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The Treatment of High Concentration Nitrogen by Phytoremediation Process Using Water Hyacinth (*Eichnornia crassipes Mart.Solms.*) and Coontail (*Ceratophyllum demersum L.*)

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ABSTRACT

Nowadays, high concentration nitrogen from community and agricultural areas were the major sources of urgent environmental issues, which had motivated this study. The objective of this study was to compare the efficiency of high concentration nitrogen removal between water hyacinth (*Eichhornia crassipes Mart. Solms.*) and coontail (*Ceratophyllum demersum L.*). The experiment used laboratory scales and performed at National Institute of Technology Okinawa College, Japan. The experimental device was plastic cylinder with 4 L of 50 mg/L nitrogen concentration (inorganic form) and without the top cover. The experimental designs were divided into three groups; no plant or control, water hyacinth and coontail, each group included three replications. The experiments had been started on August 2016, and run for 15 days period. Water samples from experimental vessels were collected and analyzed every day by economical simple pack-kit method. The results showed that water hyacinth and coontail were removed total nitrogen as much as 80%, and 50%, respectively.Total phosphorus as much as 0%, and 0%, repectively. This research concluded that water hyacinth was more effective for high concentration nitrogen removal than coontail under the experimental condition. We also had discussed the limitation of the latest experiment.

Keywords: High concentration nitrogen, Phytoremediation, Water hyacinth, Coontail

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Introduction

High concentration nitrogen in natural water body had been a dramatic water quality problem all over the world [1]. During the past decade, many researches showed that high concentration nitrogen caused eutrophication [2], effected on reproduction of mangrove forest and stimulated pH balance causing aquatic life [3]. In Thailand, there were many major nitrogen sources such as agricultural area, domestic area, commercial area and farming area causing environmental problems. Because Thailand was agricultural country, the major nitrogen source was farming area [4]. Exceed nitrogen from fertilizer and animal feces were released to natural water source and accumulated at the bottom. Due to this topic, a lot of studies try to find the best solution to reduce exceed nitrogen including; physical process chemical process and biological process [5].

Phytoremediation was the best one of biological process to improve water quality because it was costly and high potential [6].Phytoremediation, a plant- base green technology, was a promising technology for environment [7]. The use of some submerged aquatic plant and floating plants in the process of phytoremediation was commonly known as phytofilltration [8]. Water quality improved because inorganic matter was absorbed by plant for growing.

Plant used for phytoremediation might meet requirement, such as high biomass, rapid growth, and high nutrient accumulation [9].

Water hyacinth (*Eichhornia crassipes Mart. Solms.*) was a free- floating perennial aquatic macrophyte native to tropical South America [10]. The plant was notorious as highly noxious alien weed because of its tremendously vigorous growth rate. However, given its dense hair root system, peculiar physiological characteristics and nutrient absorption efficiency, and wide tolerance to environmental conditions, water hyacinth had been widely utilized and had gained increasing in recent years for phytoremediation of many types of wastewater [9].

Coontail (*Ceratophyllum demersum L.*), a completely submerged aquatic macrophyte was reportedly a scavenger of heavy metal in contaminate water [11]. However, available knowledge of the accumulate characteristic of plants exposed to nitrogen.

Therefore, the present study aims to compare the efficiency of high concentration nitrogen removal between Water hyacinth (*Eichhornia crassipes Mart. Solms.*) and Coontail (*Ceratophyllum demersum L.*). This study may serve as a practical and theoretical reference for contaminant removal from farming sewage through ecological engineering with water hyacinth or coontail.

Research methodology

1.Experimental site

The experiment was laboratory scale and was performed at National Institute of Technology, Okinawa College located in Okinawa Japan. The experimental device was plastic cylinder (4L) and without the top cover. Nine vessels were placed in nursery plant (150m^2) and all vessels were contained with 4L of synthesize high concentration nitrogen. The general of physical and chemical parameters of synthesize high concentration nitrogen wastewater were show as the follows: pH, total nitrogen and total phosphate. The experimental could be divided into 3 groups; control (No.1,2,3), water hyacinth (No.7,8,9) and coontail (No.4,5,6) group. Each group included 3 replications.

2.Experimental plants

The experimental plants in this research were water hyacinths and coontail, healthy similarly sized samples of water hyacinth and coontail were harvested from 21 century park which far form National Institute of Technology, Okinawa College for about 20 kilometers and then placed in two sets of three experimental vessels (Nos.7, 8 and 9 for water hyacinth and Nos. 4, 5 and 6 for coontail) with fresh plants of equal weight.

3.Methods

The experiment started on August 2016, and ran for 15 days period. Water samples from experimental vessels were collected and analyzed every day. The analyzed indicators included total nitrogen (TN), total phosphate (TP) and pH. Total nitrogen was measured by simple nitrogen pack- kits test, total phosphate was measured by simple phosphate pack- kits test and pH was measured by pH meter.

4.Analysis of experimental data

The data were analyzed using simple statistical such as mean and standard deviation (S.D.).

Results

The overall effect of the phytoremediation treatment on synthesize high concentration nitrogen wastewater were shown in Table 1. Through comparing indicators before and after treatment was concluded the water quality was improved.

1. Removal of total nitrogen (TN)

Table 1 showed the nitrogen removal rate of water hyacinth and coontail were 80% and 50%, respectively. However, when compared with the water hyacinth and coontail nitrogen

removal effectiveness (Fig.1), the difference was significant. The TN of the water hyacinth decrease to 10 mg/L, while the coontail and control was 25 mg/L. Although this was a sharp decline, the TN level was still high. The result showed that water hyacinth still alive until the end of experiment while coontail had dead at day 7. This was related to tolerant capacity of water hyacinth and coontail [12]. With the high concentration solution, coontail as well as other fragile cell wall plant, inside water went out from cell because of outer high concentration. Then coontail was flabby and dead that called dehydration effect [6].

