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Phytoremediation potential of water hyacinth (*Eichhornia crassipes*) in tanks with high soil organic matter

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Abstract
This study was conducted in order to assess the potential of water hyacinth (*Eichhornia crassipes*) as phytoremediator in tanks provided with bottom soil high which is high in organic matter. Three water hyacinth surface covers were evaluated: T1 = 5%, T2 = 10% and T3 = 20%. Water hyacinth as phytoremediator had no effect in altering the temperature, alkalinity and phosphorus of the water in tanks. As high as 20% water hyacinth cover (T3) had no negative effect on the concentration of dissolved oxygen. The effect of water hyacinth as phytoremediator was more observed in reduced total dissolved solids (TDS), total ammonia nitrogen (TAN) and nitrite of water. As low as 5% water hyacinth cover (T1) could significantly reduce TDS and TAN. At least 20% water hyacinth cover (T3) could result to reduction of nitrite.

Keywords: Phytoremediation, water hyacinth, organic matter, water quality, aquaculture

1. Introduction
Soil is a natural body consisting of layers that are primarily composed of minerals. Pond soil plays an important role in regulating the concentration of nutrients in the pond water [1]. According to Boyd [2], the four most important parameters of soil to aquacultural production are texture, organic matter content, pH and nutrient concentrations.

Soil organic matter (SOM) is the organic fraction of the soil that is made up of decomposed plant and animal materials as well as microbial organisms [3]. SOM is generally derived from residual plant and animal materials such as uneaten feeds, feces, dead algae and manure. Accumulation of organic sediments may limit pond intensification. Avnimelech and Ritvo [4] stated that intensive SOM degradation at the pond bottom and high sediment oxygen demand exceeds the oxygen renewal rate. High SOM will increase oxygen demand as bacteria break down organic matter [5]. In addition, the breakdown of organic matter can increase ammonia concentrations, which is toxic to the cultured aquatic organisms [5].

Development of cost-effective and environmentally friendly technologies for the remediation of soils and wastewaters polluted with toxic substances is a topic of global interest [6]. The value of metal-accumulating plants to wetland remediation has been recently realized. Liao and Chang [6] stated that one way of removing toxic gases and materials from contaminated soils and waters is through phytoremediation.

Phytoremediation utilizes physical, chemical and biological processes to remove, degrade, transform, or stabilize contaminants within soil and groundwater [7]. Currently, phytoremediation is used for treating many classes of contaminants, including petroleum hydrocarbons, pesticides, explosives, heavy metals and radio nucleotides.

Water hyacinth (*Eichhornia crassipes*) is invasive and free-floating aquatic macrophytes that is native in the Amazon basin [8]. However, this species of aquatic macrophytes is successfully used for wastewater treatment and also known for its phytoremediation potential [9].

2. Materials and Methods
2.1. Collection of soil samples and analysis of organic matter
Soil samples were collected from grow-out ponds of the Freshwater Aquaculture Center located in Central Luzon State University (FAC-CLSU), Science City of Muñoz, Nueva Ecija, Philippines. The soil samples were brought in the Soil and Water Quality Laboratory of FAC-

CLSU for the analysis of organic matter following the procedure of the Philippine Council for Agriculture and Resources Research [10]. Soil samples with high organic matter (>5.8%) were only used in the experiment. The formula used for the computation of per cent organic matter is as follows:

% OM = 6.9 (S-T)/S
Where: OM = organic matter
S = mL of ferrous solution required for blank
T = mL of ferrous solution required for sample

2.2. Collection of water hyacinth
Young water hyacinth was collected in the ponds of FAC-CLSU. Individual length and weight of each plant stolon were measured. Plant samples with comparable size were used to lessen the variability.

2.3. Experimental unit and design
Outdoor square tanks with an individual volume of 0.5 m^3 were used as experimental units. The study used one-factor in Randomized Complete Block Design (RCBD) with one control and three treatments (Table 1); each control and treatment were replicated thrice. Two-centimeter thick dried soil sample with high organic matter was placed in the bottom of each tank. Water from fertilized grow-out ponds was added gently in the tanks. Water hyacinth was placed and suspended in one side of the tank's water surface. The experimental set-up was run for 7 weeks.

Table 1: Description of treatments that were used in the study

	Description
Control	Without water hyacinth
Treatment 1	5% water surface covered with water hyacinth
Treatment 2	10% water surface covered with water hyacinth
Treatment 3	20% water surface covered with water hyacinth

2.4. Water quality analysis
Water parameters such as temperature, dissolved oxygen (DO), pH and total dissolved solids (TDS) were measured using YSI multi-parameter equipment. Meanwhile, additional water samples were collected for the analysis of alkalinity, total ammonia nitrogen (TAN), nitrite and phosphorous following the laboratory manual of the course Aquatic Ecology of the College of Fisheries-CLSU. The analyzed waster samples at 7th week were subjected to statistical analysis.

