## 2. Materials and Methods of Research

### *2.1. Collection of Wastewater*

Sewage effluent was employed to gather the samples from the Tigris River for this investigation.

### *2.2 Analytical Methods*

Before and after utilizing bacteria for treatment, the wastewater was examined using the conventional methods outlined by (APHA, 1998). The levels of pH, BOD, COD, phosphate, and nitrate, as well as several other chemicals, were measured in the effluent.

### *2.3 Microorganism Selection*

In this experiment, we employed bacteria that were obtained from Tigris River water. H. pseudo flava and P.s aeruginosa, the two bacterial strains shown to be most successful in the extremely contaminated water of the Tigris River, were initially utilized as test organisms for the treatment of wastewater from the Tigris River.

### *2.4 Experimental Set-up*

To investigate a function of bacteria In wastewater treatment: (i) wastewater treatment using a culture of H. pseudoflava and P. aeruginosa; and (ii) wastewater treatment using no such culture (Control). The tests were repeated three times. Two milliliters of a homogenous suspension of H. pseudoflava and P. aeruginosa (9-day-old culture) were added to each of the 200-milliliter f lasks holding the wastewater sample. Both H. pseudoflava and P. aeruginosa had initial total cell counts of 7.32 104 cell/ml and 3.46 104 cell/ml, respectively. The experiment lasted 20 days and was performed at a constant temperature of 27 2o C. Standard procedures (APHA, 1998) were used to evaluate samples on a regular basis (every 5th day) for physico-chemical parameters as pH, phosphate, nitrate, BOD, and COD.

## 3. Results and Discussion

All physical and chemical variables were measured on day 0, day 5, day 10, day 15, and day 20. Table 1 shows that the original pH of wastewater was 7.410.10. H. pseudoflava and P. aeruginosa treatment of wastewater resulted in a higher pH than the control. In a similar vein, Rajasulochana et al. (2009) made a similar discovery. Figure 1 displays the drastic decrease in BOD and COD values in the treated effluent. The biochemical oxygen demand (BOD) measures the amount of dissolved oxygen used by substances during the treatment process (up to day 15).

**Table 1.** pH value analysis of wastewater containing Astragalus and Pseudomonas aeruginosa

| **Initial pH** | **7.51±0.23** | | |
|---|---|---|---|
| Days | Control | H. pseudoflava | P. aeruginosa |
| Fifth | 7.59±0.06 | 7.84±0.05 | 7.62±0.03 |
| Tenth | 7.18±0.05 | 8.30±0.26 | 7.65±0.21 |
| Fifteenth | 7.76±0.13 | 7.67±0.04 | 7.56±0.05 |
| Twentieth | 7.83±0.07 | 7.55±0.18 | 8.20±0.12 |

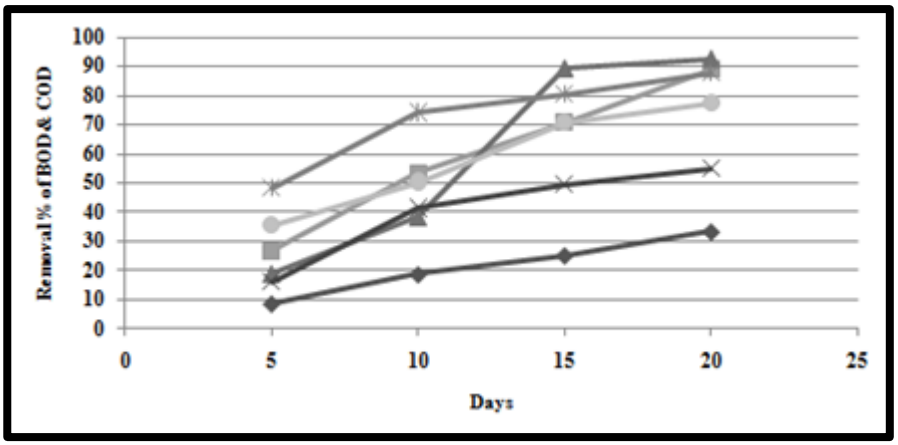


**Figure 1:** % BOD and COD removal from wastewater using H.pseudoflava and P.aeruginosaH

Hpseudoflava decreased the amount by 70.91% after 15 days, whereas P. aeruginosa decreased it by 89.21%. When investigating the potential of an activated-bacterial technique for treating wastewater, Aziz and Nag (1993) discovered that H. pseudoflava could be used to remove 80-88% of BOD and 70-82% of COD over a retention time of 15 days.

