Journal of Advances in Science and Technology
Vol. 21, Issue No. 1, March-2024, ISSN 2230-9659

DOI: https://doi.org/10.29070/qmhkdj03

Studies of Wastewater Management through Microbiology of Constructed Wetland

Sunny Pathak [1] * , Dr. Bhagawatilal Jagetiya [2]

1. Research Scholar,Department of Botany, MLV Govt College, Bhilwara, MDS University, Ajmer, Rajasthan, India

sunnypathak2k5us@gmail.com ,

2. Associate Professor, Department of Botany, MLV Govt. College, Bhilwara, MDS University, Ajmer, Rajasthan, India

Abstract: Constructed wetlands are distinguished by certain environmental factors that let many physical and biological processes to occur simultaneously. This is the outcome of a particular habitat that supports the development of microbes and hydrophytes, which are plants that can live in aquatic and semiaquatic environments and are capable of anaerobic, anaerobic, and aerobic environments. Their combined activity amplifies the processes of oxidation and reduction, which are in charge of eliminating and holding onto contaminants. Sorption, sedimentation, and absorption all aid in these processes. Treatment wetland systems have been employed in community management for more than 50 years because of these benefits. Constructed wetlands are becoming more and more popular for treating or pre-treating many kinds of industrial wastewater because of their benefits, cheap operating costs, and high removal efficiency. The paper examines how these facilities are being used worldwide to treat industrial wastewater. With a focus on particular and distinctive pollutants from industries, the conditions of usage and efficacy of pollutants removal from wastewater that degrades quickly and slowly were described. The article addressed the use of subsurface horizontal flow beds for the treatment of wastewater from various industrial processes, including the manufacturing of paper, oil, and coffee, as well as the food sector, which includes wineries and distilleries. Constructed wetlands are used in Poland to treat wastewater and milk processing sludge on a pilot size or to dewater sewage sludge generated in municipal wastewater treatment plants that handle household sewage with around 40% of wastewater from the dairy and fish industries. Constructed wetlands provide the so-called ecosystem function in addition to an adequate degree of treatment in every instance.

Keywords: Biological, Municipal, wastewater, Manufacturing, wetlands, Sedimentation

---------------------------X---------------------------

INTRODUCTION

Helophytes, substrate (soil, sand, or gravel), microbes, and natural processes in shallow (typically less than 1 m deep) beds or channels improve wastewater quality in constructed wetlands (CWs), which are simple and affordable wastewater treatment systems. Contaminants from various wastewaters, such as metals, organic and inorganic debris, harmful chemicals, and pathogens, may be reduced using CWs. Numerous treatment processes, including as biosequestration, chemical precipitation, filtration, adsorption, microbial interactions, helophyte absorption or transformation, are used to reduce or remove pollutants. These are all complex, simultaneous processes that are hard to comprehend. The helophytes that comprise the base of the CW food chain, converting inorganic substances into organic molecules, are aided in their development by incoming nutrients. Microorganisms are essential to the biochemical transformation of pollutants, and studies have shown that they may also remove harmful organic chemicals that have been introduced to wetlands. Comparing CWs to conventional wastewater treatment systems reveals that they are less costly and need less maintenance. These technologies also seem more aesthetically pleasing than conventional wastewater treatment systems. The CWs are separated into two categories based on how wastewater flows through them: first in surface flow (SF) wetlands, when wastewater moves horizontally across the substrate of the wetland, it is also called free water surface flow wetlands. The second kind of SF CWs, sub-surface flow (SSF), makes use of a variety of submerged and floating plants to treat wastewater as it flows horizontally or vertically over a porous substrate, such as soil, gravel, or rock. An assortment of plant species, including common reed, cattail, bulrush, and canna indica, are often used in SSF CWs. The kind of pollution, the wetland's layout, the hydraulic loading rate (HLR), the interactions between microbes, and climate all have a major role in how well these systems handle waste. These systems need a lengthy hydraulic retention period and a low hydraulic loading rate for optimal treatment effectiveness.

