PERFORMANCE ANALYSIS OF NUTRIENT REMOVAL IN POND WATER USING WATER HYACINTH AND AZOLLA WITH PAPAYA STEM

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ABSTRACT – *Depletion of water bodies such as lakes ponds and rivers are taking place in a faster rate due to increase in population. Excess of domestic sewage water is let into local water bodies without proper pretreatment. Domestic sewage water when mixed with surface water can lead to increase in nutrient content of the water .Eutrophification can lead to algal blooms, increase in turbidity, low dissolved oxygen and decrease in species diversity.The main objective of this project is determine the nutrient removal efficiency of papaya stem with Water hyacinth and Azolla.In this method, performance of Eichhornia sp.,Azolla sp. and papaya stem was used to find their nutrient removal in batch mode for 24 days time period in pond water and samples are collected ever four days interval over the time period.About 100g of each plant and 100g of papaya stem for each reactor was used for the treatment of pond water. Various nutrients such as ammonia,nitrate and phosphate were analysed throughtout the study.Water hyacinth with papaya stem showed greater removal of nitrate (74%) and ammonia(67%).Azolla with papaya stem showed a greater removal in phosphate(80%).From the study water hyacinth with papaya showed a better performance than azolla and papaya stem.Further pretreatment of papaya stem ,increase in size of the reactor and amount of papaya stem used could be improved for better performance of the waste water treatment. This experiment will have more scope by conducting it at a larger scale to get efficiency of the materials used.*

Keywords : Nutrient removal, Water yacinth,Azolla,Papaya stem ,Pond water.

level it could possess a major threat to the environment and a problem for the human society. Improper management of sewage could possess a vulnerable threat to soil and water table by creating a irreversible damage. Excess of nutrients in sewage could be a problem for local water bodies that have become dumpsites for local sewage.

Eutrophication is the general term used for describing the process where water bodies receive excess nutrients that could stimulate the plant or algae growth.Eutrophication is mainly caused due to the run off due to rain,farms which uses inorganic fertiliser,soil erosion, discharge of detergents containing phosphates, discharging of partially treated or untreated sewage.

It may result in increase in turbidity,plant and animal biomass increase, sedimentation rate increase there by reducing the lifespan of the lake,species diversity decreases. The most notable effect in eutrophication is algal blooms. When a bloom occurs, water body is covered with algae,which is usually bright green which blocks the light from reaching the surface of the water.This reduces the photosynthesizing of plants, which decrease the oxygen content of the water.If the bloom increases due to excess sewage it would cause organisms to die. When the oxygen in water becomes too low,this stage is called hypoxic.If hypoxia increases, no life would survive and a dead zone is created. Finally whole environment would be devasted.

Water hyacinth has accumulated a large amount of nitrogen and phosphorus without any anatomical changes in one year phytoremediation process[1].Water hyacinth is used to treat waste water from dairies, tanneries, sugar factories, pulp and paper industries, palm oil mills, distilleries, etc. The water hyacinth have been found to have potential for use as phytoremediation, paper, organic fertilizer, biogas production, human food, fiber, animal fodder[2].

Excess nitrate concentrations in aquatic systems, the primary source are surface runoff from agricultural or landscaped areas which have received excess nitrate fertilizer. Consequently, as nitrates form a component of total dissolved solids, they are widely used as an indicator of water quality[3].

Phosphorus can stimulate growth of algae and other organisms. Because of noxious algal blooms that occur in surface water, there is presently much interest in controlling the amount of phosphorus compounds that enters surface waters via domestic and industrial waste discharges and natural runoff [4].

Phytoaccumulation potential of macrophytes with emphasis on utilization of Azolla as a promising candidate for phytoremediation. The ability to hyperaccumulate heavy metals makes them interesting research candidates, especially for the treatment of industrial effluents and sewage waste water[6].

Azolla,Water hyacinth performed well in sewage effluent better than Pistia by showing a greater reduction in nutrient removal over a period of 10days in sewage treatment plant effluent under laboratory conditions[8].

2. MATERIALS AND METHODS:

Eichhornia crassipes commonly known as Water hyacinth is a free floating perennial plant that has dark green leaves as fan shaped are attached to a spongy,inflated petiole.It's roots lie beneath the water which is thick,heavily branched,dark fibrous root system.The water hyacinth is a fast growing plant and can cover a very large area of water in a very less time period.Its optimum temperature for growth is 25-30°C.

