Treatment of Vertical Blending Commercial Liquid Substances by Natural Recreation Eranthemum Nigrum Biotic System

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Abstract — These One of the most trusted and low maintenance and low in operation costs of wastewater treatment is the setup of and operation of a Vertical Flow Constructed Wetland. These wetlands systems have a very good ability to handle the sudden increase in the amount of domestic wastewater and sudden increase in a load of various contents of the wastewater. The plant here used in this wetland setup is Eranthemum Nigrum. The plant was specifically chosen for its growth of roots and development of rootzone in the soil providing more contact area and substrate for the microorganisms for their processing and playing an important role in the treatment of wastewater. A constructed wetland unit of capacity 20 litres was constructed to treat the domestic wastewater with COD and BOD values of 544 and 270 mg/L respectively. The wetland media consisted of soil and a fine aggregate bed. The bed is filled to a height of 15cm with soil of size 2 µm. The soil used for the growth of plants is laterite soil for a depth of 15cm. and fine aggregate depth is 5cm, size 300 µm. The plant used in this treatment is Eranthemum Nigrum. About 40 Eranthemum Nigrum of an average size of 30 cm are used in the constructed wetland. From the test reports, it was observed that all the pollutants were reduced to 50-80%. The highest BOD and COD removal occurred at the retention time of 6 days. The Eranthemum Nigrum plant showed good efficiency. The average removal of TDS, Nitrate, and Phosphate for a retention time of 1, 2, 4, and 6 days was 60%, 75%, 80 and 90% respectively. The treated water can be used safely for household works and irrigation purposes as the test results were within the IS standard limits. There was an increase in the height of the plant about 2-3cm averaging from the actual height. Hence the overall removal efficiency of plant Eranthemum Nigrum was proved to give better efficiency compared to conventional plants. This method can be used for small-scale domestic wastewater.

Keywords: Eutrophication, Eranthemum Nigrum, Aerators, Phytochemical and Physicochemical Analysis

I. INTRODUCTION

In this study, we focused on exploring the properties of Eranthemum nigrum, a commonly found plant in India belonging to the Acanthaceae family. This family comprises almost 4000 species of exotic plants with various species of the Eranthemum genus being traditionally used for ethnomedicinal purposes and treatment of toxic elements present in wastewater. Eranthemum genus has around 138 species, some of which include E. austrosinensis, E. burmanicum, E. capense, E. ciliatum, E. erythrochilum, E. griffithii, E. macrophyllum, E. macrostachyus, E. obovatum, E. pulchellum, E. purpurascens, E. roseum, E. strictum, E. tapingense, E. tubiflorum and E. watti. Eranthemum nigrum is native to the Pacific Islands and as well plant is situated near the riverside or seaside which is a shrub that grows to a height of 1.5 - 1.8 m. Its leaves have a blackish-purple upper surface and a purplish lower surface with dark veins. The flowers are in erect terminal spikes, white and spotted rose at the base. The plant thrives in partial shade and has elliptical, glossy, or dull leaves with smooth margins and acute tips. All parts of the plant are widely used as a folklore medicine for treating various ailments by traditional healers in India.

The Eranthemum genus has been documented to have various pharmacological activities, including antipyretic, antidiabetic, antiulcer, antimicrobial, and anti-inflammatory properties. It has also been found to have larvicidal, ovicidal, and pupicidal effects against Anopheles stephensi and gastroprotective effects. A literature study and screening of scientific data suggest that many native medicines have properties that can be beneficial for health. To analyze the pharmacognostic characteristics and physiochemical parameters of the leaves of Eranthemum nigrum (E. nigrum). The Microscopic characters and powder analysis had been carried out with the help of a microscope. The physicochemical properties such as loss on drying, total ash value, acid insoluble ash value, water soluble ash value, extractive values, and fluorescence of E. nigrum had been performed. Macroscopically, the leaves are simple, elliptical in shape, dull with smooth margins and acute apex. Microscopically, the leaf showed the presence of epidermal cells with uniseriate multicellular covering trichomes and diacytic stomata. Powder microscopy of the leaf revealed the presence of uniseriate multicellular covering trichomes, lignified xylem vessels, epidermis with diacytic stomata, and parenchyma cells. The investigations also included leaf surface data i.e., quantitative leaf microscopy and fluorescence analysis. Physiochemical parameters such as loss on drying, extractive values, and ash values were also determined. Preliminary phytochemical screening showed the presence of steroids, alkaloids, tannins, saponins, carbohydrates, glycosides, amino acids, and proteins.The morphological, microscopical, and physicochemical parameter results provided in this paper may be utilized as a basis for the preparation of a monograph on E. nigrum leaves.

