AN APPLICATION OF WATER HYACINTH FOR ENHANCING THE QUALITY OF POND WATER IN SYLHET CITY

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ABSTRACT

Water, one of the most vital elements in human and environmental survival is available in Bangladesh in ample amount both below and over the surface of the earth. While the excessive use of ground water is causing a huge decrease in the water level underground, the possibility of using surface water is taking a dive everyday due to continuous pollution. The only way to ensure a safe and cheap supply of water in future is to find a suitable solution to this surface water pollution problem. The key purpose of this study is to establish the cultivation of water hyacinth as a measure to reduce surface water pollution. This whole study was conducted in for steps which are: collection of water sample and water hyacinth, conducting the experimental settings in the environment laboratory and finally analyzing the sample from six different ponds of Sylhet city for ten water quality parameters. After thorough experimentation and analysis, the findings were that cultivation of water hyacinth does effectively reduce the amount of pollutants causing the surface water pollution which was indicated by the reduction in percentage of negative water quality parameters. Therefore, it can be confidently stated that cultivating water hyacinth in surface water can bring expected results in purifying the polluted surface water to a great extent.

Keywords: *Cultivation, Surface water, water quality, Water hyacinth, Purifying.*

1. INTRODUCTION

Survival is the most primal instinct of human beings. An average person can survive without food for three weeks but only hundred hours without water. The fact that water is the most significant element in human survival as well as a very necessary part of environmental stability can be perceived from our day-to-day experiences and regular natural occurrences. But this extremely necessary element is being scarce day by day. With the increase in population there has been a huge rise in the construction of residential buildings along with construction of factories, industries, hotels, restaurants and entertainment places. For smooth communication and transportation, roads, bridges and culverts are being developed simultaneously. All these establishments acquire a whole lot of land area which hinders not only the natural refilling of groundwater but also the flow of water toward the surface water sources. As a result, the natural flow of surface water sources is disturbed that leads to the desiccation of the source and possible pollution of the water. As a result, the pollution of surface water is becoming a growing concern all over the world including Bangladesh. The rapid urbanization and continuous migration of rural people into the major cities has caused an increase in surface water pollution in ponds, canals, lakes and rivers. The huge amount of waste created in these cities is thrown into these surface water sources without any measurement which causes in an overflow of wastes leading to harmful pollution. In some cities, the water has become so polluted that in bare eyes there may seem no difference between the surface water and sewage. As the groundwater level is decreasing in an alarming rate every year in the major cities, it is due time to consider taking necessary measures to treat the surface water properly in order to be able to use that in our everyday life. The purification of surface water and waste water reclamation and reuse is a very necessary but daunting task especially for a developing country like Bangladesh. We do not possess the required experienced personnel or the extensive knowledge and resources that are vital in using the treatment processes used in the developed countries. So it is very important to find the local elements that are available in our country and can be used at a low cost. Moreover, we need to be able to gather enough knowledge about the elements to use those as surface water purifier.

Regarding this search, macrophytes can be considered as a possible solution for their vital role in balancing the ponds ecosystem. The most common aquatic macrophytes that can be used in surface water treatment are water hyacinth (*Eichhornia Crassipes*), penny wort, water lettuce, water ferns and duck weeds (Mahmood et al. 2005). These quatic macrophytes are the needed waste water purifiers for the developing countries as they are cheap to acquire and very little skill is required to turn them into an effective treatment system (Mahmood et al. 2005). They improve the water quality by absorbing nutrients with their effective root system (Dhote, 2007). Water hyacinth does not treat nutrients by only biomass uptake but also increases the sedimentation and remove waste from pond water. The studies of Mahmood et al. (2005) studied in lab scale for Water Hyacinth (*Eichhornia crassipes*) for Biotreatment of Textile Wastewater illustrated the reduction of pH from alkaline to nearly neutral, conductivity, BOD and COD, total solids in all cases studied with the introduction of water hyacinth. It also showed the tremendous potential of water hyacinth in absorbing heavy metals from the textile wastewater as it resulted inreduction of chromium, zinc and copper. In addition, application of shallow pond system using water hyacinth for domestic waste water treatment in the presence of high total dissolved solids (TDS) and heavy metal salts by Valipour et al. (2010). Revealed water hyacinth can tolerate TDS up to 2000 mg/L in the shallow pond system. The reduction in TDS was marginal at the highest tolerable limit whereas the heavy metal reduction is 66%, 68%, 64%, 70% for Cd, Cu, Ni and Zn respectively at the outlet of the treatment system. The sewage treatment performance of the shallow pond water hyacinth system for all other parameters was estimated as 81% Chemical oxygen demand (COD), 91% Biochemical oxygen demand (BOD5), 16% Total dissolved solids (TDS), 70% Total suspended solids (TSS), 4% Chlorides, 74% Ammonia nitrogen (NH3-N), 41% Phosphate (PO4-P), 96%. Most probable number (MPN) and 98% total viable count (TVC) reduction (Valipour et al. 2010).

