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Treatment of the Influent Sewage from Stp Davangere Town from Vertical Flow Artificial Wetland Using Colocasia Esculenta Plant

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Abstract
This document is a template to provide guidance about formatting the research papers which are going to be submitted to the jou An artificial vertical flow constructed wetland (AVCW) system which is a subsurface flow is used in sewage treatment plants (STPs) to treat influent sewage by which is a mixture of organic and inorganic waste, chemicals, microbes, and nutrients. The Colocasia esculenta (elephant ears) plant species is used as the pollution removal test plant for the hydraulic retention time (HRT)of 28 days. The test plant has removed the parameters Total dissolved solids (50%), Total suspended solids (27%), Biological Oxygen Demand (54.30%), Chemical Oxygen Demand (58%), Ammonia- Nitrogen (59.48%) and Ortho- Phosphate (46.99%). pH is reduced and Dissolved Oxygen is increased during the period of 28 days hydraulic retention time (HRT). Treated sample is analyzed with an interval of 7 days during HRT is checked for the various parameters listed above. It shows that C. esculenta is better option for nutrient absorption in the artificial wetland (AW) systems, providing very economical and environmentally friendly method of treating wastewater (WW), especially in the decentralized systems and the results indicate that C. esculenta is viable options for enhancing the WW quality in STP effluent. rnal IJFMR. Authors can get a general idea of formatting and various possible sections in the research paper.

Keywords: Artificial Wetland, Colocasia esculenta, Influent sewage, Vertical subsurface flow, Wetland construction.

1. Introduction
Sewage, also known as WW, is a complex mixture of organic and inorganic materials, water, and pathogens that originates from residential, commercial, and industrial sources. It usually comprises of waste products like cooking oil, leftover food, laundry detergent, and excrement from people. To protect

the environment and public health, sewage needs to be properly managed and treated [1]. Untreated sewage can damage aquatic ecosystems and contaminate water sources, posing serious health hazards. It could also spread infections that are contracted through touch with water. Modern sewage treatment facilities employ a variety of physical, chemical, and biological processes to remove pollutants and produce treated effluent that could be recycled or discharged into the environment safely. To generate a clean water supplies and a healthy environment for next population, sustainable sewage treatment techniques are crucial [2]. Globally speaking, the developing nations that are situated in the world's most populous regions are the ones who are recently formulating and will soon be experiencing water shortages. Furthermore, untreated sewage and manufactural wastes are put into surface waters, degrading the mass and class of the water and contaminating the current water sources. Constructed Wetland (CW) sewage treatment is one of the effective treatment methods that is utilized globally. Wetlands are characterized as areas of land where the water table remains close to the surface for a sufficient amount of time each year to sustain saturated soil conditions and the associated flora. Examples of wetlands that exist naturally are swamps, bogs, and marshes [3]. An area other than naturally occurring wetlands where wetlands are already present is considered a manufactured wetland. It is created expressly to manage waste and reduce pollution. Domestic WW, storm WW, combined sewer overflows (CSF), overland runoff, and industrial wastewater, including landfill leachate and wastewater from petrochemical enterprises, could all be treated in primary, secondary, and tertiary stages using wetlands. Vertical flow (VF CWs) systems are becoming more and more frequent, although horizontal subsurface flow (HF CWs) systems are still the most common type of system design. Strong emergent plant species including bulrush, cattail, and common reed are the most often utilized ones [4].

VFS refers to above-ground buildings or shallow excavations that include a clay or synthetic impermeable liner. They are typified by sporadic (discontinuous) loading and resting times during which the WW percolates vertically through the substrate. Batch loading and intermittent loading improve nitrification by increasing O_2 transport. The primary goal of plants in VFS is to support the bed's continued hydraulic conductivity. To prevent overloading certain areas of the surface, it's critical to choose the filter material, hydraulic loading rate, and water distribution strategy correctly. Because they depend on a properly operating pressure distribution, they are better suited to environments with natural gradients that allow gravity to act as a filter [5]. Flat areas depend on a consistent power source and regular maintenance because they need to employ pumps. Depending on whether the WW is fed into the wetland's surface or bottom, VFS can be further divided into down-flow and up-flow categories. The main purpose of VFS is to treat municipal or household sewage. Additionally, the technique has been used to agriculture with success (aquaculture, swine feedlot) and municipal and industrial (food processing, airport de-icing water, acid mine drainage) WW [6].

