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Initial Study of Heavy Metals' Absorbability of some Aquatic Plants in the Water of West Lake - Hanoi

Luu Thi Lan Huong*, Bui Thi Hoa

Faculty of Biology, VNU University of Science,
334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam

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Abstract: In this study we have used 5 plant spieces (water lettuce - *Pistia stratiotes*, water hyacinth - *Eichhornia crassipes*, duckweed - *spirodela polyrhiza*, azolla - *Azolla caroliniana* and umbrella sedge - *Cyperus involucratus*) that were cultured in West lake' water, to explore the capability of absorbing heavy metals of these plants. Research results show that all plants are capable of absorbing heavy metals. Because of metals absorbability, the plants can reduce the content of heavy metals in the aquaculture water after experiments compared to that of the before experiments (the content of As decreased from 37% to 3%, Pb from 76% to 18%, Cd from 75% to 12 % and Hg from 46% to 8%) and the corresponding metal content in their bodies increases (the concentration of As increased from 147% to 15%, Cd from 67% to 20%, Pb from 152% to 41%, Hg increased a little). The result after one month shows that: These plants have good capability of absorbing As and Pb, poor capability of absorbing Cd and Hg. Umbrella sedge has the best absorbability of metals, followed by water hyacinth, water lettuce and duckweed. The absorbability of azolla is the least among plants species chosen for experiments.

Keywords: Aquatic plant, heavy metals, West lake, heavy metal absorbability.

1. Introduction

West Lake has a relatively large area in Vietnam. It is famous for the value of natural landscapes, tourism, sports and cultural activities. Therefore, we are obliged to use this lake and the surrounding area reasonably not only to achieve economic efficiency but also to protect the biological diversity on the basis of strictly handling water pollution that is caused by human activities [1].

In recent years, the substantial growth rate of urbanization degree in the suburb of the capital and climate change have made the water of West Lake heavily polluted as well as reduced the water quality. Level of some heavy metals include Cd, Pb, As in some components of the lake were high [2-7]. Therefore, it has affected the ecosystem and lives of the people in the surrounding area. However, recent studies have not provided biological treaments to reduce/diminish the water pollution of West Lake. Hence, in this study, we have surveyed the absorbability of heavy metal of some aquatic plants in order to find out the appropriate plants that have the potential species which can reduce water environmental contamination, but are harmless to water.

* Corresponding author. Tel.: 84-988175948
Email: huongjgep@gmail.com

2. Materials and methods

2.1. Materials

Five common flora species have been chosen to study the possibility of absorbing the pollutants of the West lake' water. They are umbrella sedge (Thuy truc - *Cyperus involucratus*) water hyacinth (Beo Tay - *Eichhornia crassipes*), azolla (Beo hoa dau - *Azolla caroliniana*), duckweed (Beo tam - *Spirodela polyrrhiza*), water lettuce (Beo cai - *Pistia stratiotes*).

The heavy metals (As, Cd, Pb, Hg) were selected to determine the extent of metal-absorbing capability of aquaphyte spieces.

2.2. Methods

Sampling methods

- Water samples were collected at the shelf area of West lake, which is 30 meters from the position where the sewer of Truc Bach lake pour into. The total amount of collected water is 70 L, which is used as the environment and to replenish the water content of the research plots, when water goes down and affects the viability of the plant species.

- Samples of plants: Umbrella sedge was collected nearby Thang Loi hotel, water hyacinth was collected nearby Tay Ho hotel, the remaining 3 species (azolla, duckweed and water lettuce) were collected in a pond in the village in Thanh Xuan, Hanoi.

Experimental cultivation of aquatic plants

Using 11 experimental lots (10 lots of plant breeding, 1 control lot - contained only West lake' water but plants). Each plant species was grown in two lots in one month. Experiment was repeated 3 times. For every experimental plot, the content of heavy metals was defined before and after experiment. The content of heavy metals aquatic plants are also measured before and after the experiment.

Sample analysis

Analysis of heavy metals: using mass spectrometry method ICP-MS.

3. Results and discusstion

The results of determination of the heavy metal contents in water samples of the experimental plant are presented in Table 1.

Table 1. Heavy metals concentration in water samples of the experimental plant

Water in plots	Heavy metal concentration (mg/l)							
	As		Cd		Pb		Hg	
	Befor Exp.	After Exp.	Befor Exp.	After Exp.	Befor Exp.	After Exp.	Befor Exp.	After Exp.
Control plot	0,1166	0,1014	0,0009	0,0008	0,0127	0,0103	0,0015	0,0013
Water lettuce	0,1166	0,0957	0,0009	0,0007	0,0127	0,0057	0,0015	0,0010
Water hyacinth	0,1166	0,0717	0,0009	0,0004	0,0127	0,0039	0,0015	0,0008
Duckweed	0,1166	0,0886	0,0009	0,0007	0,0127	0,0065	0,0015	0,0007
Azolla	0,1166	0,0986	0,0009	0,0003	0,0127	0,0084	0,0015	0,0012
Umbrella sedge	0,1166	0,0635	0,0009	0,0002	0,0127	0,0025	0,0015	0,0011

Table 1 shows the results of determination of the contents of heavy metals in the water of control plot and in the water of 5 aquatic plant species before and after the experiment.

