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REDUCTION OF COD AND pH OF TEXTILE INDUSTRIAL EFFLUENTS BY AQUATIC MACROPHYTES AND ALGAE

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ABSTRACT

Effluents samples collected from post discharge of equalization tanks of local composite textile mills of Saver were treated with aquatic macrophytes, algae and their combination. They were found to be effective for the reduction of chemical oxygen demand (COD) and pH. Sixty nine per cent of COD was reduced with the combination treatment of *Nostoc*, *Eichhornia crassipes* and *Pistia stratiotes.* With the combination treatment of *Nostoc* and *E. crassipes* reduced 65 per cent COD in glass containers. pH was reduced from 11.2 to 8.6. Between earthen and glass containers, glass container was found to be more effective.

Key words: Industrial effluents, COD, pH, Aquatic macrophytes, Algae

INTRODUCTION

Textile industrial sector is one of the most important and largest industrial sectors of Bangladesh. Seventy eight per cent of the total export earning come from textile and textile related goods. This sector provides 4.5 million jobs and contribute 13% to GDP (BTMA 2007).

Textile industries consume large volume of water and chemical for wet process of textile. The quantities and characteristics of effluent discharged vary from mill to mill depending on the water consumption and the average daily product (Saha 2007). One of the burning problems of our industrial society is the high consumption of water. Many approaches have been taken to reduce water consumption, but better to recycle wastewater into high quality water (Schroder *et al*. 2007).

Dyeing and finishing are two important steps in the textile industry. These steps involve the dyeing of man-made or natural fibres to the desired permanent colors and processing of the fibers into final commercial products. In the dyeing and finishing processes a considerable amount of wastewater, effluent is generated, which is very toxic and contain strong colour, a large amount of suspended solids, a highly fluctuating pH, high temperature, COD, BOD etc. (Garnham 1965). Because of these characteristics, treatment of textile wastewater is an essential requirement before it is being disposed to natural water system (Kabir *et al*. 2002).

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Attempts were made to treat textile effluents with biological means and to observe the effects of differently made culture vessels on the reduction of COD and pH during biological treatments.

MATERIALS AND METHODS

Effluent was collected from H.R. Textiles Mills Ltd., located at Kornapara in Savar upazilla Dhaka, Bangladesh, and situated at N 23° 49' 31" and E 90° 15' 28". The industry has equalizer tank which collects effluents and mix them well. Effluent samples were collected in afternoon because at that time one cycle is completed. Samples were collected during February, May and July, 2008.

Aquatic macrophytes were collected from the Jahangirnagar University campus lakes which had no connection with any textile effluent. The aquatic macrophytes were preserved in the artificial pond in Biological Research Division of BCSIR using tap water only at normal temperature. Inoculum of *Nostoc* was obtained from the Biological Research Division, BCSIR, Dhaka.

The pH of water was determined by using a glass electrode pH meter. COD was determined according to Closed Reflux, Titrimetric method (Greenberg *et al*. 1998).

Textile effluent sample was taken on big plastic bowl and let it settled for three days. After then precipitate was separated from liquid effluent and the latter was used for aquatic macrophytes and algal treatment.

In the first experiment three types of aquatic macrophytes were used separately. Two types of containers, earthen and glass jar were used for each type of aquatic macrophyte. Every container was washed with tap water and then rinsed with effluent. Two liters of effluent was taken in each container. For *S. cuculata* and *P. stratiotes* treatment, eight-ten fresh plants were used. But for *N. indicum* treatment two fresh plants were used. The body and root part of the plants were washed with tap water to remove sediment and other impurities. Plants in each type of treatment were changed at every two days interval and continued for seven days including settlement. Control treatments included effluent in respective containers without any aquatic macrophytes.