The water level in these systems is intended to stay below the substrate's surface. They also have plants that emerge with long root systems within the media. CW with sub-surface flow can be categorized based on the direction of flow, falling into soil, sand, and gravel-based wetlands on the one hand, and horizontal and vertical flow on the other. Micro life's that can change organic pollutants into CO_2, CH_3, H_2S, and other by-products anaerobically—or anoxically, depending on the presence of nitrate—have support and an attachment surface in the substratum [7]. In addition, the substratum serves as a basic filter, retaining incoming suspended solids and produced microbial solids, they are then reduced down and stabilized in the bed over time to limit the amount of suspended solids that exit the system. The most expensive part of subsurface flow systems is usually providing a sufficiently permeable substrate in relation to the hydraulic loading to prevent surface ponding. Other names for subsurface systems include vegetated submerged beds, planted filters, reed beds, root zone method, gravel bed hydroponics filters, and AWs [8].

2. Materials and Methodology

2.1 Materials: Pond size 0.35 x 0.22 x 0.17 meter fibre tub was selected to produce an AW. In the figure 1 of the VFCW container which also highlights its strength, high transparency, and adaptability to drilling, cutting, and moulding. Fine Aggregate, they go through the 9.5 mm screen entirely and are crushed stones or sands. Coarse Aggregate, the majority of this is crushed stone and gravel that is kept on the 4.75mm screen. Aggregate size utilized ranges from 20 to 40 mm. River Bed Stone, this particular variety of limestone is sedimentary in origin. Quartz, calcium carbonate, and other materials make up its composition. The sizes span from 4 mm to 2.64 mm. River stone is found in the riverbed naturally. Stainless Steel Wire Mesh, this is a stainless steel product with several uses that can be put to good use by a broad range of users. Wire mesh kept the filtering layer apart. 4.76 mm mesh size in the sieve apertures. Fibre tap, the reinforced plastic that makes up the fibre tap. A half-inch-diameter pickoff was utilized. Containers, to collect treated water from the artificial VFCW pond and release influent from the sewage treatment plant, a four number 5-litre containers were used.

Fig 1: Materials setup in Vertical subsurface flow artificial wetland model

2.2 Study Area: Davanagere, located in the heart of Karnataka, is being developed under the Central Government's Smart City initiative. As to the census conducted in 2021, Davanagere town has approximately 5,30,000 residents. The city's wastes are effectively treated by the well-designed municipal sewage treatment plants. With a 20MLD capacity, one of the STPs is situated at Shivanagar, Davanagere. The canal that runs beside Doddabudihal, Chikkabudihal, and other villages that join the Thunga Bhadra river receives the treated wastewater from this STP. For this experiment, the influent sewage from this STP is chosen as sample for treatment process.

2.3 Test Plant - Colocasia esculenta: There are different names for the tropical plant Colocasia esculenta, including Taro and Eddoe. Taro is closely related to Xanthosoma and Caladium, they are also mostly grown as ornamentals. It is also sometimes referred to as elephant ear, as the figure 2 illustrates. In India, it is known as "arbi" or "arvi". Colocasia esculenta belongs to the Kingdom Plantae and can reach a maximum size of 40 x 24.8 cm. Its leaves originate from a rhizome and have rounded or sub rounded tips for the basal lobes and are triangular-ovate, sub rounded, and mucronate at the apex [9].