Sylhet is one of the most densely populated urban areas which has been suffering from poor water supply condition and surface water pollution for a long time. This major city in north-eastern Bangladesh was granted metropolitan city status in March 2009. Sylhet is located on the banks of the Surma River and is surrounded by the Jaintia, Khasi and Tripura hills. The city has a high population density, with nearly 500,000 people and an area of 26.50 km². It is one of the largest cities in Bangladesh (Seckler, et al.,1999) and is prone to the modern urbanization and migration of rural people. The ponds and canals in the city are used for domestic purposes and often as waste and wastewater dumping locations which has caused severe pollution to the water of those sources. This situation makes the ponds in Sylhet city a perfect location to conduct a necessary research using water hyacinth as a water purifier. The objective of this study is to establish the use of water hyacinth as a purifier for polluted surface water.

2. METHODOLOGY

Sylhet city has a large number of ponds and canals among which most are used as a waste and wastewater dumping location and are the examples of the extreme water pollution situation in the city. Therefore there were numerous options to conduct the study but eventually the six main ponds were selected for the study. These ponds received pollutants mainly from food waste, household waste, industrial waste water and in many cases poor and faulty drainage system. This exposure to different kinds of waste has caused the water to become severely polluted. As a result, these six ponds were selected as the research locations for this study. Those six ponds are the Lamabazar pond (LBP), Dhupadighi pond (DDP), Ram-Krishna Mission and Ashram pond (RKMP), Shahjalal Majar pond (SJMP), Kajitula pond (KTP) and Kajal Shah Pond (KSP). The detailed present conditions of the selected ponds are listed in Table 1:

Table 1: Detailed condition of the six ponds chosen for collection of water samples

No.	Name of ponds	Acronym	Area name	Ward No.	Length width & depth	Present conditions of ponds
1.	Lamabazar pond.	LBP	Bil Par, Lamabazar.	11	160′× 145′× 12′	❖ Retaining walls: Northern and Southern sides. ❖ Water color: Green. ❖ Water hyacinth: Not present. ❖ People throw garbage waste. ❖ Entrance of drain and rain water: From the southern part of the pond.

2.	Dhupadighi pond.	DDP	Dhupadighir par.	14, 15	598′ × 360′ × 13′	❖ Retaining walls: Not available. ❖ Water color: Greenish black. ❖ People throw waste, plastic, polybags, oil and grease. ❖ Entrance of drain and rain water: From all around. ❖ At West bank have slum, North bank have Shishupark, East bank have motor workshops & South bank have houses. ❖ Water hyacinth: Not present.
3.	Ram-Krishna Mission & Ashram pond.	RKMP	Mirabazar.	18	385′ × 180′ × 16′	❖ Retaining walls: All around. ❖ Water color: Green. ❖ Water hyacinth: Not present. ❖ Entrance of drain and rain water: From the Eastern and Western part of the pond. ❖ Cultivate fish in pond. ❖ The idols of gods and goddesses are thrown into the pond.
4.	Shajalal Majar pond.	SJMP	Dargah Gate.	1	120′ × 83′ × 15′	❖ Retaining walls: All around. ❖ State of water is overall well but at the surface level there are floating algae. ❖ Gajar fishes are available in the pond & people throw small fishes to feed them. ❖ The bed of the pond is R.C.C dalai. ❖ At one corner, there is some water hyacinth.
5.	Kajitula pond.	KTP	Kajitula.	17	190′ × 78′ × 14′	❖ Retaining walls: All around. ❖ Water color: Green. ❖ Water hyacinth: Not present. ❖ People wash clothes and bathe here.
6.	Kajal shah pond.	KSP	Kajal shah.	3	218′ × 67′ × 15′	❖ Retaining walls: All around. ❖ Water color: Green. ❖ Water hyacinth: Not present. ❖ People wash clothes and bathe here. ❖ Enter rain water.