These systems have been built during to improve during the last many decades quality of wastewaters that come from various sources. Agricultural wastewaters, acid mine drainage, urban stormwater, landfill leachate, household wastewaters, and industrial wastewaters from tanneries, food processing, paper and pulp, and the petrochemical sector are all treated using CWs. From various kinds of home and industrial wastewaters, both surface flow and sub-surface flow systems may remove nitrogen, phosphate, suspended sediments, metals, and pathogens. They can also reduce chemical and biochemical oxygen demands. Depending on the system type, the nitrogen removal effectiveness in CWs varies from 25 to 85%. CW was filtered to remove lead, zinc, cadmium, and silver. According to reports, the removal efficiency was 75–99.7% for zinc, 26% for lead, 75.9% silver, and 66.7%, for cadmium. A 150 m^2 Iran conducted tests on SSF CW to cleanse domestic wastewater. The COD, BOD, TSS, N, P, and faecal coliform bacteria removal efficiencies were 86%, 90%, 89%, 34%, 56%, and 99%, respectively, when an organic input of 200 kg/ha/day was used. There are a number of dangerous chemicals in the effluent of the pulp and paper sector that have the potential to negatively affect the environment if they are directly dumped into receiving waterways. Chlorinated organic compounds, such as furans (TCDF), tetrachlorodibenzo-p-dioxins (TCDD), di, tri, and tetra chlorophenols, and chloroguaiacols, are some of the substances that are known to cause toxicity. It has been noted that the CW systems can readily break down these hazardous organic chemicals to satisfy ever-tougher discharge limitations. The efficacy of subsurface flow-built wetlands in treating the effluent from pulp and paper mills was evaluated by Choudhary et al. (2010).

India is a tropical nation with a wealth of groundwater resources confirmed by its many alluvial basins and 113 rivers. Despite this, water scarcity as a result of human activity is driving up demand for water for agriculture as well as residential and commercial usage. As far as international environmental protection is concerned, urbanization has been a major threat. A difficult requirement for improving human health is the supply of adequate water and sanitation. Wastewater management methods in emerging metropolitan centers are lacking. The eutrophication of aquatic bodies is the primary source of the increased mortality and morbidity caused by the disposal of untreated wastewater, which is a major concern in and of itself. Sustainable water usage is crucial for managing residential wastewater. Effective wastewater management also requires a planned disposal strategy due to the peculiarities of wastewater. The pollution of freshwater bodies is accelerated by the constant buildup of human waste and untreated wastewater. Environmental and human health has been negatively impacted as a result. Standard treatment capacity in India is 5900 MLD for household wastewater and 8000 MLD for industrial wastewater; however, the amount of wastewater produced by urban areas is 22,900 MLD for wastewater from homes and 13,500 MLD from businesses, respectively. The removal of harmful organic and inorganic compounds is not possible using conventional methods for treating residential wastewater. Domestic wastewater's high nitrogen, phosphorus, total suspended material, and organic matter concentrations are the primary causes of widespread eutrophication and water loss due to recreational and industrial uses.

The Microbiome of Wastewater Treatment Facilities

Certainly, insights into wastewater treatment will be provided by the revelation of the many and diverse microbial populations. In this context, a wide range of biological methods and techniques are employed to thoroughly assess the microbial community in wastewater treatment plants. These include terminal-restriction fragment length polymorphism, 16S rRNA gene clone libraries, denaturing gradient gel electrophoresis, and fluorescence in situ hybridization studies. It is believed that the culturing method is an effective and straightforward way to characterise microbial communities. Although synthetic media cannot be used to cultivate the majority of bacteria found in natural environments, molecular based approaches are crucial.

Phylum Bacillus is used in municipal wastewater treatment facilities. Betaproteobacteria, the most numerous classes of proteobacteria, is engaged in organic and nutrient removal and has emerged as the most common phylum (21–62%). The subdominant phyla include Acidobacteria, Bacteroidetes, and Chloroflex. In a recent study, Meerbergen et al. used the pyrosequencing technique to compare the bacterial populations of wastewater treatment facilities for textiles and those of wastewater treatment facilities for municipalities. The goal was to identify the microbes that were most effective in purifying textile wastewater. There were a lot more nitrifying and denitrifying bacteria and phosphate-accumulating bacteria in the effluent from textile plants, according to their research, but essentially no sulfur-reducing bacteria. An illuminate throughput sequencing technology was used to try to find microbial coal-mine water treatment systems. The investigation identified the following genera as being prevalent: Nitrospira, Comamonas, Thiobacillus, Azoarcus, Nitrosomonas, Ohtaekwangia, Thauera, and Pseudomonas. The towns in this area were drastically different from the ones in the municipal sludge. An efficient method for treating wastewater from coal mines may be developed with the use of knowledge about the microbial populations found in coal wastewater treatment plants.