2.4 Experimental Flow Rate Analysis: To ascertain the calculative flow rate, the flow rate investigation was completed. The round consists of Crushed stone placed 20 mm apart covers the entire intended wetland lake. to determine the amount of water that fills in the voids and the overall volume of water that a wetland lake can store at any given time. Next, in stage to determine the daily total flow that could be supplied into the pond, it must be filled with water all the way to the top. This can be accomplished by using a glass jar to calculate the flow in litre. The flow rate determined through experimentation was eight litre per day. A WW sample of eight litre per day needs to be fed into the AW pond for a one-day HRT. The amount of WW that needs to be fed into the pond is 4 litre per day for a 7-day retention period; 2 litre per day for a 14-day retention period; 1.5 litre per day for a 21-day retention period; and 0.8 litre per day for a 28-day interval of HRT, since a 7-day retention period was selected for the work [10].

2.5 Experimental Setup: The experiment is conducted in AW with VFCW and configured input and outflow configurations. The wetland cell is an acrolithic sheet that is 0.35 m * 0.22 m * 0.17 m * 0.05 mm thick. Crushed stones that are contained on a 20 mm sieve size fill the entire cell. Batch operation is used, and WW is supplied into the cell through the influent tank. As seen in figure 2, the plant employed is karka and elephant ears, which have multiple uses including removing sulphates and chlorides and providing oxygen to the root zones to aid in the breakdown of organic materials. The entire system was housed on a roof, and WW was continuously injected into the system. Fifteen days before to the start date of WW being injected into the cell, wetland vegetation was sown there [11].

Fig 2: Setup of artificial vertical subsurface flow wetland model using the C. esculenta plant

2.6 Sample Collection: The samples are collected from the Shivanagar, Davanagere, sewage treatment plant, where they enter the facility. WW samples were gathered in polythene water bottles, and refrigerated at 4° C to slow down the activities of bacteria. May 2024, throughout the summer season, is when the sample was taken. The samples are tested before the experiment started to analyze the initial reading of the experiment.

2.7 Methodology: Firstly, the model is setup by arranging the layers and the plants are planted before 15 days of day 0 of experiment started. The influent sewage is let in the quantity of 0.8 liter per day to model and filtered the water from the tap at the regular interval of 7 days till 28 days. The filtered water is stored in the containers and tested for parameters such as pH, BOD, COD, TSS, TDS, A-N and PO4 Regularly monitor the water quality, plant development, and presence of wildlife in the wetland. Perform necessary maintenance, such as removing unwanted species or rubbish. The treated WW flow is collected in a container for the report's analysis on days 7, 14, 21, and 28. [12].

3. Result and Discussion

Parameter analysed: The following parameters are anaylsed: pH, colour, temperature, BOD, DO, COD, TSS, TDS, A-N and (PO_4).

3.1 Colour and Temperature: The main causes of colour in WW are fulvic acid, humic acid, and dissolved organic matter. It has been seen that the treated sample in the VFAW with the test plant eventually turned yellowish and lost its dark and deep grey colour. The wetland processes of adsorption, microbial degradation, solar degradation, and flocculation cause the colour to disappear or turn yellowish. Given that the sample was taken throughout the summer, its temperature was 22℃. On the 28th day of the sample's treatment in the AWs, the temperature was lowered to 18℃ using the C. esculenta test plant.

3.2 pH*:* pH meter was used to measure the pH The pH of samples the treated sample steadily dropped throughout the HRT period in the C. esculenta plant. The slightly alkaline influent of the sewage sample is neutralized by the considerable reduction in pH in HRT. Day 7's pH was 7.9; day 14's was 7.6; day 21's was 7.5; and day 28's was 7.2 as shown in the figure 3.

Table 1: The changes seen in the untreated influent sewage and post treated WW throughout the HRT

Sl no	Parameter	Initial reading of the influent	Treated effluent with C. esculenta (7^{th} day)	Treated effluent with C. esculenta (14^{th} day)	Treated effluent with C. esculenta (21^{th} day)	Treated effluent with C. esculenta (28^{th} day)
01	Colour	Dark grey	Light grey	Yellowish	Yellowish	Yellowish
02	Temperature	22^0 C	18^0 C	18^0 C	18^0 C	18^0 C
03	pH	8.1	7.9	7.6	7.5	7.2
04	TDS	498 mg/l	353.58	323.7	288.84	299
05	TSS	206	186.54	166.21	158.89	150.39
06	DO	0	1.2	2.3	3.6	4.9
07	BOD	260 mg/l	184	156.8	140	119.6
08	COD	538 mg/l	413.96	330.12	298.68	220.08
09	A-N	22.1 mg/l	17.38	14.96	12.54	8.93
10	PO_4	10.8 mg/l	9.504	8.1	6.8	5.73

