

Possibility of Low-cost Water Desalination using *Sporobolus Virginicus*

Chainarong Sanala¹, Chatree Tisongmuang² and Petch Pengchai^{2,*}

¹Engineering/Construction Department, Udon Thani Rajabhat University, Thaharn Road, Amphur Muang, Udon Thani, 41000 Thailand

²Environmental Engineering Laboratory, Faculty of Environmental Engineering, Mahasarakham University, Kham Riang, Kantarawichai, 44150 Thailand

petchpengchai@zoho.com*

Abstract. Brackish water is inappropriate for either tap water production or agricultural use. Desalination can be done to solve the problem but the conventional processes require large amount of energy and high cost. To propose an alternative low cost technology, phytoremediation for salinity removal was done in a batch experiment. *Sporobolus virginicus* was applied to 3 L brackish water of 5 ppt salinity. The result revealed that 107 g of *Sporobolus virginicus* can remove 37% of salinity at 25 days retention time. *Sporobolus virginicus* survived without soil and continuously grew up along the experimental period.

Keywords:

Sporobolus virginicus, desalination, phytoremediation, brackish water, salinity

1. Introduction

Saline soils and brackish water are generally found in many places of Thailand. Some are caused by the intrusion of seawater during drought season [1], some are the result of geological conditions [2]. Chao Phraya [1] and Ta Chin [3] rivers, sources of tap water in Bangkok metropolitan, are often invaded by seawater. Salinity in the water causes salty tap water [4] and damages to orchid plants [3]. The spread of dryland salinity, such as found in northeastern area of Thailand is another phenomenon caused by the rock salt deeply buried underground [2]. This natural condition turns fresh water into brackish water. Therefore, water availability for domestic and agricultural use has been limited in this area [2]. Besides reservoir construction and salt mining, water desalination is put forward as a possible way to overcome these problems.

Desalination methods that have been widely used in wastewater treatment are thermal based and membrane based processes. Typical thermal based desalinations are Multi Stage Flash (MSF) and Multi Effect Distillation (MED) which require 2.75-5 kWh/m³ of energy [5]. Comparatively, membrane based desalinations, such as Reverse Osmosis (RO) and Electrodialysis (ED) consume less energy of 2.5-2.75 kWh/m³ [5].

However, both types of technologies have capital cost of 800-1,500 USD/m³/day and fresh water production cost of 1-2 USD/m³ [5] which is much higher than typical tap water production cost, 0.147-0.268 USD/m³ [6].

Recently, low cost technology called "phytoremediation" has been applied for saline soil desalination. By planting halophytes such as *Echinochloa stagnina*, *Suaeda australis*, *Sesuvium portulacastrum*, *Sporobolus virginicus*, salts from contaminated soils can be removed [7]. This technology is preferable especially for farmers who can harvest and feed their live stocks with these halophytes.

In Thailand, *Sporobolus virginicus*, namely Dixie grass, has been recommended by the provincial Land Development Station to be planted in saline soil in order to rehabilitate the land [8]. Using osmotic adjustment, *Sporobolus virginicus* excludes salts from the soil by its roots, stores water in tissues and excretes salt via its leaves and stems [8].

According to the above information, *Sporobolus virginicus* should also be available for water desalination. However, no proof has been reported yet. In order to provide alternative low cost approach for water desalination, various masses of *Sporobolus virginicus* was applied to brackish water and examine for the possibility of salinity removal in this study.

2. Methodology

Brackish well water was collected from Borabue city of Mahasarakham province, Thailand and measured for the salinity. *Sporobolus virginicus* was collected from Ban Pai city of Khon Kaen province, Thailand and applied to the brackish water in a batch experiment.

Seven glass containers were filled with 3 liters of the brackish water. Specific mass of *Sporobolus virginicus* (18-125 grams, see Table 1) was put in a plastic basket before placing on top of each container. Roots of *Sporobolus virginicus* were soaked in the brackish water while the leaves rise out of water to expose sunlight (see Fig. 1).

Salinity of brackish water in 7 containers was measured using salinity meter (ExStik® EC400, Extech, United States) every day for 25 days. Water level in each container was measured every day and used for removing the impact of water evaporation on raw salinity data. Clean water was once added to every container at day 9th to maintain the water levels. Longest root length of *Sporobolus virginicus* in each container was also measured every 5 days.

Table 1: *Sporobolus virginicus* used in the batch experiment

Container No.	Initial condition of <i>Sporobolus virginicus</i>	
	Mass (g)	Length of root (cm)
1	18	1
2	35	1.5
3	53	1
4	72	2
5	89	1.5
6	107	1.5
7	125	2.2



Fig. 1: Batch experiment of salinity removal

3. Results

Reduction of salinity was found in all containers as shown in Fig. 2. Although the salinity levels had increased in day 9th, it was a temporary incident. During the experiment, granular salt was observed at leaves and stems of *Sporobolus virginicus* (Fig. 3). Consequently, clean water added to the containers could wash some of this salt back down into water samples again.

At retention time of 25 days, total removal efficiency of 28-37 % was observed for the application of 18-125 g *Sporobolus virginicus*. Comparatively high removal efficiency of 37 % was reached in case of 107 g *Sporobolus virginicus* application (see Fig. 4). From Fig. 4, 35 g, 53 g, 72 g and 89 g of *Sporobolus virginicus* applications achieved comparative level of removal efficiency, 30-33 %. The result suggested that the amount of *Sporobolus virginicus* did not sensitively affect the removal efficiency. Focusing in the case of 107 g *Sporobolus virginicus* application, the plot of salinity levels versus retention time and its regression equation was shown in Fig. 5.