LITERATURE REVIEW

Anil, A & Sumavalli, K & Charan, S (2023) Wetland systems that are designed and maintained and that are gaining popularity worldwide for the treatment and reclamation of wastewater. Constructed wetlands offer a lot of promise for use in small communities since they are less costly, simpler to maintain, and easier to run than traditional wastewater treatment facilities. In the last several decades, constructed wetlands have grown dramatically for the purpose of treating wastewater. Constructed wetlands are an environmentally favorable way to treat wastewater from industry, agriculture, and municipalities that can be economically, ecologically, and effectively done. Getting rid of things like biological debris and suspended particles is greatly aided by built-up wetlands; however, nitrogen removal is only somewhat successful. This might be changed by combining various built-up wetlands that adhere to irrigation reuse regulations. In most cases, unless specific media with a high sorption capacity are used, the elimination of phosphorus is low. It is difficult to remove pathogens from wetland effluent to satisfy irrigation reuse requirements unless more lagoons or systems of mixed wetland vegetation are used. In this paper, we examine and talk about many urban wetland case studies in India, including systems that include the building and restoration of habitats as well as artificial and natural wetlands.

Taha, Duaa & Faisal, Ayad (2023) Recycling wastewater for non-potable applications has drawn a lot of interest in an effort to lessen the strain on freshwater supplies. In order to do this, natural municipal wastewater treatment must be done sustainably rather than utilizing traditional technologies, particularly in arid and semi-arid rural regions. Constructed wetlands (CWs) are a promising approach that has been employed widely in most nations worldwide over the past several decades to meet the goal of wastewater reuse. The description, categorization, and constituents of CWs are reviewed in great detail in this paper, which also identifies the processes governing the elimination process within these units. Different kinds of wastewater from individual homes, trash disposal facilities, oil refineries, agricultural operations, and tannery effluent were treated using vertical, horizontal, and hybrid CWs.

Waly, Marwa & Ahmed, Taha & Abunada, Ziyad (2022) Unconventional water sources are driving the need for more eco-friendly wastewater treatment technologies. There is some evidence that constructed wetland systems (CW) may be a successful and cost-efficient remediation option. By modifying various design elements, CWS has the potential to treat a broad spectrum of contaminants using natural processes and minimum energy. Both vertical flow (VF) and horizontal flow (CW) are possible in man-made wetlands (HF). Both designs have a track record of satisfactory wastewater treatment efficiency and have seen extensive application in both pilot and large-scale trials. This study takes a look at the current advancements in CW technology, as well as its important improvements and practical usage for wastewater treatment at various locations. Using customised CW systems with variable treatment rates for various pollutants leads to a considerable improvement in removal efficiency, as shown in the research. A number of variables influence treatment efficiency, including wastewater type, scale dimensions, applied plant, and retention length. The findings of comparing the treatment efficiencies of VF and HF revealed that the two settings achieved differing rates of BOD, COD, TSS, TN, TP, and NH_4 elimination. The VF example achieved a considerably higher removal efficiency (77% vs. 68%) than the HF instance. Both systems attained an average treatment level. The research shows that the CW is an effective and environmentally friendly way to clean wastewater. The microbial biofilm, configuration, starting influent level, detention time, plant species, and initial influent level are the most critical elements that directly impact removal rates.

Vymazal, Jan & Zhao, Yaqian & Mander, Ülo (2021) Based on a study of over 710 scholarly articles published in 2019 and 2020 so far that were indexed by Web of Science has indexed using the keyword "constructed wetlands for wastewater treatment," this review paper was produced. 132 of these articles address "new" subjects, including the utilization of vegetation, floating treatment wetlands, novel filtering materials, wastewaters treated in CWs, microbiology, CWs' impact on the environment, CWs' impact on sustainability, and CWs' ancillary benefits. The provided supporting literature from earlier eras allows for a deeper investigation. The data shows that CWs are becoming more and more popular, and their jobs are becoming more varied. This demonstrates the necessity for further investigation into the features and processes of CWs connected to design. Long-term studies and full-scale CW research rather rare, and full-scale fieldwork is also required to enhance CW technology.