3.3 TDS: The TDS meter was used to measure the TDS in WW over time. TDS has decreased in treated samples by 353.58 (29%) on day 7, 323.7 (35%) on day 12, 288.84 (42%) on day 21, and 249 (50%) on day 28 in total. C. esculenta removed the highest percentage of TDS on the first day of growth, with a removal rate of 30%. C. esculenta has great quality in removing the TDS as shown in the figure 4.

3.4 TSS: The filter and evaporation method was used to measure the TSS in WW over time. TSS had decreased in treated samples to 186.54 (14%) on day 7, 166.21 (19%) on day 14, 158.89 (42%) on day 21, and 150.39 (50%) on day 28. C. esculenta (26%) on day 14, 135.69 (33%) on day 21, and 121.54 (41.1%) on day 28. C. esculenta removed 41.1% of the total as shown in the figure 5.

3.5 DO: DO was measured using titration method Given that it shows how clean the water is, DO could be a very significant factor. As stated to figure 6, the high level in DO focus with in the water design shows a measurable drop in the impurities BOD and COD. Furthermore, our test results say that the DO levels were steadily extended inner the influent of sewage WWs treated with C. esculenta. In C. esculenta, the BOD content has decreased significantly and the DO has increased. On days 7, 14, 21, and 28, DO levels were 1.2 mg/l, 2.3 mg/l, 3.6 mg/l, and 4.9 mg/l, respectively.

3.6 BOD: BOD was measured using titration method The plant successful in reducing the BOD of the effluent throughout the HRT, as indicated by table 1 figure 7. Sample BOD_5 has demonstrated a good reduction, with values of 260 (29%), 184 (39%), 156.8 (46%), and 140 (54.30%) reductions on days 7, 14, 21, and 28, respectively. BOD was reduced by 29% in the first week, and the remaining three weeks' percentage removal was lower than the first weeks. Due to the reason that commencing days' plants made greater use of the organic matter (OM) in the WW sample and other last-week plants were able to take other nutrients in addition to OM, both plants were able to eliminate the BOD in comparison to the first two weeks.

3.7 COD: COD was measured using open reflex method Since the COD of the WW is a reliable predictor of the level of contamination in the water, it was analyzed frequently, relay on the outcomes of an experiment. Better than any other metric, the C. esculenta test plant eliminated the COD from the influent of the effluent. Figure 8 displays changes in the COD of the WW following treatment, 21% on day 7, 37% on day 14, 43% on day 21, and 58% on day 28.

3.8 Ammonia- Nitrogen (A-N): A-N was measured using spectrophotometer. An essential component of the WW is A–N. In a 28-day HRT, the plants demonstrated a notable reduction of this element from WW. Levels of C. esculenta A-N have decreased by up to 60% in this test plant: on days 7, 14,96 (32%), 21, and 28, 17.38 (21%) and 12.54 (43%) respectively as shown in figure 9. The plant can absorb urea through their roots, they eliminate urea on average by 60%. In the process of eliminating the parameters from the WW sample by artificial CW, other processes such assimilation, interaction with microbial activity, and transit of materials from one form to another are also critical to the removal of A-N. Due to their natural environmental modifications, this plant is considerable reduction in A-N

3.9 PO_4: PO_4 was measured using spectrophotometer. The influent's PO_4-P level varies, although it normally falls between 3 and 15 mg/l. This fluctuation is similar as that affect A-N content. 9.504 (2%) on day 7, 8.1 (25%) on day 14, 6.8 (37%) on day 21, and 5.73 (46.99%) on day 28 have seen a decrease in sample PO_4 levels. As stated to the figure 10 pattern that varies over the last two weeks of the HRT period, C. esculenta removes around 70% of the total percentage of PO_4 that is removed.