In general, metal concentration in the water of control plot before and after the experiment is changed. After experiments, the metal content of the control plot was slightly lower than that before experiments. Thus, in the control lot, despite uncultivation of aquatic plants, the West Lake water still has a certain amount of microorganisms, algae cells and small animals. These organisms also contribute to reducing the amount of metals in the lake water, although it is very small.

These results show that all 5 plant species in the experiments are capable of absorbing different heavy metals at different levels. Due to the absorption into the plant, the concentration of heavy metals in water decreased markedly after experiments compared to that in control plot and that before experiments. Specifically: in all 5 species of plant, the capability to absorb As is the highest, followed by those to Pb, Cd and Hg. The capability to absorb each heavy metal in each plant species is described as follows:

The concentration of As in the aquacultural water in experimental lots decreases in the following order: the lot with umbrella sedge, the lot with water hyacinth, the lot with duckweed, the lot with water lettuce and the lot with azolla. Thus, the ability to absorb As in umbrella sedge > water hyacinth > duckweed > water lettuce > azolla.

The concentration of Pb in aquaculture water decreases in experimental lots decreases in the following order, the lot with umbrella sedge, the lot with water lettuce, the lot with water hyacinth, the lot with duckweed and the lot with azolla. Thus, the ability to absorb Pb in umbrella sedge > water hyacinth > water lettuce > duckweed > azolla.

The concentration of Cd in aquaculture water decreases in experimental lots decreases in the following order, the lot with umbrella sedge, the lot with azolla, the lot with water hyacinth. In water that the lot with water lettuce and the lot with duckweed cultured there were equal concentrations of Cd that slightly decreased compared to that before experiments. Thus, the ability to absorb Cd in umbrella sedge > azolla > water hyacinth > water lettuce = duckweed.

The concentration of Hg in aquaculture water decreases in experimental lots decreases in the following order, the lot with duckweed, the lot with water hyacinth, the lot with water lettuce, the lot with umbrella sedge, and the lot with azolla. Thus, the ability to absorb Hg in duckweed > water hyacinth > water lettuce > umbrella sedge > azolla.

Table 2. Concentration of heavy metals in plant samples

Plants	Heavy metals concentration (mg/l)							
	As		Cd		Pb		Hg	
	Befor Exp.	After Exp.	Befor Exp.	After Exp.	Befor Exp.	After Exp.	Befor Exp.	After Exp.
Water lettuce	0,0134	0,0165	0,0004	0,0005	0,0054	0,0106	0,0004	0,0004
Water hyacinth	0,0116	0,0251	0,0003	0,0005	0,0035	0,0075	0,0002	0,0003
Duckweed	0,0201	0,0261	0,0005	0,0006	0,0057	0,0093	0,0001	0,0002
Azolla	0,0112	0,0129	0,0004	0,0006	0,0027	0,0038	0	0
Umbrella sedge	0,0131	0,0323	0,0003	0,0005	0,0029	0,0073	0,0003	0,0003

Table 2 shows results of determination of heavy metal concentrations in plant samples of 5 aquatic plant species grown before and after experiment.

Results of Table 2 showed that all 5 plant species in experiments are capable of absorbing heavy metals. The ability to absorb As is the highest, followed by those to absorb Pb, Cd and Hg. Due to the absorption of metal into the plant, the concentration of heavy metals in the plants after experiments increased markedly compared to that before experiments.

The results of Table 1 and Table 2 showed that: all 5 plant species are able to absorb As. Specifically, umbrella sedge has the largest capacity of absorption As (the content of As in plants increased by 147% and that in water reduced by 45% after experiments compared to that before experiments). Besides, it is the results of water hyacinth (the content of As in the plant increased by 116% and that in water fell 38% after experiments compared to that before experiments). Coming last in the ability of absorption As are duckweed, water lettuce and azolla. The concentration of As in plants increased, reaching 30%, 23% and 15% respectively.

All plant species which were chosen for experiments have the ability to absorb Cd at different degrees, but not much. The absorption capacity of umbrella sedge, azolla, water hyacinth are higher than the other (the concentration of Cd in the plant increased a little, the concentration of Cd in the water environment reduces by 77,8%; 66,7%; 56,6% respectively). The absorption ability of Cd of the two remaining species is relatively poor, the concentration of Cd in the water environment of water lettuce and duckweed reduces at 23%.

