Wettend treatment (HSSP) of wastewater from a milk-processing unit using Bambusa vulgaris, Typha Iatifolia and Cyperus rotundas

Article *in* Indian Journal of Environmental Health · January 2010

Source: PubMed

CITATIONS
3

READS
40

3 authors:

Shalini Tandon
National Environmental Engineering Research Institute
17 PUBLICATIONS **90** CITATIONS

SEE PROFILE

Mangesh B. Inarkar
Institute of Chemical Technology, Mumbai
3 PUBLICATIONS **65** CITATIONS

SEE PROFILE

Rakesh Kumar
114 PUBLICATIONS **2,328** CITATIONS

SEE PROFILE

J. Environ. Science & Engg. Vol. 52, No. 1, p. 23-26, January 2010

Wetland Treatment (HSSP) of Wastewater from a Milk-Processing Unit Using *Bambusa vulgaris*, *Typha latifolia* and *Cyperus rotundus*

SHALINI TANDON*+, MANGESH INARKAR** AND RAKESH KUMAR***

Studies were conducted in soil-less horizontal sub-surface flow wetland (HSSF) embedded with graded gravels using Golden bamboo, *Bambusa vulgaris* (a non-wetland species), *Typha latifolia* and *Cyperus rotundus* (wetland species) for the treatment of wastewater from a milk processing unit. The wastewater was treated with a dilution ratio of 3:1. Removal efficiencies of BOD and COD were studied at one, two and three days hydraulic retention time (HRT). At one day HRT, the removal efficiency (%) of these parameters was lower in comparison to when the wastewater was subjected to two and three days HRT. The increase in removal efficiency with increase in HRT was marginal when it was increased from 2 days to 3 days. The percentage removal of COD and BOD at two days retention time followed the order: Golden bamboo (93, 88) > *Cyperus rotundus* (91, 90) > *Typha latifolia* (85, 87).

Key words : *Golden bamboo, constructed wetland, horizontal sub-surface flow system*

Introduction

Dairy plants process a wide variety of products including milk, cheese, butter, ice cream, yoghurt, nonfat dry milk, whey and lactose. The volume and composition of dairy wastes from each plant depend on the products produced, waste minimization practices, types of cleaners used and water management in the plant. Since, most dairy plants process several milk products, characteristics of waste streams vary widely from day to day. The main sources of dairy effluent are spills and leaks of products or by-products, residual milk or milk products in piping and equipment before cleaning, wash solution from equipment and floors, condensate from evaporation process and pressing brines from cheese manufacturing[1].

Constructed wetlands are being used as a part of municipal wastewater treatment and also for the treatment of agricultural wastewaters in developed countries. These can treat variety of wastewaters's types by reducing nutrients, organic matter, solids, and pathogens, under a wide range of loading conditions. A significant concern when dealing with agricultural wastewaters is nutrient reduction, particularly nitrogen and phosphorus, as these can lead to eutrophication of surface waters.

Case studies of dairy and swine wastewater treatment wetlands have shown nitrogen and phosphorus removal between 48–98% and 35–96%, respectively, depending on nutrient loading conditions and wetland age. Generally, higher removal in wetlands with lower loading rate, that has been more recently established, has been observed[2,3]. In recent years, the use of constructed wetlands for the treatment of dairy wastewater has been gaining popularity due to low capital cost, maintenance requirement and non-reliance on machinery or energy inputs [4]. It has been demonstrated that dairy farming can benefit from sub-surface flow (SSF) for the treatment of wastewaters with a low content in organic matter and nutrients, such as those derived by washing operation of milking area but trod over by cows[5].

* Scientist, Mumbai Zonal Laboratory, National Environmental Engineering Research Institute (NEERI, CSIR), 89/B, Dr. A. B. Road, Worli, Mumbai - 400 018

** Project Fellow, Mumbai Zonal Laboratory, National Environmental Engineering Research Institute (NEERI, CSIR), 89/B, Dr. A.B. Road, Worli, Mumbai - 400 018

***Scientist and Head, Mumbai Zonal Laboratory, National Environmental Engineering Research Institute, (NEERI,CSIR), 89/B, Dr. A.B. Road, Worli, Mumbai - 400 018