In the second experiment for algal treatment three types of containers were used, earthen container, conical flask and glass jar. Every container was treated as mentioned above. Two liters of effluent were taken in earthen container and in glass jar and 500 ml were taken in conical flask. In earthen container and in glass jar 400 g and in conical flask 20 g *Nostoc* were used. After an interval of two to three hours the effluent was stirred with a stick to maintain equal distribution of alga in the effluent. Control was also taken for each kind of treatment. Effluent with algal treatment was kept for four days.

In the third experiment after settlement the effluent was taken for *Nostoc* and *E. crassipes* treatments. For this two types of containers were used, earthen container and glass jar. Two liters of effluent were taken in each earthen container and glass jar. Washed two plants of *E. crassipes* and 77 g of *Nostoc* were used. After two days interval *E. crassipes was* changed and again replaced by fresh plant, but *Nostoc* was not changed. Effluent remained under this treatment for four days.

RESULTS AND DISCUSSION

Results of the reduction of COD of effluents using aquatic macrophytes, alga and their combination treatments are shown in Table 1. In the first set of experiment, the initial COD was 720.0 mg/l. After treatment with *P. stratiotes, N. indicum, S. cuculata, Nostoc* and combination of *Nostoc* and *E. crassipes* COD was reduced to 300, 391.6, 389.6, 337.6 and 300 mg/l, respectively in earthen container. In the second set of experiment, the initial COD was 652.8 mg/l. After treatment with *P. stratiotes*, *N. indicum, S. cuculata*, *Nostoc* and combination of *Nostoc* and *E. crassipes* COD was reduced to 306, 244.8, 346.8, 448.8 and 244.4 mg/l, respectively in glass jar. In the third set of experiment, the initial COD was 800 mg/l. After treatment with *P. stratiotes*, *N. indicum, S. cuculata, Nostoc*, combination of *Nostoc* and *E. crassipes* and combination of *Nostoc*, *E. crassipes* and *P. stratiotes* COD was reduced to 270.6, 312, 353.6, 530.0, 280.8 and 250.68 mg/l, respectively in glass container. In all three sets of experiments, highest amount of reduction was observed by the combination treatment of *Nostoc* and *E. crassipes* and/or *P. stratiotes*.

COD was reduced to 61% in coagulation method (alum + lime + ferric chloride) from textile effluent (Rajraiday and Markendey 1998) and the adsorption filtration method reduced COD to 40 - 75 % on column configuration (Ahmed 2007). The COD removal rate with microflora (biological method) was 69% (Rajraiday and Markendey 1998). The elements which are needed in coagulation system and adsorption filtration method are very expensive and complex to use than the aquatic macrophytes and algae used in this study. Aquatic macrophytes and algae are available in our country. So, aquatic macrophytes and algae combination method is more effective and less costly than coagulation and adsorption filtration method. Wolverton and McDonald (1976) observed that *E. crassipes* reduced the BOD of polluted waters. The study of Sooknah and Wilkie (2004) evaluated the potential of *E. crassipes*, *P. stratiotes* and *Hydrocotyle umbellata* in improving the water quality in terms of nutrient, COD, solids and salinity reductions. They reported the reduction in nutrients and COD with water hyacinth exhibiting the highest rates. For water hyacinth, total Kjeldahl nitrogen was reduced by 91.7%, ammonium by 99.6%, total phosphorus by 98.5%, and soluble reactive phosphorus by 96.5% in 31-day-batch growth. A polyculture of the three plant species in 1 : 1 diluted exhibited the next best performance.