Hassan, Ikrema & Chowdhury, Saidur (2021) Constructed wetlands (CW) are an eco-friendly method of eliminating contaminants from wastewater. It has been used for acid mine drainage, agricultural runoff, municipal wastewater, and wastewater from petroleum refineries. In the last ten years, the rapidly expanding discipline of microbiology has seen an astounding number of discoveries. Different types of CW, contaminants and their removal processes, degradation routes, challenges and opportunities, materials, applications, theory, and recent advances over the last 30 years are all thoroughly examined in this paper. Furthermore, an attempt has been made to foretell future advancements in the field by outlining significant open-ended problems in CW. Key design components are standardized to provide guidelines for the rapidly expanding area of computational welding. To help the rapidly expanding CW community come together, this assessment evaluates the cutting-edge current work in CW offers terminology for performance metrics and definitions. It also offers a forecast for the new CW trends and suggests avenues for further study and advancement.

WASTEWATER TREATMENT USING CONSTRUCTED WETLAND

Over the last ten years, there has been a rise in environmental consciousness, and addressing environmental degradation and contamination has taken center stage in the agendas of concerned international governmental organizations. Generally, choosing the right environmental remediation strategy for a deteriorating process involves considering both the efficiency of the process and the cost of the procedure certain kind of waste. More significantly, since certain remediation techniques produce daughter products from the course of deterioration that do greater damage than the original pollution did, the environmental effect of the chosen approach is very crucial. Researchers and scientists agree that there isn't a single remediation technique that works for every kind of contamination and every source; rather, a successful remediation program may include two or more techniques. Nowadays, environmentalists are drawn to wetlands as one of the efficient remediation techniques for treating wastewater pollution. Natural wetlands allow Mother Nature to filter pollutants out of water supplies by means of sorption, phytostabilization, phytoextraction, biodegradation, and rhizofiltration, among other natural processes. Built wetlands are designed to replicate the ways in which pollutants in wastewater are naturally removed or broken down. Wetlands may be used to treat several types of polluted wastewater, such as municipal wastewater, industrial wastewater (especially from sour-water treatment and petroleum refineries), agricultural garbage, runoff, effluent from textiles, landfill gas, drainage from mines, and so forth. Constructed wetlands are an ecologically benign restoration solution with no negative environmental effect since they employ natural processes to break down contaminants. CW is made to handle wastewater from various sources in a manner similar to those of conventional effluent treatment facilities.

In general, soil saturation that lasts enough for the onset of anaerobic conditions defines wetlands. Wetlands come in several varieties, such as artificial wetlands and natural wetlands that include both fresh and salt water. Preserves created for the purpose of remediating toxins include intricate, all-encompassing processes involving soil, water, plants, animals, microbes, and the environment. Several remediation techniques, including as biodegradation, phytoremediation, and natural attenuation, were used in constructed wetlands. Physical tasks such as filtering and sedimentation, chemical procedures such as adsorption and precipitation, and biological procedures such as plant assimilation and biodegradation are the primary processes that take place in wetlands.

Vascular plant density is a defining characteristic of most wetlands. In addition to slowing down water flow and forming microenvironments, high-density vegetation also offers sorption sites for contaminants and microbial attachment sites. When plants wilt and drop into water, the parts above ground provide additional sorption and exchange sites. In addition, microbes may use the organic carbon and phosphorus and nitrogen found in plant waste as building blocks in their metabolism. Soil saturation causes oxygen concentrations in wetlands to be relatively low. Therefore, only vascular plant species that can thrive in environments with low oxygen levels concentrations may be found in wetlands.

In the process of contaminant degradation and contamination shift in the relationship between the plant and its surroundings, microorganisms are crucial players. The degradation and transformation activities of contaminants are often carried out by a microbial consortium. Every microbe has a unique degrading route by which it may break down a particular pollutant. The presence of microorganisms necessary as well as the appropriate environmental factors for the degrading process are essential for the successful degradation of contaminants.

Wastewater treatment via constructed wetlands has been used worldwide. For instance, CWs have been in use throughout Europe since the late 20th century, with Germany serving as an early adopter. The United Kingdom, Austria, Slovenia, Switzerland, and Denmark are among the many additional countries have CWs. Some African countries have been using CWs, including as South Africa, Tanzania, Kenya, and the Seychelles. Subsurface CWs in Africa treat wastewater for roughly $5 per person, whereas mechanical wastewater treatment (i.e., activated sludge systems) costs about US $50 per person, according to some sources. A recent study found that the whole cost of wastewater treatment—including sludge disposal, operation, and maintenance—was ranges from €0.30 to €0.88 per m3. There are almost 400 CWs in China.