Water hyacinth was collected from a local stream and it was carefully cleaned for dirt and debris attached to the root and the water hyacinth was allowed to grow in continer under lab conditions for acclimatization for a duration of 1week.And about 100g of the plant was used for experimental use. Water hyacinth was selected due its adaptability to the environment and for its overall performance.

Azolla microphylla commonly known as Azolla is a free floating aquatic fern.It grows from 1 to 2.5cm wide and is bright green colour.It changes to deep red when it is exposed to sun .When there is excess nutrients ,profilic growth will be a problem for waterways. It can grow at an optimum temperature of 30°C.

Azolla was collected from Agricultural College, Madurai where it was grown as a fertilizer in ponds. About 400g was collected and brought in a plastic container and moved to another tank for acclimatization for a duration of 1 week. After a week 100g of azolla was weighed and used for experimental purpose.

After the acclimatization for a time of about 1 week the plants are removed from the control tank and the weighed for about 100grams each.

Carica Papaya which is commonly known as Papaya which is extensively cultivated throughout the world. Papaya is a tropical fruit obtained from papaya tree like plant growing to a height of 5-10m.Papaya stem is strong due to rich fibre and water content but of no use. Generally it is considered as agricultural waste and often occupies landfill once the field is cleared.

Papaya stem was obtained from the local farm and then cut into sticks of required sizes and then the cortex region is alone left and pith region is removed .The cleaned stem is allowed to sun dry to obtain a filter like material .This sun dry is for a period of about 1 month in which the stem dries there by the water content of the stem is reduced to a greater extent. Then the dried stem is cleaned for any foreign particles and then weighed.About 100g of dried stem is taken for the each reactor.

Waste water was collected from Thiruparankundram pond where the sewage of the area is dumped mostly.Due excess sewage let into the pond the nutrient content increases drastically to provide a suitable environment for algal blooms and other species over grow thus affecting the ecosystem.

2.1 Experimental Setup

About 35 litres of waste water was collected in plastic containers from the pond at the mixing point of sewage. The experiement was conducted with three rectangular glass reactors(0.4m length x 0.18m width x 0.2m height) with a working depth of 0.14m each, a surface area of 0.37m^2 and a capacity of 10L.Three reactors are R1-Water hyacinth with papaya stem,R2-Azolla with papaya stem,R3-Papaya stem alone. Initially the weighed papaya stem of about 100g is submerged into each reactor and 100g of water hyacinth is added to R1 and 100g of azolla is added to R2.And R3 is left alone with the papaya stem.About 30% of reactor height is provided with papaya stem .A tube of about 1cm dia and 25cm length is fitted to the left side of all reactors. A small pipe of about 0.5cm dia and 6cm long is attached to the right side of the all reactors at 9cm from bottom and one end and a stopper is provided at the end .The permissible limit was obtained from General standards for discharge of environmental pollutants Part-A : Effluents,Schedule-VI,The Environment Protection Rules,1986[7].Nutrient content was analysed over a time period of about every four days after the initial test has been made.

2.2 Estimation of Initial Parameters of the Waste water:

Major parameters such as pH,TSS, Temperature, BOD,COD,Phosphate,Nitrate,Ammonia were analysed and tabulated in [5].

Then initial analysis for various parameter have been tabulated in Table. 1

Characteristics	Permissible Limit	Obtained
pH	5.5 – 9.0	8.1
TSS	100 mg/L	760 mg/L
Temperature	-	24°C
BOD	30	72 mg/L
COD	250	166 mg/L
Phosphate (PO_4)	5	5.2 mg/L
Nitrate(NO_3)	10	12.4 mg/L
Ammonia(NH_3)	5	7.6 mg/L

Table-1: Initial analysis of water sample

After the initial analysis,about 500ml of waste water from each reactor is collected regularly at an interval of 4 days upto 24 days for nutrient variation of the time period.

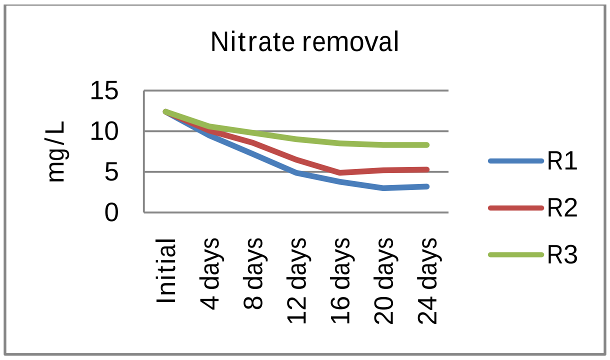
Removal efficiency was calculated using the formulae:-

$$\text{Efficiency} = \frac{\text{Initial} - \text{Final}}{\text{Final}} \times 100\%$$