The practical works were completed in four steps as shown in the flow chart below:

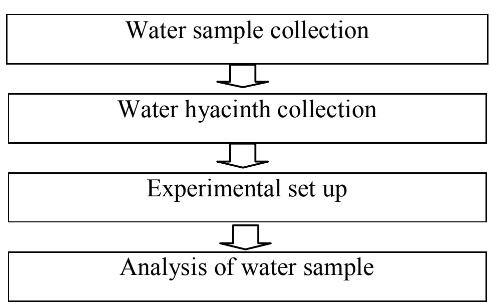


Figure 1: Steps of Practical Work

The water samples from the six ponds were collected by using fresh plastic drams each having a capacity of 20 litres with proper precaution to avoid any mishap that can cause error to the result. The water was stored in glass tanks and plastic jars. The water hyacinth was collected from a natural lake near south Surma upazilla and among the ones present in the lake, the young daughter ones were collected for the study.

The water samples were initially analysed for various water quality parameters before introducing to water hyacinth. Then the sample was treated in glass tanks of 5 mm thickness having a size of 2ft x 1.5ft x 1.5ft and volume of 4.5 ft^3. Each tank was filled with 60 litres of water and three-fourth of the tank was covered with water hyacinth for treatment purposes. The treated water samples were tested again for the same parameters as before. The water samples were collected six times every six times at a 7 day interval and the changes in those parameters were recorded both before and after using the water hyacinth to treat the sample water to show that water hyacinth causes a purifying change to surface water.

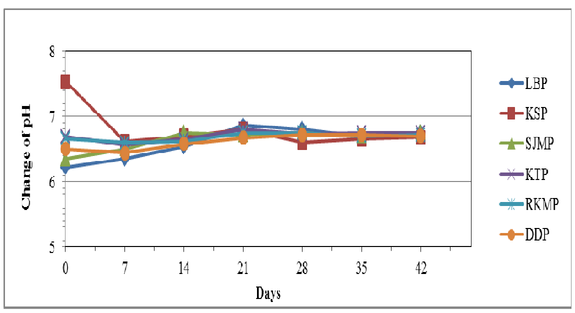
The water samples were tested for the following parameters:

- pH
- Elective conductivity
- Turbidity
- Dissolved Oxygen(DO)
- Biochemical Oxygen Demand (BOD)
- Alkalinity
- Hardness
- Total dissolved solids (TDS)
- Total suspended solids (TSS)

All the tests were performed in the Environmental Engineering laboratory of the Department of Civil Engineering, Leading University, and Sylhet.

3. DATA ANALYSIS AND RESULT

The 10 different parameters for which the water sample was tested before and after using water hyacinth to purify the water showed a variety of changes over the course of 42 days. But the significant changes occurred when water hyacinth was present in the sample water. (With WH means using water hyacinth and without WH means without using water hyacinth).



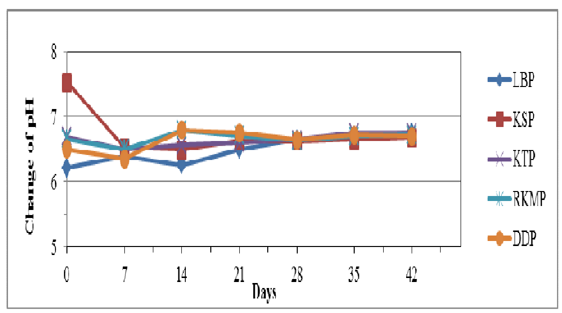
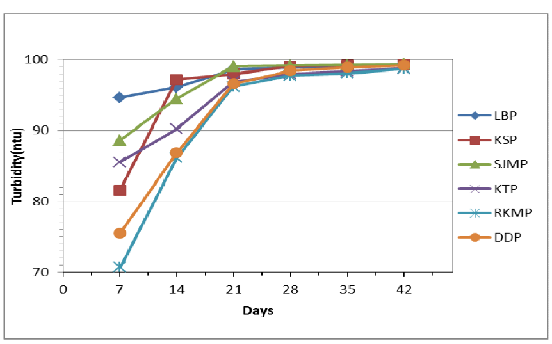