Shallow water depth and very sluggish water flow are characteristics of constructed wetlands. Long retention times produced by sluggish water flow help sediment settle and extend the amount of time that wastewater and wetland components are in touch. As a result, selecting an appropriate flow velocity during design is essential to giving microorganisms enough time to break down the pollutants. The elements of the artificial wetland have an impact on the processes of deterioration. For example, the bioavailability and degradation process are controlled by the quantity of sorption sites in the substrate and the soil. There are two schools of thought when it comes to bioavailability. Some scientists think that pollutants do not need to be desorbed in order for bacteria to break them down. However, other scientists think that before bacteria can break down pollutants, they must first be desorbed. Certain bacterial strains could produce biosurfactants, which help to speed up the desorption process. Thus, an effective treatment strategy for artificial wetlands depends on a knowledge of the capacities of the available microorganism consortia.

Wetland Treatment Systems

Generally speaking, a variety of it is possible to classify man-made wetlands according to hydrology (surface and subsurface flow), macrophyte type (free-floating, emergent, and submerged), and flow direction (horizontal or vertical). A number of types of man-made wetlands exist; they include hybrid systems that include elements of both surface and subsurface flow wetlands, as well as SF and SSF wetlands. Throughout the several phases that make up the hybrid system, therapy is administered in several units intended to fulfil distinct roles. For wastewater treatment, for example, some units are made for anaerobic circumstances, while others are made to encourage aerobic reactions. Aerated CW refers to a wetland that has an air pump attached to it that connected to a subterranean network of air distribution pipes. In wetlands with horizontal flow (HF) or vertical flow (VF) types, the air pump's introduction of air bubbles may accelerate the rate at which oxygen is transferred, therefore establishing aerobic conditions. With the predicted oxygen consumption rate in CW might be 250 g of $O^2/m^2/d$, given an air flow rate of ≥ 0.6 $m^3/m^2/h$ and a distribution of 30 cm × 30 cm. Wetlands that are mechanically aerated have the capacity to transmit oxygen at levels above 1 $m^3/m^2/h$. The oxygen-rich marsh offers superior subsurface and plant biogeochemical conditions, as well as increased capacity for nitrification and denitrification.

MATERIALS AND METHODS

Experimental set-up

For the purpose of control, one VFCW was built using plastic containers and planted with Typha augustifolia, whereas the other was built without plantings. As seen in Figure 1, their overall dimensions were 29 cm in diameter and 40 cm in height, with a total capacity of 25 liters. Two beds were used, each with 15 cm of gravel and sand. Table 1 provides a full description of the two VFCW beds.

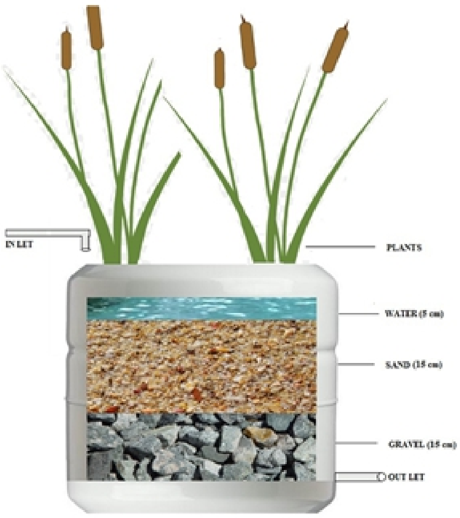

Figure 1. Schematic diagram of the vertical flow constructed wetlands (VFCW) systems for domestic wastewater treatment

Table 1. Characteristics of VFCW constructed wetland design, physical and

Plants	
Method	Plug flow
Design flow	Vertical

Operation mode	Batch
Depth (m)	0.4
Diameter (m)	0.29
Volume of the reactor (m^3)	0.0264
Volume of the bed (l)	26.4
Substrate	
Gravel	15 cm
Sand	15 cm
Outlet PVC pipe	15 mm
Hydraulics Retention Time (HRT)	12,24, 36 Hours
Water level	5 cm
Plants (Cattail)	*Typha augustifolia*

Sample collection

After a 6-hour period of gravity settling in a sedimentation tank, 20 liters of clear supernatant wastewater was delivered to the newly-constructed wetland from the raw household wastewater collected from the Bharathidasan University postgraduate dormitory. Hydraulic retention periods ranging from 12 to 36 hours were used to remediate the effluent. The trial ran from August 2008 to January 2009, a total of six months.

