SCENARIO OF WATER POLLUTION BY RETTING OF JUTE AND ITS IMPACT ON AQUATIC LIVES

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ABSTRACT

The Gangetic delta of Bangladesh and India contributes approximately 80–85% of world jute production. Jute fibers are separated from the stems of jute plants by retting process. This study aims at focusing the effect of jute water-retting process on aquatic lives and hence developing a pilot-scale treatment process. Attempts were made to evaluate changes in the physicochemical parameters of water caused by jute retting, and their impact on the survival of aquatic species as well as freshwater fish. In order to evaluate the pollution level in wastewater sample, the major water quality parameters that were determined in this study included BOD_5, COD, color, turbidity, etc. The concentration of P^H and dissolved oxygen (DO) had been recorded in the range of 3.0~3.5 and 1.0~1.5 mg/L, respectively. While the concentrations of other water quality parameters such as BOD_5 and COD of wastewater were found to be in the range of 29~37 mg/L and 4030~6600 mg/L respectively. In this context, a pilot-scale treatment process had been developed using various unit operations such as screening and multi-layer filtration. The treatment efficiency of the developed system was closely monitored in the laboratory in various batch operations. The BOD_5 and COD removal efficiency in treated water were achieved around 67% to 85% and 46% to 64%, respectively. Removal efficiency of other water quality parameters such as color, hardness and total solids etc. were found to be varied in the range of 95-98%, 41-56% and 40-58%, respectively.

Keywords: *Aquatic lives, characteristics, jute-retting wastewater, treatment process*

1. INTRODUCTION

Jute dicotyledenous fibre-yielding plant of the genus Corchorus, order Tiliaceae. This plant is acknowledged for its potential as a source to produce plant based raw material and also capable to absorb carbon dioxide (CO_2) higher than other plant. Bangladesh, India, China, Nepal, and Thailand account for approximately 95% of world jute production (FAO, 1998). Jute is also famous for its traditoinal products are limited to packaging materials like twine, hessian, gunny bag, twill, carpet backing, wool pack, tarpaulin, mats, canvas, wall cover, upholstery, and as furnishing fabrics of different types and natures. (http://en.banglapedia.org/). Jute fibers are separated from the stems of jute plants by retting process. Traditionally, two different types of microbiological retting were mainly adopted; those are dew and water retting (Elena, et al., 2004). Commonly water-retting procedure is selected because it is simple and often produced a good quality of fibre. However, large amount of water in fibre separation (retting) process is required to obtain the fibers. For 10,000kg of jute, approximately 432m3 of water is used in water-retting process (Huda et al., 2012). Matured jute stems are tied in bundles and kept immersed in shallow water for 5–15 days for a series of microbial action to take place, leading to loosening of the fibers from the woody stem (Basak, et al., 1998). A huge amount of biomass undergoes decomposition in the water during this process (Banik, et al., 1993) and results in the generation of waste liquor, and scum that appears on surface of the water (Banerjee and Dastidar, 2005). Water quality of the retting water was change due to the retting process. The degradation process produces smelland also change in color of the water use for retting (Ahmed and Akhter, 2001). There is an ecological consequence of this problem, because this is the season of spawning of many freshwater fish and the shallow marginal areas of ponds, canals, and floodplain lakes, which are used for jute retting, are also used by these fish as their optimum breeding and nursery ground. (Mondal and Kaviraj, 2008). It can be concluded that further treatment is required for this wastewater to ensure pollutants in the wastewater meet the acceptable limit before discharge into the water stream.

2. MATERIALS AND METHODS

2.1 Selection of study area

Nilphamari, Bangladesh was selected as my study area.According to Bangladesh Bureau statistics 2013-2014, this distinct contains total 22736 acres and total production of 99356 bales. Jute retting wastewater was collected from this area.