II. MATERIALS

Throughout our research, we gathered an array of materials that were essential to its successful completion to take a test on a sample of untreated water. Some of the key components included a study 20-litre transparent vertical can, which served as the foundation for our design. In addition, we utilized a wooden scale to support the lighting arrangement, a hexa blade for precision cutting of the can's top, and a drilling machine to create a perfectly sized tap hole. To ensure that all measurements were accurate and exact, we relied on a height measuring tool (Scale).

Other materials that played an important role in our project are sieves for sieving soil and sand, mesh to filter water between layers, aesthetically pleasing washed pebbles for added texture and style, washed coarse aggregates to provide a solid base, sieved fine aggregates and laterite soil for optimal drainage, and an artificial lighting system to simulate optimum temperature. Finally, to bring our design to life, we included an eranthemum nigrum plant that served as the centerpiece of our creation.

III. Methodology

The research began with a detailed plan for creating a self-sustaining ecosystem in a transparent container. We selected a 20-litre transparent vertical can, so we could observe the growth of the plant and the movement of water in the system. We marked the container 5 divisions at each 7 cm interval to measure the height of each layer accurately.

To create the ecosystem, we collected the materials we needed, which included pebbles, coarse aggregate of 2 different grades, fine aggregate (sand), laterite soil, and an Eranthemum Nigrum Plant. We selected these materials carefully to ensure that they were compatible and would provide the nutrients necessary for the plant to grow.

To provide the plant with the necessary light, we set up a bulb that would provide artificial light for the plant when natural light was not available. We also made sure that the container was placed in a location where it would receive the necessary amount of natural light.

We cut the upper portion of the container to create space for planting and pouring materials. We also made a hole to fix the tap, through which the treated water would be released. This tap would help us to collect and reuse water in the system, making it self-sustaining.

For the first layer of the container, which was 7 cm in height, we arranged the pebbles. We chose pebbles because they would provide a stable base for the rest of the layers. Next, we arranged coarse aggregate of larger grade, followed by mesh placed between the larger and smaller grades of coarse aggregate. This mesh would help to prevent the soil from mixing with the aggregate layers.

The next layer was arranged with the smaller grade of coarse aggregate, followed by a mesh placed between the smaller grade of coarse aggregate and fine aggregate (sand). This sand layer would help to retain moisture and provide essential nutrients to the plant.

Finally, we poured the soil and planted the eranthemum nigrum (Black Kodia). We chose this plant because it is known for its ability to grow in different soil types and is resilient in harsh conditions. The model preparation was completed on February 7th, 2024.

In order to conduct the necessary testing, our first step is to establish two stands and secure them firmly into the soil on opposite sides. It is crucial to ensure that the arrangement is stable and does not shift from its original position. Following this, two transparent bottles should be affixed to each stand using binding wire. The first bottle should be gradually filled with a sample of wastewater collected from the municipal source prior to reaching the river. The second bottle should be filled with a sample of treated water used for daily activities, such as tap water. Both bottles should be securely capped after the filling process is completed.

The next step involves acquiring two sterile tubes and creating holes at the lower end of each bottle. Sterile spikes should be inserted into the holes of the bottles, and the lower ends of the tubes should be left in the soil. This will facilitate the necessary testing of the water samples.

