

Optimum dilution for Phytoremediation of distillery effluent in constructed wet lands

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Abstract- Effluent 'Coda' originating from palmyrah toddy distillery units is the major source of environmental pollution in the Jaffna district of Sri Lanka. Spent wash produced from distilleries is rich in organic material and characteristically less toxic. A research was carried out to find the optimal dilution factor of the effluent before discharge through construction of wet lands which is a new, ecofriendly, economically viable and environmentally safe strategy to manage the distillery effluent. The effluent was diluted as 5, 4, 3, 2, and 1 times with ground water. Complete failures of first series of dilution, treatments were discarded and new effluent was further diluted 5, 10 and 20 times to facilitate the optimum plant growth. The results revealed that aquatic plants, Eichhormia sp, Lemna sp, Pistia sp and Lemna minor were used successfully to treat the spent wash, after aeration, pH adjustment, and dilution. It was found that dilution factor 5. The water samples were collected from inlets and outlets of constructed and analyzed for EC, PO₄³⁻, and NO₃⁻. The removal rates of PO₄³⁻ in constructed wetland were 48.24%, 25.88%, and 51.76%, Eichhormia sp, Lemna and Lemna minor respectively. It was found constructed wetland shows higher removal efficiency of NO₃⁻. The 35.63%, 42.53%, 55.17% removal rates of NO₃⁻ were obtained by Eichhormia sp, Lemna sp, Pistia sp and Lemna minor. It could be use the spent wash as a liquid fertilizer for cultivating field through, construction of wetlands.

Index Terms- Constructed wetland, Dilution factor, Distillery effluent

I. INTRODUCTION

Direct discharge of effluent from the toddy distillation units in to the environment is causing significant environmental pollution in Jaffna peninsula. A large and increasing volume of wastewater is produced globally by the winery and distillery industries. Considerable amount of effluent is coming from the distillery units which are situated in Jaffna at Navally and Thikkam. In the Northern part of Sri Lanka, especially in the Jaffna peninsula the distilleries are using, naturally fermented palmyrah and coconut sap called 'palmyrah toddy' and 'coconut toddy' respectively to obtain ethanol. This distillery unit generates 1.3 million liters of effluent annually and the principle waste is locally referred as "Coda" (Amara et al., 1990).

A large and increasing volume of wastewater is produced globally by the winery and distillery industries (Peter et al., 2008). The fresh acidic spent wash produced from the distilleries are of high in temperature and have high Biological Oxygen Demand (BOD), and also consisting large amount of suspended solids and high turbidity. Moreover, 88% of raw materials used in the distilleries are converted into waste and discharged into the water bodies without recommended treatments. Because of the above reasons, distillery industries have become a major source for the water pollution (Farid et al., 2010). The disposal of large quantities of biodegradable waste into the water bodies without adequate treatment has been banded through the Environmental laws. Distillery industries have become a major source of pollution, because values of constituents of distillery waste are often above the permissible standards specified by the Central Environmental Authority. Also discharge of untreated acidic spent wash can destroy aquatic organisms and natural fresh water which is the prime source for agricultural and animal production.

There is no any well sound management techniques proposed until now to overwhelm liquid waste management problem which is the major deadlock for producers. This recent study focusing new strategy to manage this problem through the construction of wet lands to treat the nutritive effluent and reuse it for agriculture as an alternative for chemical fertilizer and irrigate the crop land (Sathish et al., 2013). Moreover, constructed wetlands can also be a cost-effective and technically feasible approach for treating wastewater. Wetlands are often less expensive to build than traditional wastewater treatment options, have low operating and maintenance expenses and can handle fluctuating water levels. Additionally, they are aesthetically pleasing and can reduce or eliminate odors associated with wastewater. This experiment is seeking to find out the best dilution factor for wetland treatment.

II. METHODOLOGY

Fresh effluent samples were collected directly from the out let unit without accumulating in aerobic tank from Thikkam distillery in Jaffna. Fresh effluent samples were collected into 20 liter plastic containers. The following Aquatic plants, Eichhormia sp, Lemna sp Pistia sp and Lemna minor were selected for this study because of their fast growing habit in fresh water and high nutrient feeding. According to the study of Amara et al., 1900 Eichhormia sp, Lemna sp Lemna minor and Pistia sp were used for biological treatment

of distillery waste and stated that these plants were well survived to grow in effluent. Important chemical properties such as pH, dissolved oxygen, EC and TSS of fresh effluent were measured to identify the problematic parameter and to determine the dilution factor.