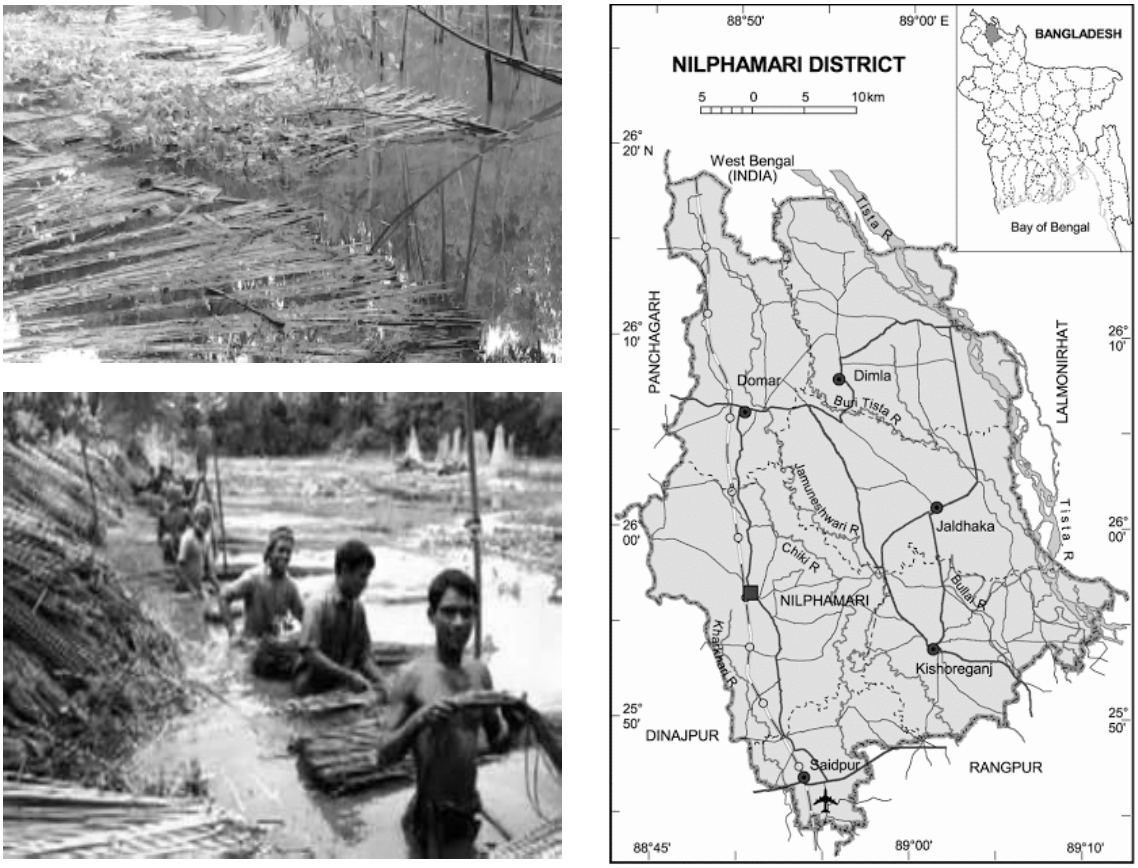

Figure 1: Jute retting and location of the study area.

2.2 Sample analysis

Both physical and chemical water quality parameters were measured and analysed. Water quality parameters includes P^H, colour, turbidity, hardness, phosphate, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS), total dissolved solids (TDS), total suspended solids (TSS) and total coliform. P^H was measured by P^H meter, DO and BOD was measured using digital DO meter and COD was measured by titration etc.

2.3 Development of treatment system

In this context, a pilot-scale treatment process had been developed using down flow system and up flow system containing various unit operations such as screening and multi-layer filtration. Gravels, brick chips, cinders and sand particles were used to develop the multi-layer filter media.