Results of the reductions of pH of textile industrial effluents using aquatic macrophytes and *Nostoc* and their combinations are shown in Table 1. In the first set of experiments, the initial pH was 9.6. After treatment with *P. stratiotes, N. indicum, S. cuculata*, *Nostoc* and combination of *Nostoc* and *E. crassipes* pH reduced to 7.47, 7.13, 7.44, 7.72, and 8.16, respectively in earthen container. In the second set of experiments, the initial pH was 10.7. After treatment with *P. stratiotes, N. indicum, S. cuculata, Nostoc* and combination of *Nostoc* and *E. crassipes* pH reduced to 9.0, 8.7, 9.3, 9.2, and 8.4, respectively in glass container. In the third set of experiment, the initial pH was 11.2. After treatment with P. *stratiotes, N. indicum, S. cuculata, Nostoc* and combination *Nostoc* and *E. crassipes*, combination of *Nostoc, E. crassipes* and *P. stratiotes* pH reduced to 8.9, 9.0, 9.6, 9.2, 8.6, 8.8, respectively in glass container. In all the experiments highest amount of reduction was observed with *Nostoc* and *E. crassipes* in combination treatment.

Mahmood *et al.* (2005) reported that biological treatment with *E. crassipes* showed a considerable reduction in the conductivity and pH of the wastewater, the pH was reduced to nearly neutral in all cases. They interpreted that the reduction in pH could be due to absorption of pollutants by plant. The reduction in pH favored microbial action to degrade BOD and COD in the wastewater.

Results presented in Table 1 also show the effect of containers. Plastic, earthen and glass containers were used with *S. cuculata* treatment. pH was reduced by 15.10, 22.5 and 14.28% with plastic, earthen and glass containers, respectively and COD was reduced to 86.67, 45.88 and 55.8% with plastic, earthen and glass containers, respectively. Earthen container was most effective for pH and plastic container for COD treatment of textile effluent with *S. cuculata*. Earthen and glass containers were used in *P. stratiotes* treatment. pH was reduced by 22.18 and 20.53% with earthen and glass containers, respectively and COD was reduced 58.33 and 66.2% with earthen and glass containers, respectively. Earthen container was most effective for pH and glass container for COD treatment of textile effluent with *P. stratiotes*.

Results presented in Table 1 showed earthen container was most effective for pH and glass container for COD treatment of textile effluent with *N. indicum*, and conical flask was most effective for pH and COD treatment with *Nostoc*. But for the combination treatment of *Nostoc* and *E. crassipes* treatment glass container was found to be most effective for pH and COD treatment.

In COD treatment higher amount reduction was observed in combination treatment and glass container is more effective for COD treatment than earthen container.

In this study pH was reduced by 25.73% with *N. indicum* treatment in earthen container but in glass container amount of pH reduction was 23.21% with *Nostoc* and *E. crassipes* treatment. The pH removal rate with microflora (biological method) was reported 16.19% (Rajvaiday and Markendey 1998). Since the variation of pH with

Table 1. Reduction of COD and pH of textile industrial effluents by aquatic macrophytes and algae in different containers.

Expt.	Biological Treatment	Container	pH			COD (mgO_2/l)		
			Initial	After 7days	% removal	Initial	After 7days	% removal
First set	Control	Earthen	9.6	8.80	8.33	720	650.0	9.72
	S. cuculata	"	9.6	7.44	22.50	720	389.6	45.88
	P. stratiotes	"	9.6	7.47	22.18	720	300.0	58.33
	N. indicum	"	9.6	7.13	25.73	720	391.6	45.61
	Nostoc and *E. crassipes*	"	9.6	8.16	15.00	720	300.0	58.33
	Nostoc	"	9.6	7.72	20.00	720	337.6	53.11
	Nostoc	Conical flask	9.6	7.90	18.00	720	311.2	56.77
Second set	Control	Glass jar	10.7	10.0	6.54	652.8	620.28	4.98
	S. cuculata	"	10.7	9.3	13.08	652.8	346.80	46.87
	P. stratiotes	"	10.7	9.0	15.88	652.8	306.00	53.12
	N. indicum	"	10.7	8.7	18.69	652.8	244.80	62.50
	Nostoc and *E. crassipes*	"	10.7	8.4	21.49	652.8	244.40	62.56
	Nostoc	"	10.7	9.2	14.01	652.8	448.80	31.25
Third set	Control	Glass jar	11.2	9.9	11.60	800	707.20	11.60
	S. cuculata	"	11.2	9.6	14.28	800	353.60	55.80
	P. stratiotes	"	11.2	8.9	20.53	800	270.40	66.20
	N. indicum	"	11.2	9.0	19.64	800	312.00	61.00
	Nostoc and *E. crassipes*	"	11.2	8.6	23.21	800	280.80	64.90
	Nostoc	"	11.2	9.2	17.85	800	530.00	33.75
	Nostoc, *E. crassipes* and *P. stratiotes*	"	11.2	8.8	21.42	800	250.68	68.66