+Corresponding author : e-mail : s_tandon@neeri.res.in

Table 1: Organic loading rates obtained in various studies

References	Location	Wetland type	Organic loading rate	Pre-treatment
Maehlum *et al* (1995)[9]	Norway	SSHF	4 g BOD m^{-2} d^{-1}	Septic tank
Neralla *et al* (2000)[10]	USA	SSHF	2 g BOD m^{-2} d^{-1}	Septic tank
Healy and Cawley (2002)[11]	Ireland	FWS	1 g BOD m^{-2} d^{-1}	Aerator/clarifier
Luederitz *et al* (2001)[12]	Germany	SSVF	21 g BOD m^{-2} d^{-1}	Aerobic digester
	Germany	SSVF	10 g BOD m^{-2} d^{-1}	Two unaerated ponds
Current study	India	SSHF	7 to 31.5 g BOD m^{-2} d^{-1}	No pre-treatment

In this study, Golden bamboo (a non-wetland plant) has been used in the HSSF without the soil but with graded gravel as a support material. The efficiency of bamboo has been compared with two locally available wetland plant species, Typha and Cyperus. An attempt has been made to optimize the minimum hydraulic retention time suitable for horizontal sub–surface flow (HSSF) constructed wetland.

Materials and method

Dairy wastewater was collected from dairy outlet of Worli milk processing unit located in Worli, Mumbai (India). The activities carried out in the unit were pasteurization, homogenization, cooling, packaging, washing of bottles, reactors etc. The plants used in the study were locally available- *Typha latifolia, Cyperus rotundus,* and *Bambusa vulgaris.* Plants were planted seperately in each experimental cell of size 0.8m x 0.3m x 0.3m with water holding capacity of 27 liters with graded gravels. The plants were first acclimatized for a period of one month with dairy wastewater using variable dilution ranges from 10% to 50%. After acclimatization, studies were carried out with 75 % (3:1) of dairy wastewater. This was studied at a retention time of 1, 2 and 3 days. **Table 1** presents the different loading rates in various studies ranging between 7.8 to 31.5 g BOD m^{-2} d^{-1}.

Hydraulic characteristics

The average wastewater arriving at the wetland system was 27 L/day. Considering this wastewater volume, the hydraulic retention time studied for the system were one, two and three days. The media used for the experimental units was gravels with the porosity of 0.375. The retention time was calculated as reported by[6].

$$HRT = \frac{PHLW}{Q}$$

Where P- porosity of media gravel
L – Length of the wetland cells
W – Width of the wetland cells
H – Effective depth of system
Q – Mean flow rate (m^3/day)

Chemical Oxygen Demand (COD by open reflux method), Biological Oxygen Demand (BOD_5 by azide modification)[7,8] were analysed using APHA (1998) Standard Methods[7,8].

Results and discussion

The pH of the influent during the study period ranged between 5.25 to 8.54, whereas conductivity ranged from 178 to 276 µS/cm. The pH ranged from slightly acidic to alkaline condition due to variable activities prevalent in the dairy during the different shift operations.

When compared the COD of different wetland units and control, it was observed that the maximum reduction in COD was seen in Golden Bamboo unit followed by *Cyperus* and *Typha* sp. Increase in removal efficiency was observed in all units including control unit as retention time was

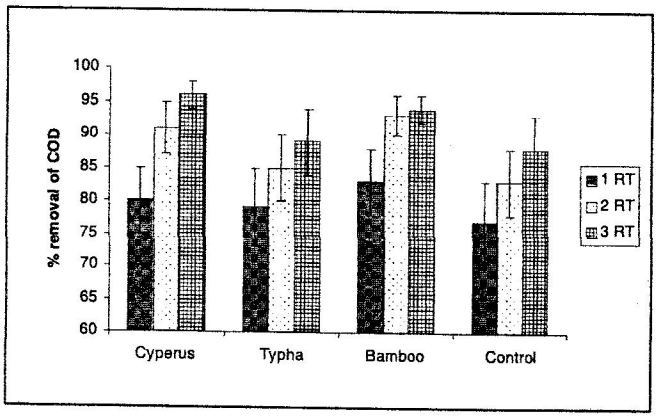

Fig. 1: Percent removal of COD in different wetland units subjected to dairy wastewater of 3:1 dilution with different retention times