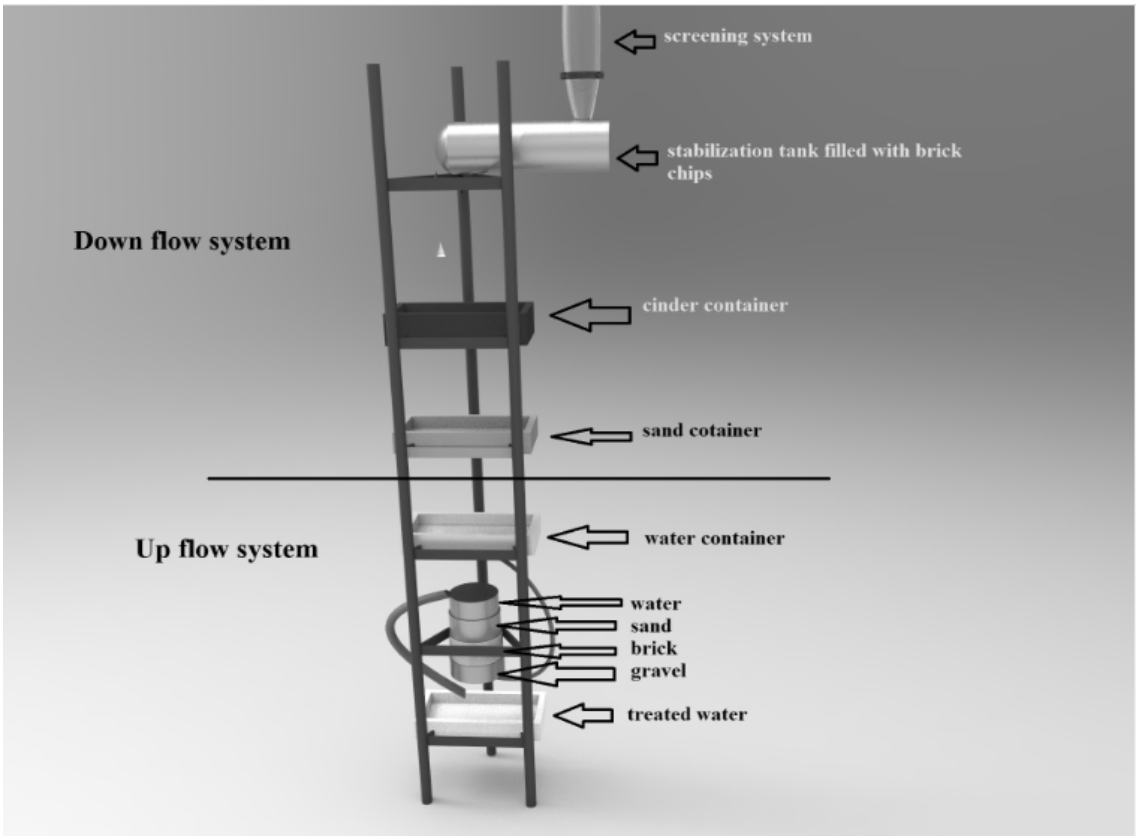

Figure 2: Developed treatment system of jute retting wastewater.

3. RESULTS AND DISCUSSION

This study has been undertaken to determine the wastewater quality from jute-retting process. After retting process, the wastewater sample was immediately analysed according to procedure. The results of wastewater characterization were listed in Table1. The wastewater results were compared with the allowable limit that regulated by Department of Environment (DOE) Bangladesh. After analysis the wastewater characteristics a pilot scale treatment system was developed and its performance was analysed.

Table: 1. Summary of the test results of raw water and treated water with DOE standard

Parameter	Units	Raw water Results	Treated water results	DOE standard for fish
P^H	--	3.0-3.5	7.5-8.5	6.5-9
Colour	Pt Co. Unit	169-210	3.0-9.0	--
Turbidity	NTU	9.5-16	5.5-7	--
Hardness	mg/L	188-210	170-190	80-102
Phosphate	mg/L	4.5-5.5	4.0-5.0	0.005
Dissolved Oxygen (DO)	mg/L	1.0-1.5	7.0-8.0	4-6
Biochemical Oxygen Demand (BOD)	mg/L	29-37	5.0-10	6
Chemical Oxygen Demand (COD)	mg/L	4030-6600	1612-3560	--
Total solid (TS)	mg/L	152-302	91-128	--
Total Coli Form (TC)	N/100mL	9853-12400	6011-7654	--