A phytoremediation filtration unit is an innovative and sustainable approach to cleaning up the environment that utilizes the natural stabilizers of plants to mitigate contamination of toxins in soil, water, and air. The process begins with a thorough assessment of the contaminated site, identifying the types and concentrations of pollutants present, and evaluating site characteristics such as soil composition and hydrology. Once the site is characterized, suitable plant species are carefully selected based on their ability to tolerate and absorb specific contaminants, known as hyperaccumulators. This plant was acquired from Professor Jayashankar Telangana State Agricultural University, Rajendra Nagar, Hyderabad at Rs. 130. Then strategically planted and established in the contaminated area, where they begin the process of contaminant uptake and transformation. An artificial lighting system is set to room temperature, 28 degrees Celsius above the plant.

Through mechanisms such as phytoextraction, rhizofiltration, phytodegradation, and rhizodegradation, plants absorb pollutants through their roots or leaves and either store, metabolize, or break down the contaminants within their tissues. Regular monitoring of plant health and contaminant levels guides the timing of biomass harvesting, ensuring optimal remediation outcomes. The harvested biomass is handled and disposed of properly to prevent recontamination and minimize environmental impact.

Ongoing maintenance activities, including irrigation, fertilization, and weed control, support the continued growth and effectiveness of the remediation process. Long-term management and restoration efforts focus on sustaining environmental improvements and restoring ecosystem health through revegetation, habitat restoration, and community engagement.

By integrating these components into a holistic approach, phytoremediation offers a cost-effective, environmentally friendly solution to environmental pollution, contributing to preserving and protecting natural ecosystems for future generations.

IV. RESULTS AND ANALYSIS

(Before Pre- Treatment)

STATION	Height of the Plant (in "cm")		pH	Phosphorus	TDS [mg/l]	Temperature in Degree Celsius	DO	BOD	Total Persulf Nitrogen	Turbidity	Conductivity	Alkalinity
IS Limits	Forenoon	Afternoon	6.5 to 7.5	0.08 to 0.10 ppm	500-2000mg/l	27'C to 28'C	6.5-8 mg/L	1 - 2 ppm	10mg/l	1NTU-5NTU	Microsecond/cm 1-1660	200-600mg/l
D-BLOCK	24	24.2	6.1	0.223	2300	26	9.2	3	12	6	30	220
D-BLOCK	24.3	25	5.8	0.32	2200	27	9.3	4.8	12.8	8	30	180
D-BLOCK	25.3	26	4.3	0.322	2900	22	9.2	3.96	13.2	7.2	30	165
D-BLOCK	26.2	26.4	4.8	0.42	2865	27	8.8	4.92	12.6	7.6	30	142
D-BLOCK	26.8	27	4.6	0.28	2365	29	8.9	6.2	11.6	8.1	40	132
193	193	193	193	193	193	193	193	193	193	193	193	193

(Before Pre-Treatment)-Overall Analysis

STATION			pH	Phosphorus	TDS [mg/l]	Temperature in Degree Celsius	DO	BOD	Total Persulf Nitrogen	Turbidity	Conductivity	Alkalinity
IS Limits			6.5 to 7.5	0.08 to 0.10 ppm	500-2000mg/l	27'C to 28'C	6.5-8 mg/L	1 - 2 ppm	10mg/l	1NTU-5NTU	Microsecond/cm 1-1660	200-600mg/l
Overall analysis			36.43	32.43	2137.17	54.00	7.83	35.98	42.53	38.32	58.83	172.00

(After Treatment)