respect to distance in lake where the textile effluent of Dhaka Export Processing Zone released is very low and the pH value was found 9.1 (Ahmed 2007), so in glass container *Nostoc* and *E. crassipes* treatment reduce pH from 11.2 to 8.6 which is quite helpful for fish culture.

CONCLUSIONS

Combination treatment of aquatic macrophytes and an alga were found to be effective for the reduction of COD. Sixty nine per cent of COD was reduced with the combination treatment of *Nostoc*, *E. crassipes* and *P. stratiotes* and 65% of COD was reduced with the combination treatment of *Nostoc* and *E. crassipes* in glass container. In glass container *Nostoc* and *E. crassipes* treatment reduced pH from 11.2 to 8.6. Treatment in glass container was more effective than earthen container for reduction of pH and COD.

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REFERENCES

Ahmed T. 2007. *Characterization of textile effluent from selected industries in DEPZ and their treatment by adsorption-filtration process.* M. Sc. Thesis, Department of Environmental Sciences, Jahangirnagar University.

Bangladesh Textile Mills Association (BTMA), 2007. Annual Report, 14-35.

Greenberg A. E., L. S. Clesceri and A. D. Eaton. 1998. *Standard method for the examination of water and wastewater.* 20th Edition. Eds. American Public Health Association, American Water Works Association & Water Environment Federation.

Gurnham F. C., (Ed.) 1965. *Industrial wastewater control*. Academic Press, New York.

Kabir E. S., M. Kabir, S. M. Islam, C. M. Mia, N. Begum, D. A. Chowdhury, M. S. Sultana, and S. M. Rahman. 2002. Assessment of effluent quality of Dhaka export processing zone with special emphasis to the textile and dying industries. *Jahangirnagar Uni. J. Sci.* **25**: 137-138.

Mahmood Q., P. Zheng, E. Islam, Y. Hayat, M. J. Hassan, G. Jilani and R. C. Jin. 2005. Lab scale studies on water hyacinth (*Eichhornia crassipes* Marts Solms) for biotreatment of textile wastewater. *Caspian J. Env. Sci.* **3**: 83-88.

Rajvaiday N. and K. D. Markendey. 1998. *Advances in Environmental science and technology*, Vol. 8: Treatment of textile industrial effluent. A. P. H. Publishing Corporation, New Delhi, **6**: 51-68 & 163-172.

Saha R.. 2007. *Impact of the effluents of textile dying industries on the water quality of D.N.D. embankment area, Narayanganj*. M. Sc. Thesis, Jahangirnagar University.

Schröder P., J. Navarro-aviñó, H. Azaizeh, A. G. Goldhirsh, S. Digregorio, T. Komives, G. Langergraber, A. Lenz, E. Maestri, A. R. Memon, A. Ranalli, L. Sebastiani, S. Smrcek, T. Vanek, S. Vuilleumier and F. Wissing. 2007. Using Phytoremediation Technologies to Upgrade Waste Water Treatment in Europe. *Env. Sci. Pollut. Res.* **14**: 490- 497.

Sooknah R. D. and A. C. Wilkie. 2004. Nutrient removal by floating aquatic macrophytes cultured in anaerobically digested flushed dairy manure wastewater. *Ecological Engineering* **22**: 27–42.

Wolverton B. C. and R. C. Mcdonald. 1976. Don't waste waterweeds. *New Scientist*, **71**: 318–320.

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