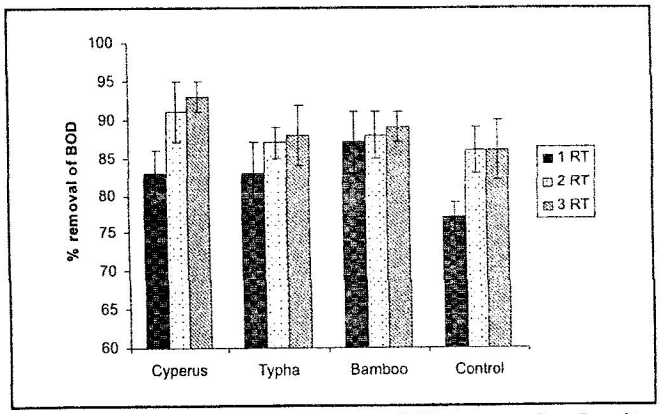

Fig. 2: Percent removal of BOD in different wetland units subjected to dairy wastewater of 3:1 dilution with different retention times

increased. Golden Bamboo exhibited 93 and 94 % removal of COD at 2 and 3 day retention time, respectively as shown in **Fig. 1**.

The BOD reduction in different wetland units was the highest in *Cyperus* units followed by bamboo and *Typha* irrespective of the retention time. With the increase in retention time the percentage removal increased. The increase from 2 day retention time to 3 day retention time was marginal. Bamboo exhibited 88% and 89 % removal of BOD at 2 and 3 day retention time, respectively compared to 90% and 93 % of *Cyperus* as shown in **Fig. 2**.

At one day retention time the removal percentage of BOD and COD was found to be more than 80% but on increasing the retention time to two days it further increased to above 85% in most cases. The increase from two to three days retention time was marginal. Golden bamboo, a non-wetland plant, contributed to 93% and 88 % removal of COD and BOD at two days retention time.

Conclusions

On increasing the retention time from one to three days the removal percentage of BOD and COD was found to increase but the increase from two days to three days was marginal. For lowering the COD and BOD of wastewater from a milk processing unit at a dilution of 3:1 a combination system is more efficient than a single plantation unit but *Bambusa vulgaris* can very well be used for the purpose as it showed more than 90 % and 85% of COD and BOD removal. This establishes the scope for using other non-wetland plants for treatment purpose in the given constructed wetland. Further research can be conducted with less dilution of the dairy wastewater and also with other types of wastewater having high organic loading using non-wetland plants specially where there is paucity of wetland plants.

References

1. Wendroff W L, Treatment of dairy waste, in *Applied Dairy Microbiology* (CRC Press, USA) 681 (2001)
2. Newman J M, Clausen J C and Neafsey J A,. Seasonal performance of a wetland constructed to process dairy milk house wastewater in Connecticut, *Ecol Engg*, **14**, 181–198 (2000)
3. Schaafsma J A, Baldwin A H and Streb C A, An evaluation of a constructed wetland to treat wastewater from a dairy farm in Maryland, USA, *Ecol Engg*, **14**, 199–206 (1999)
4. Tanner C C, Clayton L J S and Upsdell M P, Effect of loading rate and planting on treatment of dairy farm wastewaters in constructed wetlands—i. Removal of oxygen demand, suspended solids and faecal coliforms, *Water. Res.*, **29 (I)**, 17-26 (1995)
5. Cronk, J K, Constructed wetlands to treat wastewater from dairy and swine operations: A review, *Agric. Ecosys. Environ.*, **58 (2–3)**, 97–114 (1996)
6. Vymazal J, Brix H, Cooper P, Haberl R, Green M and Haberl R, Removal mechanism and types of constructed wetland. *In Constructed Wetland for Wastewater Treatment in Europe* (Backhuys Publishers, Leiden, The Netherlands) (1998)
7. APHA 1989, Standard Method for Examination of Water and Wastewater. 17th Edition Washington DC, USA
8. APHA 1998, Standard Method for Examination of Water and Wastewater, 20th Edition, Washington DC, USA
9. Maehlum T, Jenssen P D and Warner W S, Cold-climate constructed wetland, *Water Sci and Tech*, **32 (3)**, 95-101 (1995)
10. Neralla P, Weaver R W, Lesikar B J and Persyn R A, Improvement of domestic wastewater quality by subsurface flow constructed wetland, *Biores Tech.* **75**, 19-25 (2000)

11. Healy M G and Cawley A M, The nutrient processing capacity of a constructed wetland in western Ireland, *J of Env Qual,* **31(5)**, 1739-1747 (2002)

12. Luederitz V, Eckert E, Lange-Weber M, Lange A and Gersberg R M, Nutrient removal efficiency and resource economics of vertical flow and horizontal flow constructed wetland, *Ecol Engg,* **18(2)**, 157-171 (2001)