Umbrella sedge has the best absorption capacity of Pb (after experiment, the concentration of Pb increased by 152% compared to that before experiment, the concentration of Pb in the water environment reduces approximate by 76%), followed by water hyacinth (increased by 114% in the plant, decreased by 70% in the water), water lettuce (increased by 96% in the plant, decreased by 55% in the water) and duckweed (increased by 63% in the plant,). The worst in absorbing Pb culrated is azolla (increased by 40% in the plant,).

According to the results of Table 1, the concentration of Hg in water samples of plant cultured after experiment is lower than that before the experiment. However, the results in Table 2 showed that the concentration of Hg in plants did not increase significantly. The increase of the concentration of Hg is found the highest in duckweed, then in water hyacinth. This concenstration increased only a little in umbrella sedge, water lettuce and azolla.

Thus, among 5 plant species which were chosen for experiments, all are capable of absorbing heavy metals. The capacity of absorbing As and Pb are the most evident and the capability of absorbing Cd and Hg is very small. We think that due to the extreme toxicity of Cd and Hg, the plants could not absorb. However, the fact that the concentration of Cd and Hg in the water has decreased after the experiments is due to the contributions of microorganisms, algae and small animals living in the aquatic environment. On the other hand, the low concentration of Cd and Hg in the water leads to the low accuracy of sample analysis.

Overall, among five plant species which were chosen for experiment, umbrella sedge and water hyacinth have the best ability to absorb heavy metals, followed by water lettuce and duckweed. Among them, azolla have the least absorbtion ability.

4. Conclusion

- All 5 plant species in experiments (umbrella sedge, water hyacinth, water lettuce, duckweed and azolla) are capable of absorbing different heavy metals (As, Pb, Cd and Hg) at different levels. Because of metals absorb ability, the plants can reduce the content of these metals in their aquaculture environment and increase the content of these metals in their bodies.

- Experimental results show that these plants have good absorbability of As and Pb, poor absorb ability of Cd and Hg. Umbrella sedge has the best absorbability of metals, followed by water hyacinth, water lettuce and duckweed. The absorbability of azolla is the least among plants species chosen for experiments.

- Umbrella sedge and water hyacinth can be used to handle Pb and As-contaminated water at a certain level. However, this approach requires further study.

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Bước đầu tìm hiểu khả năng hấp thu kim loại nặng của một số thực vật thủy sinh trong nước hồ Tây - Hà Nội

Lưu Thị Lan Hương, Bùi Thị Hoa

Khoa Sinh học, Trường Đại học Khoa học Tự nhiên, ĐHQGHN,
334 Nguyễn Trãi, Thanh Xuân, Hà Nội, Việt Nam

Tóm tắt: Trong nghiên cứu này chúng tôi đã sử dụng 5 loài thực vật (bèo cái - *Pistia stratiotes*, bèo tây - *Eichhornia crassipes*, bèo tấm - *Spirodela polyrrhiza,* bèo hoa dâu - *Azolla caroliniana* và thủy trúc - *Cyperus involucratus*) nuôi trong nước hồ Tây, nhằm thăm dò khả năng hấp thụ các kim loại nặng của các thực vật này. Kết quả nghiên cứu cho thấy các loài thực vật này đều có khả năng hấp thụ kim loại nặng. Do hấp thụ kim loại nặng nên hàm lượng kim loại trong nước nuôi trồng chúng giảm đi (hàm lượng As giảm từ 45% đến 15% so với trước thí nghiệm và giảm 37% đến 3% so với lô đối chứng, hàm lượng Pb giảm từ 80% đến 34% so với trước TN và 76% đến 18% so với lô ĐC, hàm lượng Cd giảm từ 78% đến 22% so với trước TN và 75% đến 12% so với lô ĐC và hàm lượng Hg giảm từ 53% đến 20% so với trước TN và 46% đến 8% so với lô ĐC) và hàm lượng kim loại tương

ứng trong cơ thể chúng tăng lên (hàm lượng As tăng từ 147% đến 15%, Cd tăng từ 67% đến 20%, Pb tăng từ 152% đến 41%, Hg tăng một chút). Kết quả sau một tháng nuôi trồng cho thấy: Các cây này đều có khả năng hấp thụ tốt đối với Pb và As, hấp thụ kém đối với Cd và Hg. Khả năng hấp thụ kim loại tốt nhất là thủy trúc, sau đó là bèo tây, tiếp theo là bèo cái và bèo tấm. Bèo hoa dâu có khả năng hấp thụ kém nhất.

Từ khoá: Thực vật thủy sinh, kim loại nặng, hồ Tây, khả năng hấp thu kim loại nặng.