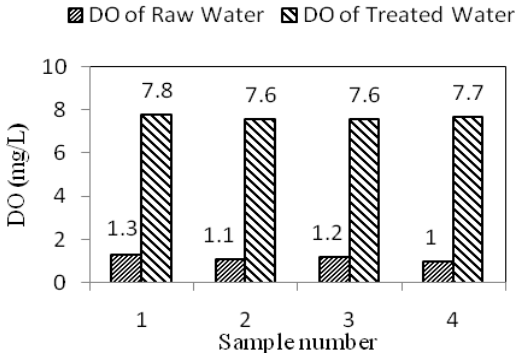

Figure 3: Variation of DO

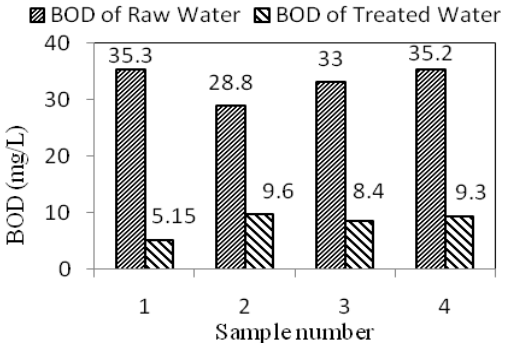

Figure 4: Variation of BOD

The dissolved oxygen (DO) concentration in the jute retting was found to be within the range 1.0 to 1.5 mg/L and was below the fishing standard (DOE) Bangladesh. As the value below 2 mg/L will not support fish at all. There are several reasons for lowering the DO value in jute retting wastewater. As jute is rotten in open space and the sun directly warming the water may reduce DO levels in stream water. The increased molecular activity of the warm water pushes the oxygen molecules out of the spaces between the moving water molecules. Another cause of decreasing DO levels may also be indicative of too many bacteria and an excess amount of biochemical oxygen demand (BOD_5) which uses up DO. Moreover the DO can also be reduced due to fertilizer runoff from farm fields. The same fertilizer which was meant to make land plants grow better now makes the aquatic plants do the same. The treatment system was very effective to increase the DO value within the standard limit.

Form the analysis of the figure 4, biochemical oxygen demand (BOD_5) parameter in raw water was detected between 29 to 37 mg/L. BOD_5 concentration in the wastewater higher than the acceptable limit by DOE, Bangladesh. The ratio of BOD_5/COD of wastewater is always being described by researcher as biodegradability level of materials by which organic matter containing wastewater is readily broken down in the environment. From the results obtained from an analysis shows that the BOD_5/COD ratio of wastewater before treatment is ranging from 0.0042 to 0.0.0063. As the BOD/COD ratio less than 0.1, it indicates the presence of large portions of hard-biodegradable COD. The BOD_5 removal efficiency in treated water was achieved around 67% to 85%.