3. Results and Discussion
Water hyacinth as phytoremediator (T1 to T3) had no effect in altering the temperature, alkalinity and phosphorus of the water in tanks provided with bottom soil high in organic matter. The water temperature and alkalinity remained conducive for fish rearing despite the provision of bottom soil environment which was high in organic matter. Temperature recorded in the afternoon was higher as compared in the morning. Phosphorus concentration was beyond optimum in all tanks; even though not statistically significant, tanks with water hyacinth (T1 = 0.32±0.24 ˚C, T2 = 0.19±0.14 ˚C, T3 = 0.14±0.05 ˚C) had lower phosphorus concentration as compared with control (0.38±0.16 ˚C). Sooknah [11] stated that water hyacinth utilizes nitrogen, phosphorus and other minerals as a food source. Phosphorus removal is due to the plant uptake, retention by the underlying sediments, and precipitation in the water column. Since phosphorus is retained in the system, the ultimate removal from the system is achieved by harvesting the plants and removal of sediment [11].

During morning, DO in treatments (T1 to T3) was higher as compared to control with statistical significance when T1 (6.59±0.29 ppm) was compared to control (4.79±0.90 ppm). Increase in DO was observed in the afternoon wherein DO in control (13.90±1.47 ppm) was significantly higher as compared to the rest of treatments (T1 = 10.69±1.25 ppm, T2 = 9.13±0.81 ppm, T3 = 8.45±1.31 ppm). This study provided information that as high as 20% water hyacinth cover (T3) had no negative effect on the concentration of DO. Villamagna [12] found that up to 25% cover of 0.04 ha experimental 6 ponds did not cause DO to reach levels that threaten fish survival (less than 2 mg/L), although they did find an inverse negative relationship between DO and water hyacinth cover. Macrophytes like water hyacinth provide surface cover and impede light penetration and atmospheric oxygen exchange in the system, thus, might cause reduced oxygen production from phytoplankton [13]. This plant was associated with significantly lower concentrations of DO when compared to *Hydrilla verticillata* and *Sagittaria lancifolia* L [12].

The water pH during morning and afternoon remained optimum for fish culture. Afternoon pH in T1 (7.94±0.09) was significantly higher to T2 (7.78±0.13) and T3 (7.81±0.18). In case of the macrophytes *Eichhornia crassipes*, there was recorded decline in pH alongside with temperature and biological oxygen demand [14].

The effect of water hyacinth as phytoremediator was more observed in TDS, TAN and nitrite. The TDS of T1 in the morning (431.18 ppm) and afternoon (427.00 ppm) was significantly lower as compared to control (AM = 496.89 ppm, PM = 482.71 ppm). Water hyacinth has been used successfully in wastewater treatment systems to improve water quality by reducing the levels of organic and inorganic nutrients [6]. Water hyacinth was also effective in significantly lowering the TAN and nitrite of water. Readings of TAN in all treatments (T1 = 0.15±0.04 ppm, T2 = 0.13±0.02 ppm, T3 = 0.10±0.01 ppm) were significantly lower as compared to control (0.22±0.07 ppm). Meanwhile, nitrite concentration in T3 (0.005±0.003 ppm) was significantly lower when compared to control (0.024±0.016 ppm). Hyacinth plants are capable of assimilating both ammonium and nitrate; however as with many aquatic plants there is a preferential uptake of ammonium over nitrate, even though both ions are present in the wastewater at the same time [15]. According to Chukwuka *et al*. [16], water hyacinth has been reported as an aid in water purification through conversion of toxic ammonia to usable nitrates as well as capacity to absorb heavy metals and organic compounds from water body. Removal of nitrogen through plant uptake will depend on the growth rate of the plant and culture [11]. Experimental trials indicate that, at very high nutrient levels, dissolved nitrogen typically will be depleted by water hyacinth stands at higher rates than phosphorus due to both luxury uptakes by plants and denitrification [15].