Figure 2:Change of pH vs time Graph (with using WH)   Figure 3:Change of pH vs time Graph (without WH)

There was not very noticeable change in pH in any of the six ponds over the course of 42 days with or without using water hyacinth. The figures varied in the range of 6-7 in the whole time except in case of KSP at the beginning. The pH rapidly dropped from 7.53 to a value less than 7 (6.62 while using water hyacinth and 6.53 without water hyacinth). This proves that water hyacinth can reduce the pH to the neutral range of 6.5-7.5 and contain the pH within the neutral range which makes the water usable (Figure 2 and Figure 3).



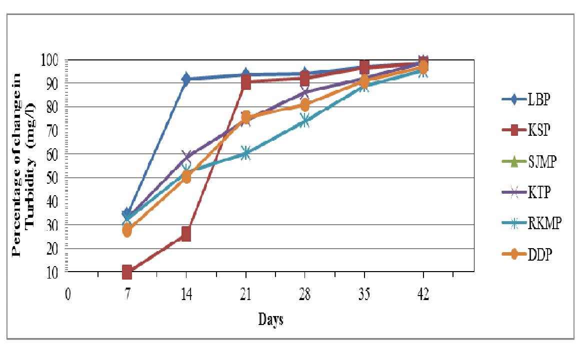


Figure 4:Change of turbidity vs time Graph (with WH)   Figure 5:Change of turbidity vs time Graph (without WH)

There were significant decreases in turbidity while using water hyacinth. The highest decrease recorded was 99.31% for SJMP whereas it was 88.64% in the beginning. Almost similar decreases were observed in the other five ponds where the initial decreases were within the 70%-90% range but final decreases were greater than 99%. On the other hand, when tested without water hyacinth, the initial results were in the range 25%-35% but the final results were low but close to the final result found using water hyacinth, between 98% and 99%. (Figure 4 and Figure 5).

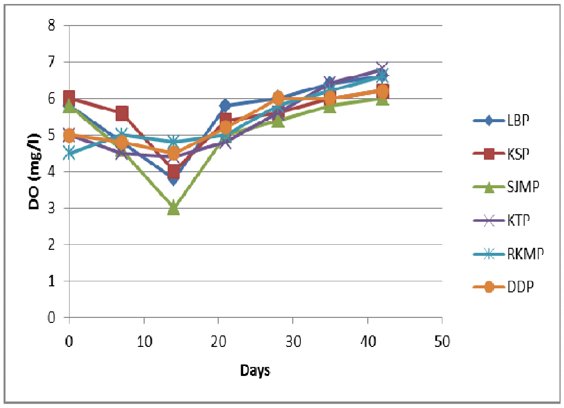


Figure 6:Change of DO vs time Graph (with WH)

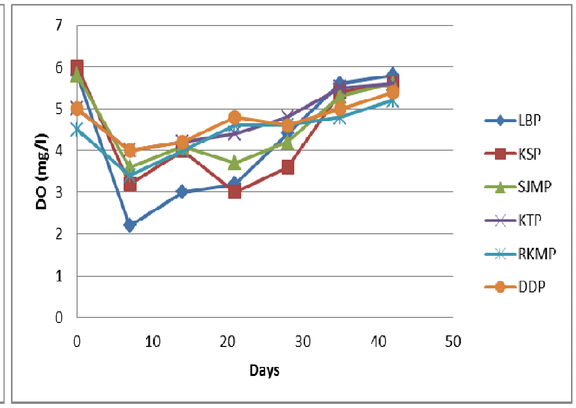


Figure 7:Change of DO vs time Graph (without WH)