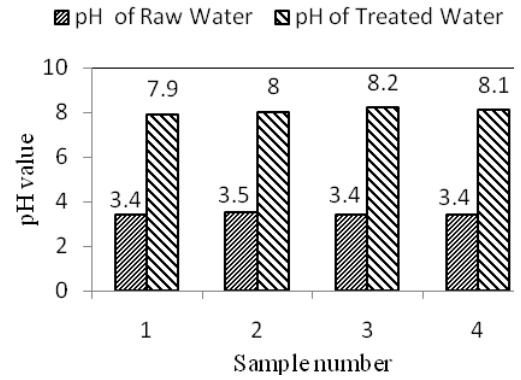

Figure 5: Variation of P^H

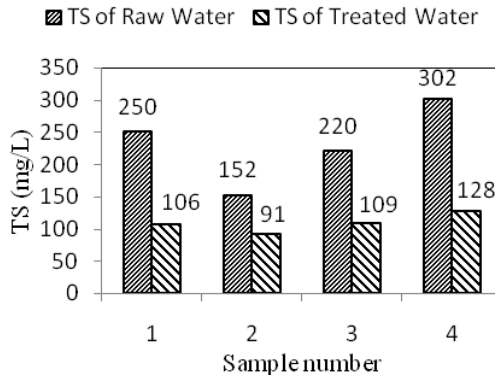

Figure 6: Variation of TS

From the analyses of figure 5, pH of wastewater was found to be in acidic range, which is 3.0-3.5. Organic acid from the jute plant diffuses into water during fibre-separation process, and this occasion may influence the pH of wastewater. Other cause can be identified that the retting process was done in open water body and other organic matters such as leaves unexpectedly rotted into the water. The pilot scale treatment system was very effective to get back the pH value within the DoE standard value and provides a suitable pH in water for aquatic lives.

Concentration of colour measured in the raw water was 169 to 210 Pt Co. Unit. The measurement of colour was true colour. The value indicated that colour in the wastewater was not originated by suspended solids. It might due to the compounds from the fibers that dissolved into the water. The concentration of colour was considered

high. In the regulation, the regulation did not mention acceptable limit for colour in Pt Co. Unit. The color removal efficiency of the treatment system was very high (95-98%) and the treated water easily acceptable for the aquatic lives

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Parameter of turbidity was detected between 9.5 to 16 mg/L. Generally, turbidity has direct relation with presence of finely divided organic matter, plankton and micro-organisms in wastewater sample.The treatment system reduced the turbidity value. But this result could not compare with the standard turbidity value for fisheries due to the limitation of data.

Phosphorus parameter in raw water was found to be in the range of 4.5 to 5.5 mg/L. Possibility the existence of Phosphorus elements in the wastewater sample, may be its come from the fertilizer used for jute plant or soil at the area of jute cultivated area. Phosphorus elements detected in the samples were excided listed in the DOE standard. The phosphorous removal efficiency was found to be 3-12% which did not satisfy the DoE standard and would be a thread for the aquatic lives.

Hardness parameters were analyzed and found in the range of 188 to 210 mg/L. Calcium, magnesium and ferrous ions are responsible for this hardness value which were come from fertilizer used in jute plant. The DOE standard value of hardness for fish cultivation is 80 to 102 mg/L. hardness removal efficiency of the treatment system analyzed 41-56%.

Chemical oxygen demand (COD) also presences in high concentration between 4030 to 6600 mg/L. COD term was referred as indicator to measure organic matter that exists in the wastewater and the results obtained were agreed with findings reported by them, since the origin of wastewater come from plant that contained organic acids and other element. This is due to the due to the presence of higher organic compounds in the wastewater can be chemically oxidized. In comparison, COD concentrations were higher than BOD_5 due to more compounds in the wastewater can be chemically oxidized than biologically oxidized. The COD removal efficiency in treated water were achieved around 46% to 64%.

The concentration of other selected water quality parameters such as total solids and total coliform etc. were also very in jute retting wastewater and the developed treatment system played a very important role to subside the amount of impurities from the wastewater.

4. CONCLUSIONS

Wastewater generated from jute retting process contains high concentrations of organic compounds. Organic substances are the major contributor for BOD and COD concentrations in wastewater and hence influence the dissolved oxygen (DO) concentration in aquatic environment.

Laboratory analysis on jute retting wastewater identified that most of the water quality parameters did not comply with the standard limit for fisheries development and hence pause an adverse environmental impact on the aquatic lives.

In this context, a pilot-scale wastewater treatment unit was developed and its performance was studied. The BOD_5 and COD removal efficiency in treated water were achieved around 67- 85% and 46- 64%, respectively. Removal efficiency of other water quality parameters such as color, hardness and total solids etc. were found to be varied in the range of 95-98%, 41-56% and 40-58%, respectively.

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