The Species composition of bacteria found at various stages of treated and untreated Wastewater

The research details the examinations of the microbiological make-up of wastewater collected from two biological treatment facilities: one at a rest stop along the highway, which uses a tank with a submerged biofilter, and another at a city plant, which employs a hybrid circulation-flow reactor and a hydroponic lagoon as its third stage of treatment.

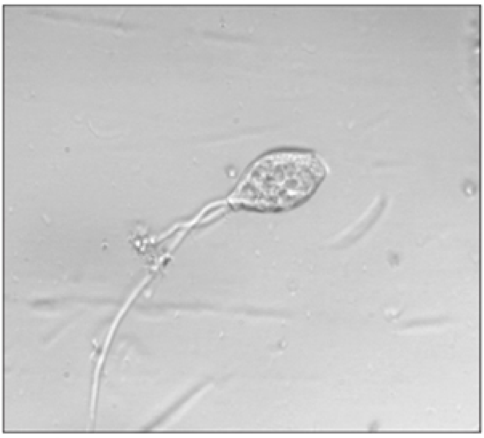

Figure 2. Ciliate of the Vorticella genus

Figure 3. Infestation of nematodes by activated sludge floc

A two-chamber septic tank and a chamber with a submerged biofilter make up the wastewater treatment plants at the rest area located in India. The septic tank uses two processes: sedimentation, which involves the production of sediments, and flotation, which involves the development of scum, to mechanically re-move suspensions from sewage.

Statistical analysis

The SPSS 16.0 statistical package was used for the analysis. Each parameter's clearance rate was determined by taking the mean effluent values from each batch sampled over the course of a month. A one-way analysis of variance (Tukey's method) was conducted at a significance threshold of to examine the amount of association between the HRT and the removal % statistical test $P < 0.05$.

RESULTS AND DISCUSSIONS

Characteristics of raw and influent domestic wastewater

Table 2 displays the parameters of the raw domestic wastewater from the Bharathidasan University postgraduate dormitory as well as the pretreated water/influent (6-hours settled effluent before it was used in the VFCWs). To reduce the likelihood of system blockage, the influent has properties typical of household wastewater that has undergone primary treatment.

Table 2. Characteristics of raw and influent domestic wastewater

Parameter	Raw Mean ± SD	Influent Mean ± SD	WHO	BIS (1993)
pH	8.04 ± 0.069	7.84 ± 0.049	6.5 – 9.2	6.5 – 8.5
EC (dS/m)	1.92 ± 0.10	1.78 ± 0.13	-	-
Turbidity (NTU)	24.79 ± 1.61	16.80 ± 1.99	-	-
TDS (mg/l)	587.95 ± 28.50	463.01 ± 14.16	1000	500
DO (mg/l)	1.01 ± 0.15	1.73 ± 0.16	-	6
BOD5 (mg/l)	173.63 ± 10.20	143.01 ± 6.54	-	-
COD (mg/l)	396.14 ± 12.51	360.12 ± 11.37	-	250
Phosphate (mg/l)	17.63 ±1.67	20.90 ± 2.74	5	-
Nitrate (mg/l)	86.74 ± 6.57	74.52 ±4.94	50	-

As a consequence of the detergent that the prisoners use, the pH and electrical conductivity of the raw and influent household wastewater were found to be 8.04 and 7.84, and 1.92 and 1.78 dS/m, respectively (Table 2), indicating that it is somewhat alkaline in nature. Input household wastewater had a turbidity of 16.80 NTU and total dissolved solids of 463.01 mg/l, whereas raw wastewater had a turbidity of 24.79 NTU and a total dissolved solids concentration of 587.95 mg/l. The influent water had a COD content of 360.12 mg/l and a BOD5 level of 173.62 mg/l, whereas the raw residential wastewater had a COD content of 396.14 mg/l. The phosphate and nitrate levels in the raw and influent household samples were found to be 17.93 and 86.74 mg/l, respectively, while the levels in the influent sample were 20.90 and 74.52 mg/l. The physicochemical characteristics of the effluent from homes were found to be greater than the allowable limit.