In case of the dissolved oxygen (DO) determining tests, the results were very satisfactory. The DO value gradually increased after 14 days of using water hyacinth in spite of taking a dive at the beginning. That could be caused by the weather condition during those 14 days. But after that, the values rose to as high as 6.8mg/l from 5 mg/l for KTP, to 6.6 mg/l from 4.5mg/l for LBP and all the other results were above 6. But any significant changes were absent in the test results found for DO without using water hyacinth. So water hyacinth effectively increases the DO of pond water. (Figure 6 and Figure 7)

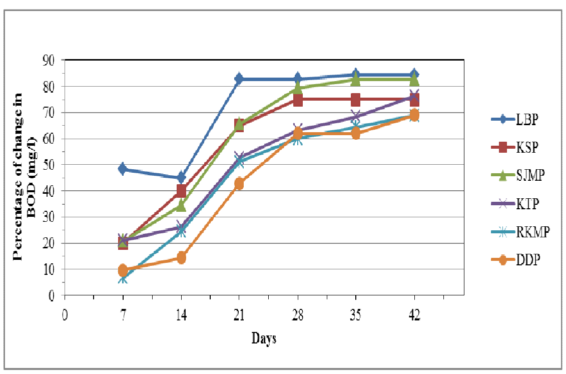


Figure 8: Change of BOD vs time Graph (with WH)

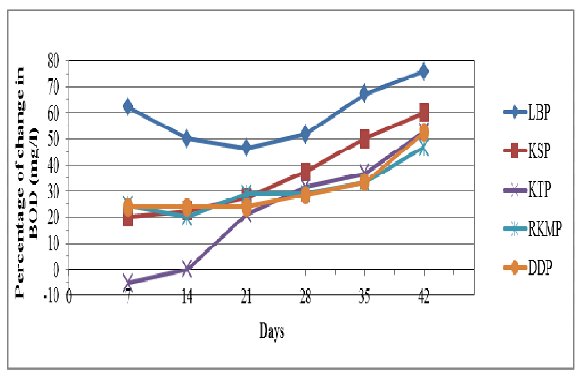
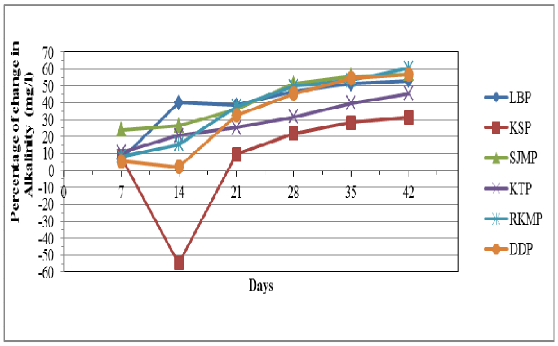


Figure 9: Change of BOD vs time Graph (without WH)

Appreciable decreases were also found in the BOD tests using water hyacinth. Initially 48.27% and 40% decrease occurred in LBP and KSP respectively but in the final tests, the decreases were 84.48% and 75%. Almost similar results were found for other ponds. When tested without water hyacinth instead, the decreases were much lower than what we found after using water hyacinth. The highest decrease was for LBP with 75% and an initial decrease of 62.06%. The lowest initial decrease recorded was for KTP with -5.26% while the final decrease was for RKMP with 46.66% (Figure 8 and Figure 9).