Based on the equation, permissible salinity level of 2 ppt defined in Irrigation Water Quality Standard [9] may be reachable under retention time of 36 days. Longest root length of *Sporobolus virginicus* in each container (see Fig.6) implied that the plants in all containers were healthy and might have grown more if the retention time were expanded into longer than 25 days. However, further experiment is needed to verify that assumption.

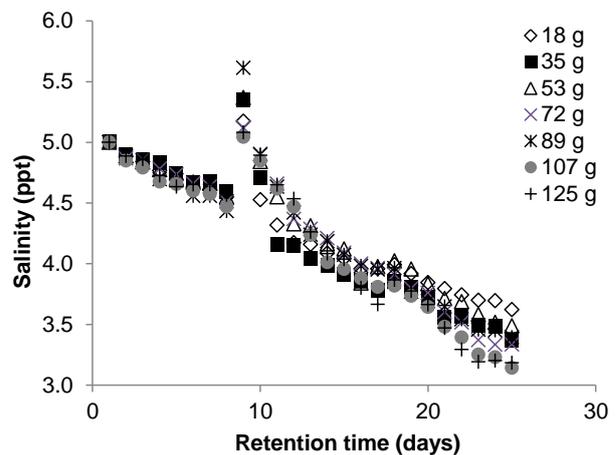


Fig. 2: Salinity levels in 7 containers



Fig. 3: salt excreted from leaves and stems of *Sporobolus virginicus*

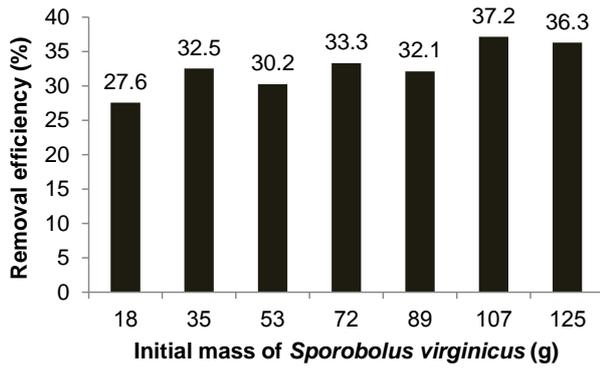


Fig. 4: Salinity removal efficiency of 7 containers

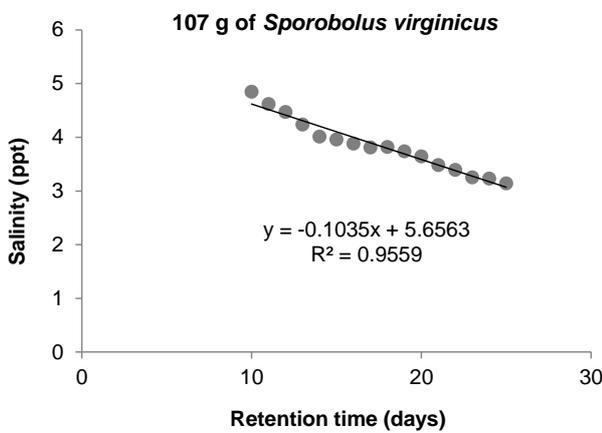


Fig. 5: Regression equation in case of 107 g *Sporobolus virginicus* application

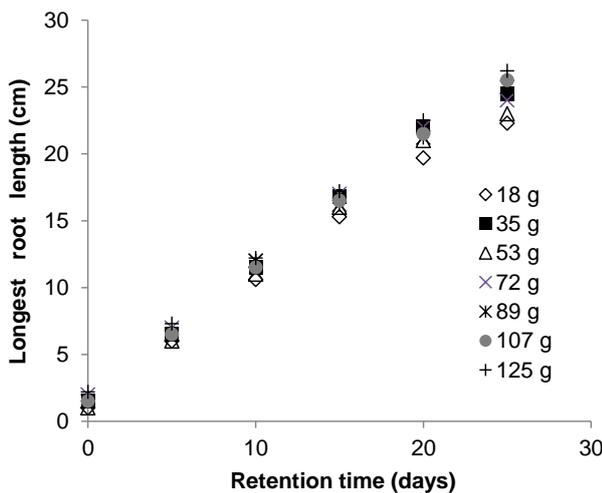


Fig. 6: Longest root length of *Sporobolus virginicus* during experiment

In fact, there are many limitations for practical use of *Sporobolus virginicus* in desalination. Firstly, such long retention time of 36 days is not suggested in conventional constructed wetland approach. Facultative lagoon with

recommended retention time of 20-180 days [10] might be one of the application choices. Secondly, the *Sporobolus virginicus* excreted salts throughout its stem and leaves. Therefore, the removed salt might be washed down into the water again by wind or rain. The plants should be well harvested before the salt washing.

4. Conclusion

Low-cost water desalination was proved possibility of using *Sporobolus virginicus*. Removal efficiency of 37 % was observed after soaked 107 g of *Sporobolus virginicus* in 3 L of brackish water for 25 days. However, further study in reactor design and plant harvesting is needed for practical use in agricultural water treatment.

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Biography



Chainarong Sanala received his Bachelor degree in Civil Engineering from Mahasarakham University, Thailand, in 2012. Now he works as an engineer at Engineering and Construction Department, Udon Thani Rajabhat University, Thailand.



Chatree Tisongmuang received his Bachelor degree in Civil Engineering from Mahasarakham University, Thailand.



Petch Pengchai received her PhD. in Environmental Engineering from University of Tokyo, Japan, in 2002. Now she is a lecturer at the Faculty of Engineering, Mahasarakham University, Thailand. Her research interests include low cost technology, microbial fuel cell.