STATION	date	pH	Phosphorus	TDS [mg/l]	Temperature in Degree Celsius	DO	BOD	Total Persulf Nitrogen	Turbidity	Conductivity	Alkalinity
IS Limits		6.5 to 7.5	0.08 to 0.10 ppm	500-2000mg/l	27'C to 28'C	6.5-8 mg/L	1 - 2 ppm	10mg/l	1NTU-5NTU	Microsecond/cm 1-1660	200-600mg/l
D-BLOCK	07-02-2024	7.1	0.086	800	26	6.5	3	8	3	30	235
D-BLOCK	08-02-2024	6.8	0.092	896	27	6.9	4.8	7.6	3	30	242
D-BLOCK	09-02-2024	6.8	0.098	962	22	7.6	3.96	7.8	3	30	256
D-BLOCK	10-02-2024	7.9	0.092	950	27	7.8	4.92	8.2	3	30	325
D-BLOCK	12-02-2024	7.8	0.16	1012	29	8.9	6.2	10.8	4	40	720
D-BLOCK	13-02-2024	7.6	0.2	1080	28	9.3.	5.8	10.9	4.3	40	680

(After Treatment)-Overall Analysis

STATION	date	pH	Phosphorus	TDS [mg/l]	Temperature in Degree Celsius	DO	BOD	Total Persulf Nitrogen	Turbidity	Conductivity	Alkalinity
IS Limits		6.5 to 7.5	0.08 to 0.10 ppm	500-2000mg/l	27'C to 28'C	6.5-8 mg/L	1 - 2 ppm	10mg/l	1NTU-5NTU	Microsecond/cm 1-1660	200-600mg/l
Overall analysis		7.33	0.12	950.00	26.50	7.83	4.78	8.88	3.38	33.33	409.67

Day – 1

Day – 2

Day – 3

Day – 4


Day – 5


Final Set up

V. DISCUSSION

The experiments are carried out for treating commercial wastewater in a Vertical Flow constructed wetland. The characteristics of the samples such as pH, BOD5, COD, Total solids, potassium, Nitrate, phosphate is to be analyzed. Experiments are conducted using plant Eranthemum Nigrum in the constructed wetland system for a Hydraulic retention time of 1, 2, and 4 days loading. Waste water is allowed to stand for the provided retention time so that plant absorbs the nutrients present in the commercial wastewater. The treated water is collected from the constructed wetland in the Cans and taken for the analysis of different parameters in the main laboratory situated at Vidya Jyothi Institute of Technology, Hyderabad.

VI. SCOPE OF THE STUDY

1) Research can be carried out with respect to the type and kinematics of micro- organism involved in the treatment of Food industry wastewater.
2) If properly built, maintained and operated, constructed wetlands can effectively remove many pollutants associated with municipal and industrial wastewater and storm water.
3) Such systems are especially efficient at removing contaminants such as BOD, suspended solids, nitrogen, phosphorus, hydrocarbons, and even metals.
4) A constructed wetland is an organic wastewater treatment system that mimics and improves the effectiveness of the processes that help to purify water similar to naturally occurring wetlands.
5) The effect of temperature variation and agitation on treatment efficiency can be studied.

VII. CONCLUSION

1) Effective solutions for wastewater treatment have been presented through the use of vertical flow constructed wetlands technology, emphasizing the low cost of construction and operation.
2) The application in treating a variety of pollutants produced through several human activities. VFCW facilities are promising technologies that operate smoothly, without problems, and are effective systems for wastewater treatment and management.
3) Eranthemum Nigrum used in the constructed wetland as an aquatic plant has high performance for the treatment of Food Industry wastewater.
4) From the analysis, it was observed that all the pollutants were reduced in the range of 50- 90%. The highest BOD and COD removal occurred at a retention time of 6 days loading. The elephant ear plant showed good efficiency in removing sodium and potassium with a removal efficiency of 70% and 80% respectively.
5) The percentage removal of TDS, Nitrate, and Phosphate for a retention time 1, 2, 4, and 6 days loading were 70%, 80%, 85%, and 90% respectively.
6) The treated water can be used safely for household works and irrigation purposes as the test results were within the IS 10500 2012 standard limits. There was the increase in the height of the plant about 2-3cm averaging from the actual height.

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