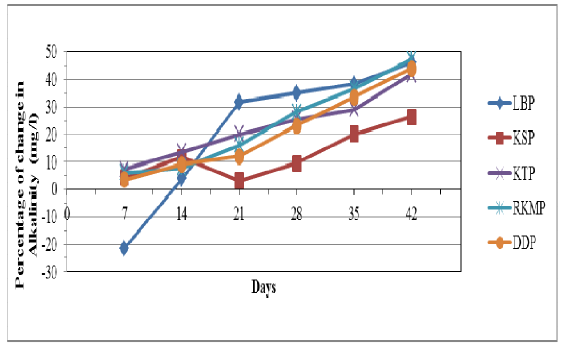
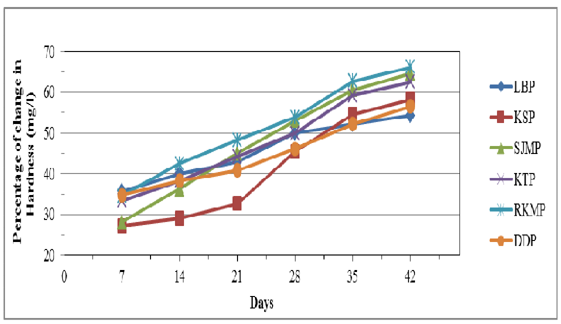


Figure 10:Change of alkalinity vs time Graph (with WH) Figure 11:Change of alkalinity vs time Graph (without WH)

When the sample water was tested after being purified with water hyacinth, there were noticeable decreases observed in the alkalinity tests. While most of the initial data for a decrease in alkalinity were in the range of 5%-25%, the final test data were within the range of 30%-60%. The highest initial decrease was 24.06% for SJMP and highest final decrease was 60.47% for RKMP. An abnormal decrease was found during the 2nd test at KSP due to the presence of a large amount of hydroxide ion (OH^-) during that time. Testing the water samples without water hyacinth did not show a decrease in alkalinity as much as with water hyacinth. The initial results were all less than 8% whereas the final results were less than 50% (Figure 10 and Figure 11).



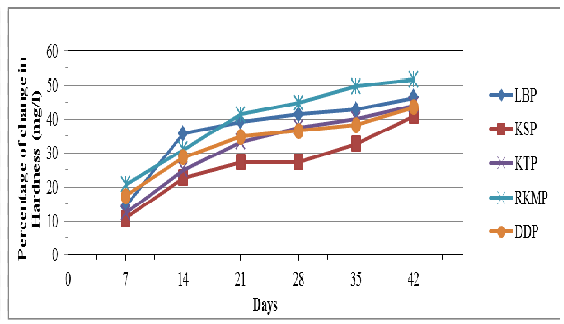
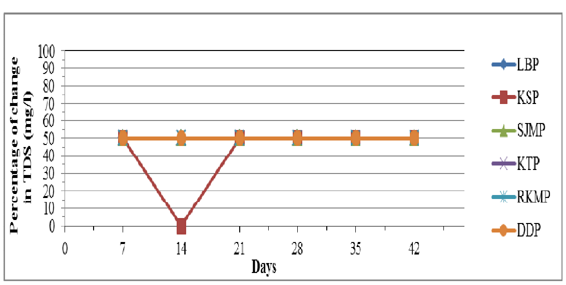


Figure 12:Change of hardness vs time Graph (with WH) Figure 13:Change of hardness vs time Graph (without WH)

There were significant decreases in hardness while using water hyacinth. The highest decrease recorded was 66.20% for RKMP whereas it 34.48% in the beginning. Almost similar decreases were observed in the other five ponds where the initial decreases were within the 25%-35% range but final decreases were in between 55%-65%. On the other hand, when tested without water hyacinth, the initial results were in the range 10%-20% but the final results were quite lower than the ones found using water hyacinth, between 40% and 50%. Only for RKMP, a 51.72% decrease was observed as the final result (Figure 12 and Figure 13).



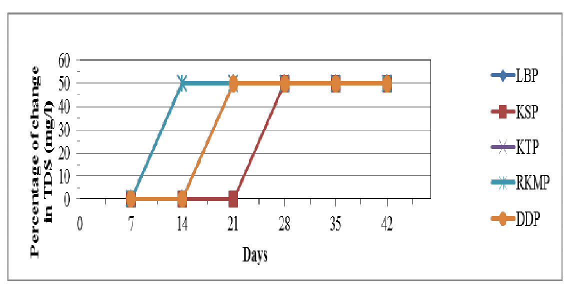


Figure 14: Change of TDS vs time Graph (with WH) Figure 15: Change of TDS vs time Graph (without WH)

After the initial change of 50%, the test results remained the same throught the whole test period when the samples were tested for total dissolved solids. The only change was for KSP in the 2nd test. Almost the same trend was found in the test samples without water hyacinth as when there were changes in this case, all of them were 50% (Figure 14 and Figure 15).