Fig 3: pH variation in the time of 28 days

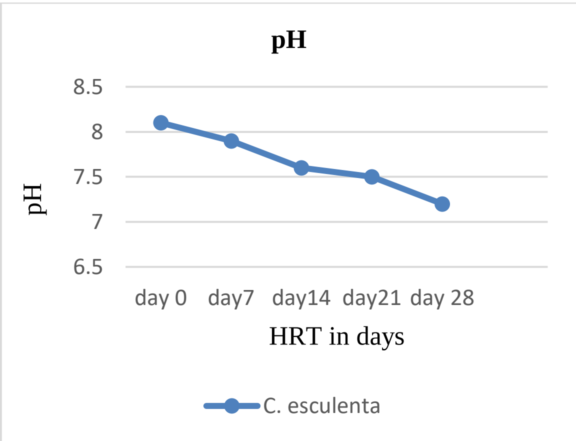

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Fig 6: DO variation in the time of 28 days

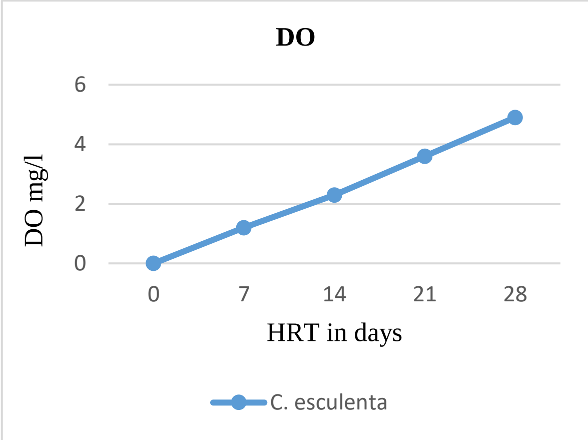


Fig 4: TDS variation in the time of 28 days

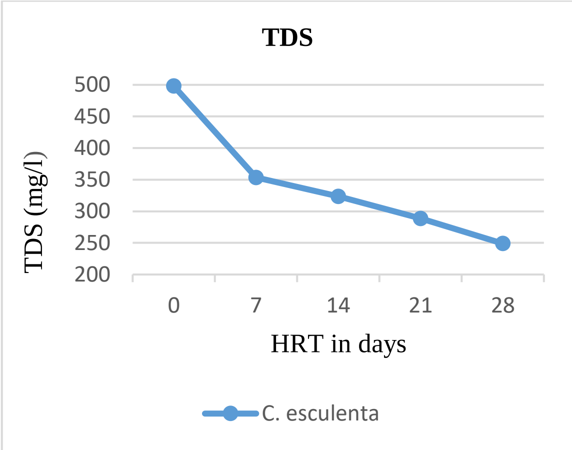


Fig 7: BOD variation in the time of 28 days

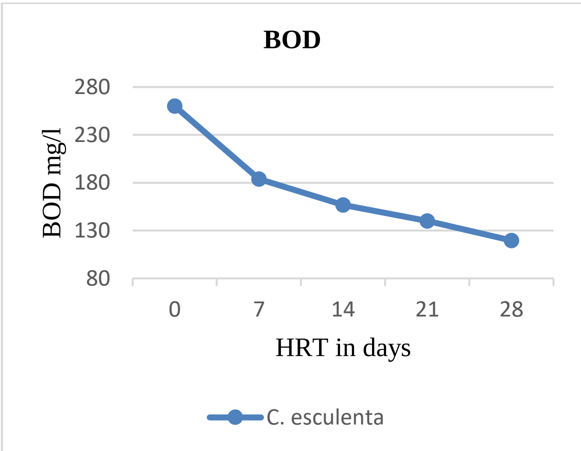


Fig 5: TSS variation in the time of 28 days

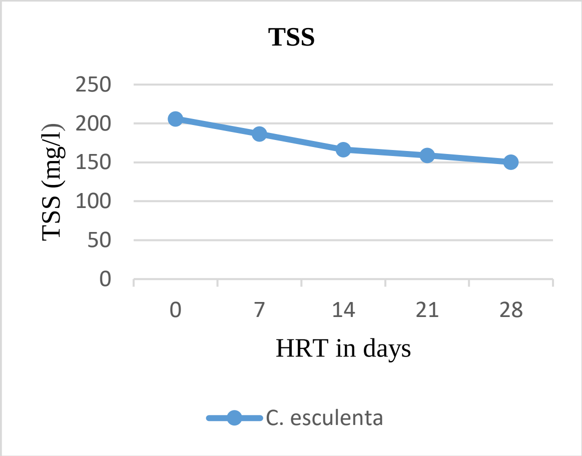


Fig 8: COD variation in the time of 28 days

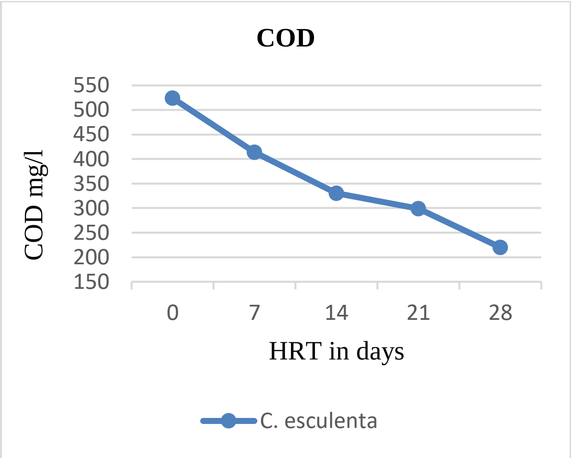


Fig 9: A-N variation in the time of 28 days

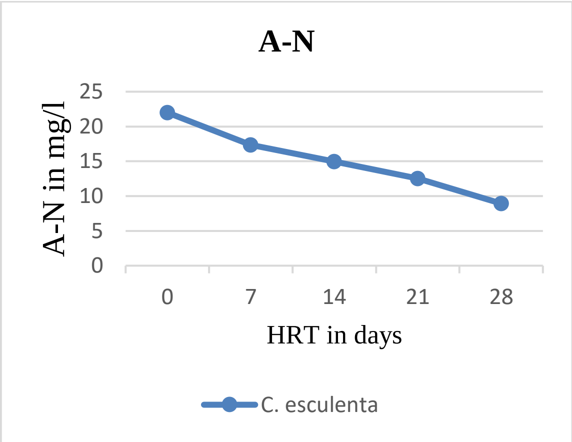
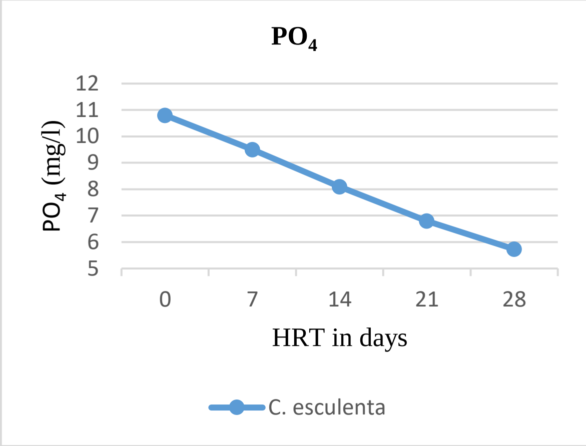


Fig 10: PO_4 variation in the time of 28 days



4. Conclusion

Colocasia Esculenta (elephant ears) have shown promising results in treating WW (sewage) in AW. This plant has a high absorption capacity for nutrients, particularly nitrogen and phosphorus, and can thrive in both partially and fully submerged environments. The study emphasizes the importance of plant choice in creating AW, focusing on specific toxins found in WW and treatment results. The test results show that plant is suitable for the pollution and nutrient removal of COD and A-N and neutralising the pH levels. Future research should focus on long-term performance, maintenance procedures, and seasonal fluctuations to ensure the success of AWs in various environmental conditions. This study is limited to the specific and certain pollutants which are tested, further research should be carried out for other pollutants and different types of sewage.

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