In the current investigation, H. pseudoflava and P. aeruginosa were able to lower the COD level for up to 15 days by 80.64 and 70.97 percent, respectively (Figure 1). The ability to remove COD from wastewater was best demonstrated by H. pseudoflava. Treatment with ethanol and citric acid manufacturing industrial effluent, Valderramna et al. (2002) found that H. pseudoflava was able to remove 61% of the COD. Due to its rapid growth rate and robust photosynthetic activity, H. pseudoflava was shown to significantly reduce effluent BOD and COD concentrations over time (Colak and Kaya, 1988). Scendesmus sp. was shown to be very effective at removing inorganic fertilizers from Tigris river effluents in a research conducted by Zhang et al. (2008). H. pseudoflava has a clearance effectiveness of 88.60% for COD and 89.60% for BOD (Azeez, 2010). H. pseudoflava and P. aeruginosa were both tested for their ability to remove nitrate from wastewater in the same experiment. Up to the 15th day after treatment, H. pseudoflava and P. aeruginosa removed 78.08% and 70.32% of nitrate, respectively, from the wastewater. In comparison to P. aeruginosa, H. pseudoflava has a higher ability for removing nitrate from wastewater. Bacteria are the

only organisms capable of efficiently detoxifying high concentrations of nitrogenous chemicals from wastewater (Tam and Wong, 1990). Narkthon (1996) researched the efficacy of H. pseudoflava in removing nitrogen and phosphorus from swine wastewater and found that, after eight days of retention, 77-86% of nitrogen and 53-75% of phosphorus were removed. According to Gonzales et al. (1997), H. pseudoflava and Scenedesmus sp. eliminated 95% of the ammonium-nitrogen and 50% of the phosphorus from wastewater.

By the fifteenth day, H. pseudoflava had eliminated 62.73 percent of the phosphate in the wastewater. By the twentieth day, its capacity to remove phosphate had risen to 79.66 percent. P. aeruginosa was determined to have been eliminated by 81.34% on the 15th day (Figure 2). The findings are consistent with those of Grant et al. (1984), who found that Chlorella and Scenedesmus were the most efficient bacterial strains for removing phosphate from municipal and refinery wastes. Phosphorus aeruginosa was able to effectively remove phosphate from the wastewater in about 15 days. P. aeruginosa-based wastewater treatment showed improved phosphate removal over conventional methods. Chevalier and Noue (1985) made a similar finding. Scenedesmus was shown to remove approximately 83% of the phosphorus present in fermented swine effluent at a concentration of 120 mg/l, according to research conducted by Kim et al. (2007). H. pseudoflava is able to remove phosphorus during remediation because it uses the nutrient for development (Rao et al., 2011). On day 20 of the experiment, H. pseudoflava was able to remove 58.7% of the phosphate in the wastewater, while **P. aeruginosa** both removed 80.0%.