All indicators, with the exception of phosphate and DO, showed a small decrease after pretreatment (six hours of settling) of the raw residential wastewater. Diluting wastewater by precipitation during the settling phase might account for the discrepancy in the decrease of pH, EC, turbidity, TDS, BOD5, COD, and nitrate. Korkusuz et al. (2004) explains that long-chained polyphosphates may be converted to shortchained polyphosphates during the sedimentation phase, which might explain why the influent water has a higher phosphate (PO4) concentration.

Determination of bacterial growth and biodegradation using a single Strain

We measured the cell growth and biodegradation of TOC in synthetic wastewater samples to track the capacity of a single bacterial strain to remediate the wastewater. Initial optical densities (OD600) of bacteria ranged from 0.037 to 0.056 after inoculation with 10 ml of active strain in all 120 ml samples with 220 mg/l TOC. The OD600 and TOC were measured after every 2 hours of sample withdrawal. Figure 5 shows the concentration of residual TOC, whereas Figure 4 shows the development of bacteria. All of the local bacteria required more time to reach stationary phase than the Sludge Hammer bacteria, as seen by the growth phase patterns. Using the growth kinetic parameters, which are shown in Table 3, we were able to assess how well each strain degraded TOC.

Table 3. The growth kinetic parameters

Parameters	*B. agri*	*B. Subtilis*	*B.Later-osponus*	*B. spp*	*P.Putida*	*P.aeruginosa*	S-Hammer
T_{lag}(h)	2	2.5	1	4	2	1	1
$L_{initial}$	0.044	0.04	0.056	0.052	0.049	0.037	0.043
L_{max}	0.074	0.08	0.091	0.063	0.095	0.077	0.12
Ts (h)	14	12.5	14	12	12	10.5	7
μ_{max} (h-1)	0.063	0.139	0.046	0.026	0.095	0.098	0.286
r_{max} (%)	36.57	54.37	52.34	32.41	25.88	42.57	71.25
q_{max} mgTOC/(d-mgVSS)	0.423	0.021	0.393	0.026	0.522	0.590	1.489

The TOC breakdown capacity was comparatively greater in B. subtilis (54%), B. laterosponus (52%), and P. aeruginosa (43%), out of the six natural strains. Nevertheless, Pseudomonas aeruginosa exhibited a somewhat longer half-life (10 hours) and a slightly higher qmax (0.59 mgTOC/(d-mgVSS). Based on these findings, Pseudomonas aeruginosa stood up as the best strain for breaking down the synthetic wastewater's organic substrate, glucose. In contrast to the SludgeHammer bacteria, the native local strains degraded much less (20-40% less). Based on the kinetic characteristics shown in Table 3, this particular bacterium exhibited the highest qmax (1.5 mgTOC/(d-mgVSS)), the shortest Tlag (<2h), and the biggest rmax (71%). By manipulating these settings, the "SludgeHammer" is hypnotised into enhancing the treatment performance of municipal wastewater.