3. RESULTS AND DISCUSSION:-

3.1. Nitrate Removal

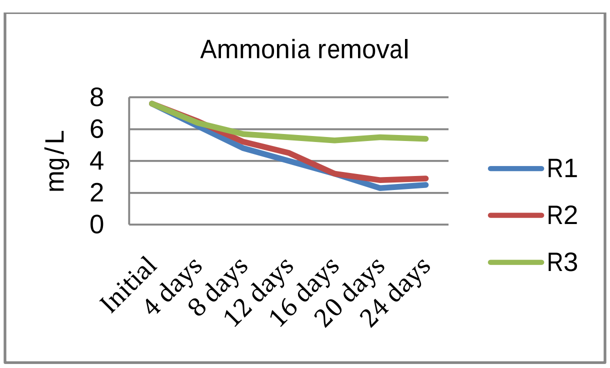
The initial level of nitrate in the waste water is about 12.4mg/l which is much higher than the permissible level 10mg/L for a inland surface water.During the time period of over 24 days R1 reduced nitrate to a effective level 3.2mg/L of about 74%,this shows water hyacinth with papaya stem reduces nitrate to a greater extent in Fig( ).R2 with azolla and papaya stem showed a nominal level in reducing nitrate to 5.3mg/L of about 57%.R3 with papaya stem alone performed average of 8.3mg/L about 33%,since no pretreatment was provided to the stem.



Graph 1 : Nitrate reduction over 24 days

3.2. Ammonia Removal

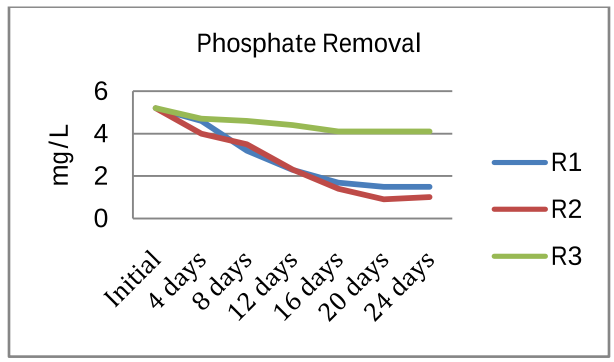
The initial amount of ammonia obtained was about 7.6mg/L which is much greater than the permissible limit of 5.0mg/L.Due to the presence of plants R1 and R2 with papaya stem decreased ammonia to 2.5mg/L (67%) and 2.9mg/L (62%) where as the R3 with papaya stem alone showed a average performance of about 5.4mg/L (29%).During the first 12 days ammonia reduction was to active and then it started to reduce. Reduction of ammonia is tabulated in



Graph 2 : Ammonia reduction over 24 days

3.3 Phosphate Removal

Phosphate was found to be 5.2mg/L which is slightly above the acceptable level of 5.0mg/L.During the 24 days removal of phosphate was found to be reduced greatly by R2 with azolla and papaya stem to 1.0mg/L about 80%.R1 also performed well but it followed R2,the removal of phosphate to 1.5mg/L in R1 is about 71%.R2 showed a constant reduction in phosphate which Fig. .R3 showed a moderate reduction in phosphate 4.1mg/L of about 21%.



Graph 3 : Phosphate reduction over 24 days

CONCLUSION:

Domestic sewage consists of enormous quality of nutrients such as nitrate, ammonia and phosphates. Nutrients in such large quantites may affect the ecological balance of the environment. These nutrients should used properly or treated effectively before they are let into the water bodies. These nutrients might induce the growth of certain species of algae and other organisms in particular leading to a imbalanced ecosystem of water body. Therefore it becomes necessary to reduce the amount of nutrients in the water. Nutrient removal was achieved to a certain level with the help of water hyacinth,azolla and papaya stem. Water hyacinth with papaya stem effectively reduced ammonia (67%) and nitrate (74%) well below the permissible level.Azolla with papaya stem reduced phosphate (80%) to a considerable amount. Papaya stem showed an average performance throughout the entire process of reduction where as water hyacinth and azolla with papaya showed a greater reduction due to the natural uptake of nutrients for the plant growth which showed greater removal than papaya stem alone. Further improvements can be achieved by change in reactor size and amount of papaya stem used .The reduction of nutrients from wastewater with water hyacinth and papaya stem achieved is acceptable.

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