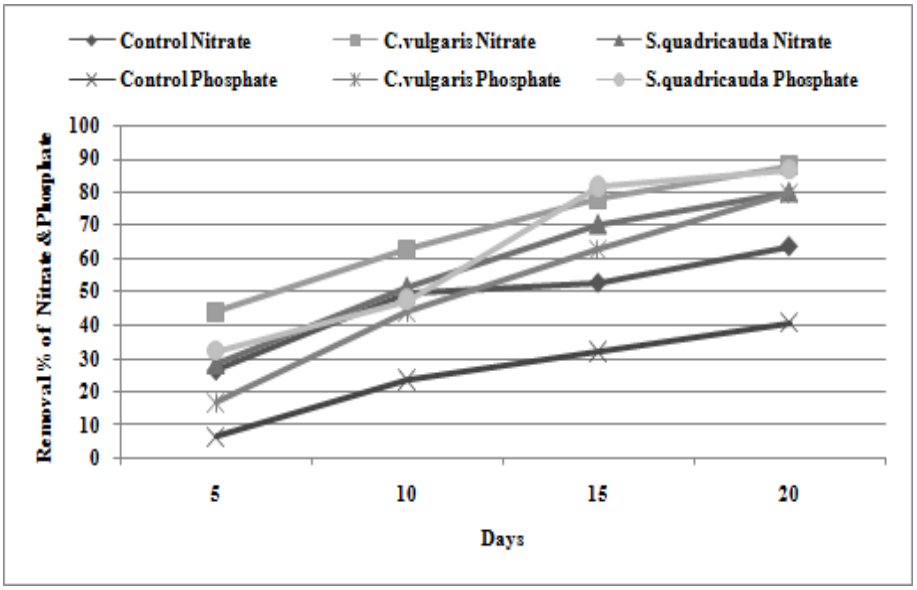


**Figure 2.** Percent (%) nitrate and phosphate removal from wastewater by H. pseudoflava and P. aeruginosa

quadricauda between days 6 and 15 (Granter et al., 1984; Kassim, 2002). A strain of H. pseudoflava grown in animal slurry accumulates 96% of the phosphorus it consumes, as demonstrated by (Garrett and Allen 1976). Over 90% of total phosphorus removal was reported by Doran and Boyle (1979) and Tam and Wong (1990) for bacterial cultivations that ended after 10 days owing to chemical precipitation. After 24 hours, free cells in a

culture of H. pseudoflava absorb 38% of the available phosphate, while cells immobilized in alginate absorb 94%. Gupta and Rao, (1980) found that studies of Chlorella and Scenedesmus were effective in removing phosphate from a waste stream that included municipal and refinery waste.

Using H. pseudoflava for up to 15 days resulted in a COD removal efficiency of 80.64%, a BOD removal efficiency of 70.91%, a nitrate removal efficiency of 78.08%, and a phosphate removal efficiency of 62.73% in wastewater. Up to the 15th day, P. aeruginosa was able to effectively remove 70.97 percent of COD, 89.21 percent of BOD, 70.3 percent of nitrate, and 81.3 percent of phosphate from the wastewater. Examples of biological treatment procedures used to reduce pH, biochemical oxygen demand (BOD), and chemical oxygen demand (COD) in wastewater include activated sludge, lagoons, anaerobic processes, and microbacterial photosynthesis (Goel, 2006).

## 5. Conclusions

Some trace elements can interfere with bacterial metabolic processes. For example, heavy metals like mercury, lead, and cadmium can disrupt enzyme activity and other cellular functions. This can lead to reduced growth rates, altered energy metabolism, and impaired physiological functions in bacteria. Trace element contamination can induce stress responses in bacteria. In some cases, this stress can lead to increased mutation rates and the development of antibiotic resistance. Bacteria may also activate detoxification mechanisms to cope with trace element stress, which could impact their interactions with other organisms and the environment. Bacteria can accumulate trace elements from their surroundings, and this accumulation can continue up the food chain as organisms consume bacteria and each other

Results showed that the pace at which H. pseudoflava and P. aeruginosa grew in the wastewater directly correlated with the rate at which certain contaminants or nutrients were removed from the water. The highest results for nitrate and COD removal were found for H. pseudoflava, whereas the best results for BOD and phosphate reduction were found for P. aeruginosa. H. pseudoflava and P. aeruginosa can grow quickly and remove a lot of nutrients from wastewater, they are frequently employed for this purpose. Thus, it was determined that H. pseudoflava and P. aeruginosa wastewater treatment is an efficient and ecologically friendly choice Used in wastewater remediation, it not only recovers important nutrients but also improves water quality. These results indicate that H. pseudo flava and P. aeruginosa are both effective nutrient removers in laboratory settings.

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