The fabricated lab scale wet land was kept above the smooth cemented place. The effluent was allowed for the sedimentation in the sediment tank for one day. After that effluent was collected from the upper region of the sediment tank. Then it was aerated by using air compressor for one hour. Again effluent was adjusted to the pH 6 by using CaCO_3 . Finally it was diluted with groundwater. Selected aquatic plants were placed into the wet land. At the same time control was maintained as treated effluent and fresh effluent was kept as without plant to get the effect of plant. Samples from inlet and outlet of the artificial wetland were collected on two days interval for one week and analyzed in replicates for pH, PO_4^{3-} , NO_3^- and EC using standard methods.

III. RESULTS AND DISCUSSION

The pH value of the fresh spent wash was an acidic nature varying from 3.2 to 3.4. Dissolved oxygen value of spent wash was less than 1. EC values of the effluent was ranged from 1.08 - 4.02 mS/cm. Complete death of aquatic plants were observed in the dilution factor of 5, 4, 3, 2, and 1 times with groundwater due to the lower pH and dissolved oxygen value. In the series of dilution, plants were survived in dilution factor of 20, because of effluent was adjusted the pH of 7 by adding water. But 20 L of groundwater was used to dilute one 1L effluent. This dilution factor is not economical one in large industrial scale.

Further the facts were used to improve the pH and increase the DO level. Even though effluent was aerated by using air compressor for one hour, the system remains in an anaerobic condition with the DO level of less than one. The pH value of the effluent was adjusted to 6 by adding CaCO_3 to the effluent. CaCO_3 was selected for neutralizing the effluent because of it is more effective and low cost than KOH or NaOH. Then this effluent was diluted with groundwater in 1, 2, 5, and 10 times. Aquatic plants were survived in 5 times of dilution with water. Finally optimal dilution factor was taken as 5. But it could be further reduced to 4 times in large scale treatment. Even further it could be reduced in contracted wetland while flowing.

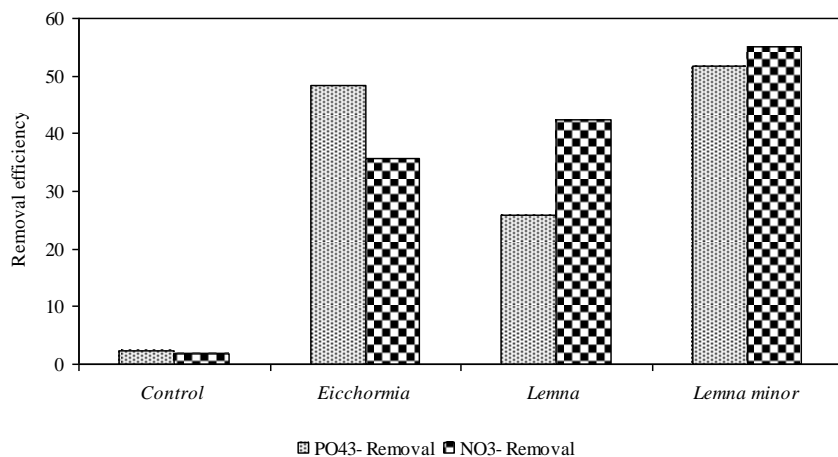


Figure 01: Removal efficiency of effluent after two days for PO43- and NO3-

Figure 01 shows the removal efficiency of the effluent with various type of plant. It was found that, Lemna minor shows higher removal efficiency compared to others. The removal rates of PO_4^{3-} in constructed wetland were 2.35%, 48.24%, 25.88%, and 51.76%, respectively for control, Eichhornia sp, Lemna and Lemna minor. It was observed Eichhornia sp, Lemna and Lemna minor produced the greatest reduction in NO_3^- . The highly removal rate of NO_3^- was found in Lemna minor which was removed 55.17% of NO_3^- within two days. In this dilution the highest reduction of PO_4^{3-} and NO_3^- would be achieved by Lemna minor. This experimental study, the dilution factor 5 which was gave good results. Dilution factor which is not harmful because, particular amount of water come from outlet of distillery as waste. Yala rain water harvesting is also possible in the peak season of distillation. Extensive usage of chemical fertilizers contributes largely to soil degradation. This safe strategy utilizes the distillery effluent for producing valuable liquid fertilizer that reduces environmental hazards.

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