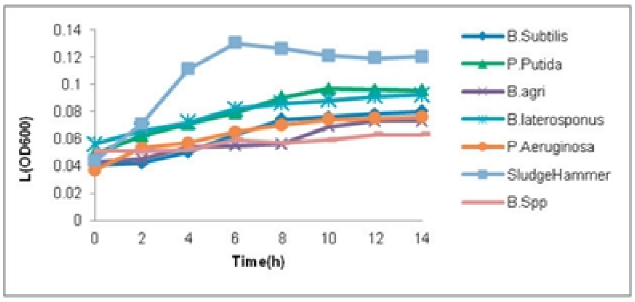

Figure 4. Cell growth of each bacterial strain in synthetic wastewater

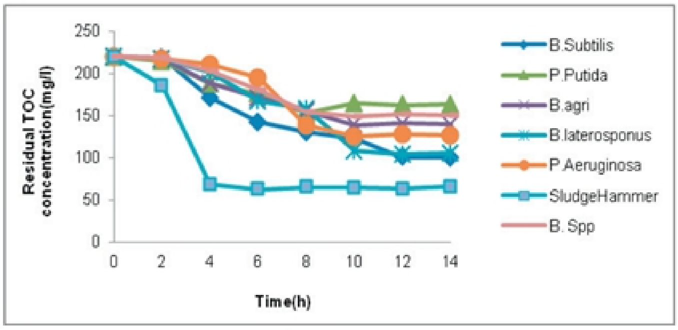

Figure 5. Biodegradation of synthetic wastewater by each bacterial strain

CONCLUSION

We can say that CWs may be a useful component of treatment since household and municipal wastewater have a low pollutant burden. For organic pollutants, nutrients (nitrogen and phosphorus), and harmful microbes, CW has excellent removal efficiency. CWs are also an excellent treatment for heavy metals and highly hazardous pollutants found in industrial wastewaters. Numerous researches have documented the elimination of toxic heavy metals using CWs, including lead, cadmium, iron, mercury, arsenic, copper, chromium, zinc, nickels, silver, and manganese. Comparing CWs to traditional wastewater treatment systems, there are several benefits. CWs provide an affordable, low-tech, low-cost, and highly energy-saving treatment method. CWs have potential for efficiently treating industrial wastewaters that pose treatment challenges, in addition to home and municipal wastewaters. Wetland systems may also lessen the number of waterborne infections. CWs are natural resource treatment systems that are beneficial to the public's health and the environment. According to Quant B. et al., there are still 104–106 faecal-type E. coli bacteria on the outflow, even though the bacterial elimination effectiveness of wastewater treatment operations is above 99%. The number of microbes that are deemed hazardous or dangerous is directly related to the treatment method that is being used. It is not mandatory to cleanse sewage in India. Hospitals, clinics, and labs are the only types of establishments that are required to prove that they disinfect their wastewater in addition to other treatment procedures. Regrettably, it fails to anticipate a clear need to disinfect wastewater prior to its release into the environment.

References

1. Anil, A & Sumavalli, K & Charan, S & Mounika, M & Praveen, P & Gayathri, A & Ganesh, V. (2023). Constructed Wetland for Low- Cost Waste Water Treatment. International Journal of Scientific Research in Science, Engineering and Technology. 328-334. 10.32628/IJSRSET2310247.

2. Taha, Duaa & Faisal, Ayad. (2023). Using of Constructed Wetlands in The Treatment of Wastewater: A Review for Operation and Performance: Review for Using of Constructed Wetlands in The Treatment of Wastewater: Operation and Performance. Journal of Engineering. 29. 169-188. 10.31026/j.eng.2023.07.11.

3. Waly, Marwa & Ahmed, Taha & Abunada, Ziyad & Mickovski, Slobodan & Thomson, Craig. (2022). Constructed Wetland for Sustainable and Low-Cost Wastewater Treatment: Review Article. Land. 11.

1388. 10.3390/land11091388.

4. Vymazal, Jan & Zhao, Yaqian & Mander, Ülo. (2021). Recent research challenges in constructed wetlands for wastewater treatment: A review. Ecological Engineering. 169. 106318. 10.1016/j.ecoleng.2021.106318.
5. Hassan, Ikrema & Chowdhury, Saidur & Prihartato, Perdana & Razzak, Shaikh. (2021). Wastewater Treatment Using Constructed Wetland: Current Trends and Future Potential. Processes. 9. 1917. 10.3390/pr9111917.
6. Stefanakis, A.I., Akratos, C.S., & Tsihrintzis, V.A. (2014). Vertical flow constructed wetlands: Ecoengineering systems for wastewater and sludge treatment (1st Ed.). Amsterdam, The Netherlands: Elsevier Publishing.
7. Vymazal, J. (2011). Plants used in constructed wetlands with horizontal subsurface flow: A review. Hydrobiologia, 674, 133–156.
8. Jethva K., Bajpai S., Chaudhari P.K., Swarnakar A.K. (2017). Wastewater nutrient removal through phytoremidiation: a review. 49th Annual Convention of IWWA on "Smart Water Management" January 19-21.
9. Srivastava J, Gupta A, Chandra H. Managing water quality with aquatic macrophytes. Rev Environ Sci Biotechnol. 2008; 7:255–266.
10. Odinga C.A., Swalaha, F. M., Otieno F. A.O., Kumar R. Ranjith, and Bux. F., (2013). Investigating the efficiency of constructed wetlands in the removal of heavy metals and enteric pathogens from wastewater. Environmental Technology Reviews. DOI: https://doi.org/10.1080/21622515.2013.865086.