Other researchers reported similar finding about the effective of water hyacinth to remove others pollutants such as heavy metals (Cr, Pb, Cd, Hg) and the report showed that the removal rate was 78.4%. [13] while the coontail was efficient in removing nitrogen from wastewater[15].

Table 1: Effect of water hyacinth and coontail treatment on high concentration nitrogen

indicators	Water hyacinth *(mg/L)*			Coontail *(mg/L)*		
	Before	After	Removal rate (%)	Before	After	Removal rate (%)
TN	50	10	80	50	25	50
TP	5	5	0	5	5	0
pH	5.8	7.5	-	4.8	7.8	-

Table 2: The average total nitrogen.

Day	The average of total nitrogen(mg./L) ± S.D.		
	Control	Coontail	Water hyacinth
0	50±0	50±0	50±0
1	50±0	50±0	50±0
2	50±0	50±0	50±0
3	50±0	50±0	50±0
5	50±0	50±0	50±0
7	25±0	25±0	33±0
10	25±0	25±0	10±0
13	25±0	25±0	10±14.4
15	25±0	25±0	10±0

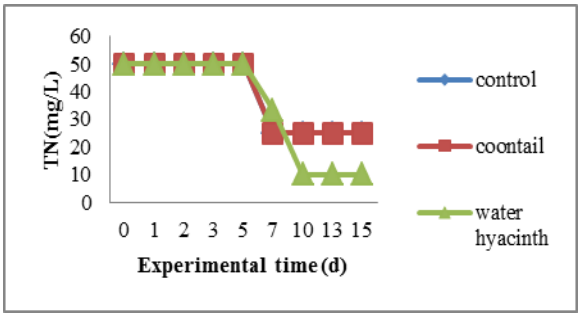

Figure 1: Changed of total nitrogen (TN)

2. Removal of total phosphorus (TP)

Table 1 showed the total phosphorus removal rate of water hyacinth and coontail were equal at 0%. This was related to beneficial form of nutrient. Water plants including water hyacinth and coontail absorbed phosphorus for growing in HPO_4^{2-} or $H_2PO_4^-$ [15] while phosphorus in this experiment was KH_2PO_4 form. Because of this reason, both water hyacinth and coontail could not remove or reduced total phosphorus from synthesize wastewater as showed in figure 2.

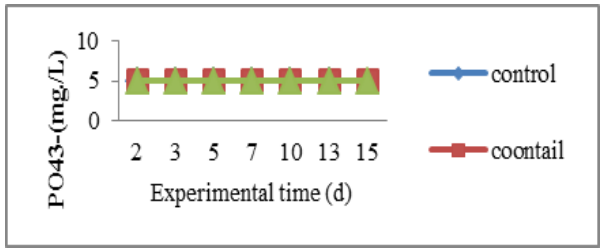

Figure 2: Changed of total phosphorus (TP)

3. Changed in pH

Fig. 3 showed the pH of water hyacinth, coontail and control was weak acid and rose to7.5, 7.7 and 7.8 respectively, at the end of experimental day. This related to neutral effect of water [16], it was not reliable in phytoremediation or wastewater treatment.

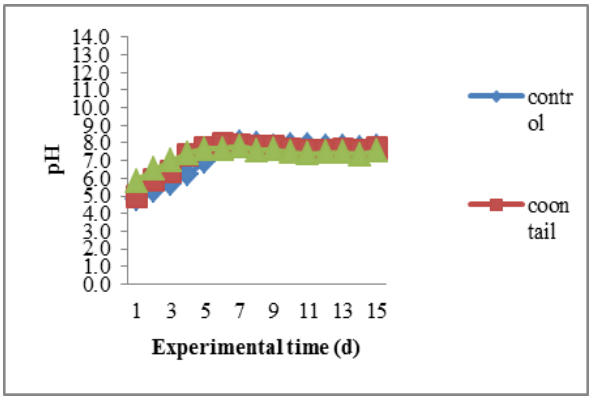

Figure 3: Changed of pH

4. The limitation of the experiment

This experiment had 2 limitations; experimental period and experimental measurement. The first condition was short experimental period, Because of limitation time in Japan, this demonstration run for 15 days period. So, the result could forecast the removal efficiency in short term and could not certain about removal trend in long term. However, 15 days was economy reasonable in laboratory scale because it could save time and cost for high concentration nitrogen removal.

The second limitation was simple measurement. Because this experiment used simple test kits for nitrogen and phosphorus measurement, it probably was coarse measurement scale. For total nitrogen measurement, the scale started at 0, 5, 10, 25, 50, and 100 mg/L, respectively while total phosphorus measurement, the scale started at 0.2, 0.5, 1.0, 2.0, 5.0, and 10 mg/L, respectively. From reason, this experiment could not verify that TN of water hyacinth decreased to 10 or 9 mg/L. However, the positive things of this method were not only easy to use especially for high school or undergraduate student but also it could forecast correctly decreasing trend.

Discussion and Conclusion

Phytoremediation process was the one of wastewater treatment and there were many water plants choice for experiment. This research decided to use water hyacinth and coontail to remove nitrogen from wastewater. The experiment was laboratory scale and run for 15 days period at Okinawa, Japan. Water samples from experimental vessels were collected and analysed every day. The total nitrogen and total phosphorus were measured by simple pack test-kits while pH was measured by pH meter. The result showed that water hyacinth was nitrogen removal

efficiency than coontail. The nitrogen removal rate of water hyacinth and coontail was 80% and 50 %, respectively. The suggestions for the future experiment were expanding experimental period and changing experimental measurement.

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