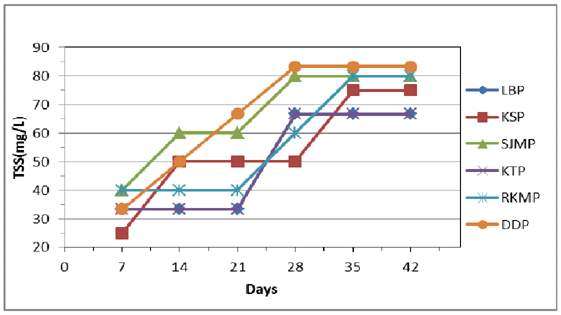


Figure 16: Change of TSS vs time Graph (with WH)

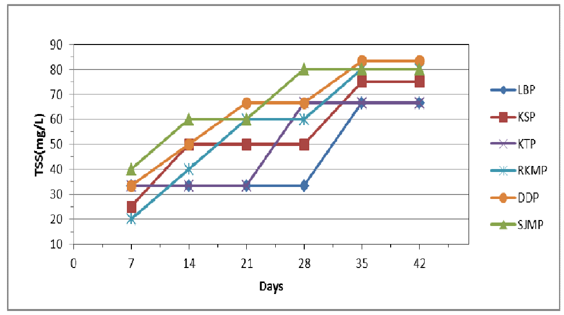


Figure 17: Change of TSS vs time Graph (without WH)

The decrease in turbidity which was found in the water samples tested after using water hyacinth indicated a possible decrease in total suspended solids as turbidity is mostly caused by TSS. This fact was proved through the total suspended solids determination tests as there were high amount of decreases found. The initial changes in LBP, KTP and DDP was 33.33%, in SJMP and RKMP was 40% and in KSP was 25% and it rose to 66.66% in LBP and KTP, 75% in KSP, 80% in SJMP and RKMP and 83.33% in DDP. But almost exact results were found when the samples were tested without water hyacinth, except for a minor difference for RKMP. These data for both the TDS and TSS suggests that water hyacinth does not affect the amount of TDS and TSS very much (Figure 16 and Figure 17).

The highest changes in the different water quality parameters are summarized in a chart below:

Table 2: Highest changes in water quality parameters with and without water hyacinth in percentage

Parameters	With the use of water hyacinth	Without the use of water hyacinth
pH	Moderate	Moderate
Turbidity	99.31% decrease	98.73% decrease
DO	6.8 mg/l	5.8 mg/l
BOD	84.48% decrease	75.86% decrease
Alkalinity	60.64% decrease	47.30% decrease
Hardness	66.20% decrease	51.72% decrease
TDS	50% decrease	50% decrease
TSS	83.33% decrease	83.33% decrease

From the above analysis, it can be deducted that using water hyacinth causes a significant positive change in case of most water quality parameters. It can reduce the turbidity, biological oxygen demand, alkalinity, hardness and effectively raise the amount of dissolved oxygen in the water which essentially improved the water quality condition and saves it form pollution. So the above described process using water hyacinth as a purifier is an effective solution to the problem of surface water pollution.

4. CONCLUSIONS

The study was conducted with a view to finding out a cheap and affordable method to solve the surface water pollution problem that is currently prevailing in Bangladesh. Our country has an abundant supply of surface water which can be used to fulfil the needs of the population but due to continuous pollution, it has always been out of reach. Our dependency on groundwater have heavily reduced the water level throughout the country, especially in the major cities and it has become a very major responsibility to seek for ways to make use of the surface water we have at hand. According to the research conducted, use of water hyacinth has a promising future in contributing to purify the surface water and make it usable and available to the people of Bangladesh. The positive change it causes towards reducing the pollution of the water provides the proof of this process being a very efficient as well as cost effective one not only in Bangladesh but also in other developing countries.

Authorities need to take necessary steps for a large scale application of this process along with further research so that the potential of water hyacinth as a remedy of the surface water pollution problem can be fully extracted.

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