Table 2: Results on water quality analysis during the 7th week of the experimental set-up using water hyacinth as phytoremediator

Water Quality Parameters	Treatments			
	Control	T1	T2	T3
Temperature AM (°C)	20.59±1.19a	21.24±1.12a	20.51±1.31a	20.61±1.24a
Temperature PM (°C)	25.94±0.86a	25.89±0.82a	25.74±1.19a	25.43±1.04a
DO AM (ppm)	4.79±0.90b	6.52±0.29a	5.10±0.60b	5.12±0.67b
DO PM (ppm)	13.90±1.47a	10.69±1.25b	9.13±0.81c	8.45±1.31c
pH AM	7.59±0.14a	7.59±0.11a	7.61±0.16a	7.59±0.13a
pH PM	7.91±0.11ab	7.94±0.09a	7.78±0.13c	7.81±0.18bc
TDS AM (ppm)	496.89±102.11a	431.18±109.21b	430.05±42.32b	456.81±23.26 ab
TDS PM (ppm)	482.71±18.54a	427.00±111.13b	429.00±44.92ab	457.51±23.71ab
Alkalinity (ppm)	311.73±36.04a	288.01±91.28a	289.21±52.06a	325.57±40.02a
TAN (ppm)	0.22±0.07a	0.15±0.04b	0.13±0.02b	0.10±0.01b
Nitrite (ppm)	0.024±0.016a	0.018±0.013ab	0.009±0.004ab	0.005±0.003b
Phosphorus (ppm)	0.38±0.16a	0.32±0.24a	0.19±0.14a	0.14±0.05a

4. Conclusion

Water hyacinth as phytoremediator had no effect in altering the temperature, alkalinity and phosphorus of the water in tanks provided with bottom soil high in organic matter. As high as 20% water hyacinth cover had no negative effect on the concentration of DO. The effect of water hyacinth as phytoremediator was more observed in reduced TDS, TAN and nitrite of water. As low as 5% water hyacinth cover could significantly reduce TDS and TAN. At least 20% water hyacinth cover could result to reduction of nitrite.

5. References

1. Adhikari S. Fertilization, soil and water quality management in small-scale ponds. Aquaculture Asia Magazine. 2003; 4:6-8.
2. Boyd CE. Bottom soils, sediment, and pond aquaculture. Chapman & Hall. New York, USA, 1995, 348.
3. Chan Y. Increasing soil organic carbon of agricultural land. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/210756/Increasing-soilorganic-carbon.pdf. 18 July, 2013.
4. Avnimelech Y, Ritvo G. Shrimp and fish pond soils: Processes and management. Aquaculture. 2003; 220:549-567.
5. Lazur A. Grow-out pond and water quality management. JIFSAN (Joint Institute for Food Safety and Applied Nutrition) Good Aquacultural Practices Program. http://jifsan.umd.edu/pdf/gaqps_en/06%20GAqPs%20Manual%20Ponds.pdf. 17 July, 2013.
6. Liao SW, Chang WL. Heavy metal phytoremediation by water hyacinth at constructed wetlands in Taiwan. Journal of Aquatic Plant Management. 2004; 42:60-68.
7. Nakbanpote W, Panitlertumpai N, Sukadeetad K, Meesungneon O, Noisanguan W. Advances in phytoremediation research: A case study of *Gynura pseudochina* (L.). http://cdn.intechopen.com/pdfs/12358/InTechAdvances_in_phytoremediation_research_a_case_study_of_gynura_pseudochina_l _dc_.pdf. 10 January, 2013.
8. Barrett SCH, Forno IW. Style morph distribution in new world populations of *Eichhornia crassipes* (Mart) Solms-Laubach (water hyacinth). Aquatic Botany. 1982; 13:299-306.
9. Narain S, Ojha CSP, Mishra SK, Chaube UC, Sharma PK. Cadmium and chromium removal by aquatic plant. International Journal of Environmental Sciences. 2001; 1(6):1297-1304.
10. Philippine Council for Agriculture and Resources Research. Standard methods of analysis for soil, plant tissue, water and fertilizer. Farm Resources and Systems Research Division, Los Baños, Laguna, 1980, 7-119.
11. Sooknah R. A review of the mechanism of pollutant removal in water hyacinth systems. Science and Technology Research Journal. 1999; 6:50-57.
12. Villamagna AM. Ecological effects of water hyacinth (*Eichhornia crassipes*) on Lake Chapala, Mexico, 2009, 1-41.
13. Evans JM. Ecosystem implications of invasive aquatic plants and aquatic plant control in Florida springs. http://waterinstitute.ufl.edu/research/projects/downloads/p001Ch5_SpringsNutrients.pdf. 14 February, 2014.
14. Tellez TR, Lopez EM, Granado GL, Perez EA, Lopez RM, Guzman JM. The water hyacinth, *Eichhornia crassipes*: An invasive plant in the Guadiana river basin (Spain). Aquatic Invasions. 2008; 3(1):42-53.
15. Reddy KR, Tucker JC. Effect of nitrogen source on productivity and nutrient uptake of water hyacinth (*Eichhornia crassipes*). Economic Botany. 1983; 37:236-246.
16. Chukwuka KS, Uka UN, Omotayo OE. Influence of persistent presence of water hyacinth on specific physicochemical properties of a freshwater body in southwestern Nigeria. Zonas Aridas. 2008; 12(1):209-217.