Removal Efficiency of Ammonia Nitrogen by Artificial Wetland and Submerged Plant in the Yintan Park of Yellow River from Lanzhou

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Abstract. Based on the determination of pH, chemical oxygen demand (COD) and electrical conductivity (EC) of the different sources of water in the inlet and outlet of Yintan wetland ecological park in Lanzhou of the Yellow River, the removal of ammonia nitrogen from wetland water were tested in laboratory by use of plant of Hydrilla verticillata in mud and Chlorophytum picking at the riverside under controlled, separately and mixed. The results showed water parameters such as pH, COD, and EC in wetland park appearing the increase of pH and decrease of COD and EC after sewage passing through the wetland park form Yellow River. The removal rate of ammonia nitrogen was 80.14% and 90.37% by Hydrilla verticillata and Chlorophytum planted separately and mixed 90.73%, respectively. These two kinds of plants can not only cooperate with the artificial wetland system to purify the polluted water, but also have certain landscape and good ecological benefits.

Introduction

The artificial wetland is a kind of ground which is constructed and supervised by artificial, similar to marshland. It makes full use of the triple coordination function of physical, chemical and biological of matrix-microbe-plant system to achieve high purification of sewage. In the artificial wetland treatment system, the aquatic plants can not only absorb some pollutants, including heavy metals, and remove them, but also can filter together with the matrix, interception of suspended substances in the water, fixed pollution area, to prevent the pollution further spread out. The penetrating effect of the root system enhances the porosity of the medium, so as to strengthen and maintain the hydraulic transmission capacity of the medium. A large number of industrial wastewater discharged into the rivers and lakes, which resulting the concentration of nitrogen and phosphorus in wastewater increased substantially and eutrophication, thereby causing aquatic organisms, plants, abnormal reproduction and growth[1]. Studies have shown that the use of a single plant sewage treatment is not satisfactory. One or several well-tolerated plants mixed and planted according to the ecological characteristics of different plants for eutrophic sewage treatment, which achieved a best biological pollution abatement effect[3]. Hydrilla verticillata is the ideal plant to purify sewage for its strong adaptability and fast growth in a wide scope of survival[3]. Chlorophytum belongs to the Liliaceae perennial evergreen herb, the biggest feature in the sewage treatment is strong sewage resistance, developed root system, and significant decontamination effect. Several studies have done on sewage treatment by Hydrilla verticillata and Chlorophytum, separately, but no related study on the effect of mixed cultivation. In this study, based on the determination of physical and chemical parameters of the water intake, the removal of ammonia nitrogen from wetland sewage were tested in laboratory by use plants of Hydrilla verticillata in mud and Chlorophytum which picked at the riverside under controlled, separately and mixed.
Materials and Methods

Study Area and Sampling

The Yintan Wetland Ecological Park of the Yellow River is located on the east and west sides of the north end of the Yintan bridge on the north riverside road of Anning district in Lanzhou City. The light, heat and water conditions meet the requirements of the ecological factors of the wetland plants. It has rich terrain and natural vegetation, belongs to urban artificial wetland ecosystem.

On March 25, 2015, in the Yintan wetland whirlpool mud of Yellow River Lanzhou city, picking *Hydrilla verticillata* back to the laboratory, doing isolation and culture in accordance with hydroponics. The *Chlorophytum* branch is collected from stolons of planted *Chlorophytum* at the riverside.

Experimental Setup and Method

The basic parameters of the artificial wetland system were determined, and a water intake point was set up every 150 meters from west to east along the direction to the flow of the wetland river. A total of 8 spots were set up, covering every 1,200 meters, water parameters such as pH, COD, and EC were determined after pretreatment in laboratory. Four control treatments were set up in the laboratory: 1) control (no plant), 2) planted *Chlorophytum* separately (2 strains per planting, about 50g or so); 3) planted *Hydrilla verticillata* separately (20 per plant, about 50g); 4) mixed *Chlorophytum* with *Hydrilla verticillata* planted , and the total weight is about 50 g).

The determination of pH using electrochemical method, the determination of COD using acid potassium permanganate method, and the determination of EC using conductivity meter.

The standard curve of ammonia nitrogen was prepared by salicylic acid-hypochlorite photometric method, and the concentration of ammonia nitrogen was determined by flocculation precipitation method.

Results and Discussion

Parameters of Sewage from Artificial Wetlands

As shown in Figure 1, there is a gradual increase of pH of sewage from the upstream to the downstream sampled on the same day, which indicating that higher ammonium ions in sewage resulting an acidic water at the upper reaches of the wetland (150 meters from the western sampling spot). Volatilization of NH3 caused the rise of pH of sewage when the sewage flowing through the wetlands into downstream, which makes pH tend to be neutral gradually. COD concentration gradually decreased in water samples taken on the same day from upstream to downstream, which shows that artificial wetland have certain removal effect on COD in Figure 2.

EC of sewage upstream (150 meters from the western sampling spot) is generally higher than that of the downstream, which indicates that pollution is reduced and sewage purified from west to east by the artificial wetland system in Figure 3. As far as this conclusion, it is unanimous as Nan Song’s.

Parameters of Control Test

<table>
<thead>
<tr>
<th>Plant</th>
<th>Treatment</th>
<th>Fresh weight of plant (g)</th>
<th>Growth rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before the experiment</td>
<td>After the experiment</td>
</tr>
<tr>
<td>Hydrilla verticillata</td>
<td>separately</td>
<td>49.0</td>
<td>51.7</td>
</tr>
<tr>
<td></td>
<td>mixed</td>
<td>24.3</td>
<td>25.5</td>
</tr>
<tr>
<td>Chlorophytum</td>
<td>separately</td>
<td>48.5</td>
<td>53.8</td>
</tr>
<tr>
<td></td>
<td>mixed</td>
<td>25.0</td>
<td>27.3</td>
</tr>
</tbody>
</table>

The speed of water clarification in the experimental group is obviously faster than that in the control group during the experiment. Adventitious roots of *Hydrilla verticillata* and *Chlorophytum*
effectively adsorbed suspended materials of sewage, which plays an important role in the holding on
the clear status and stability of polluted water\textsuperscript{[11]}. At the end of the experiment, the fresh weight of
\textit{Hydrilla verticillata} and \textit{Chlorophytum} increased, and that of \textit{Chlorophytum} was more. As shown in
Table 3.1, the growth rate of \textit{Hydrilla verticillata} was 5.5\% and that of \textit{Chlorophytum} reached 10.9\%
in the 8-day treatment, separately. When mixed planting, the growth rates of fresh weight two of them
were slightly decreased. The reason is that the roots overlapped each other in the water when mixed
planting \textit{Hydrilla verticillata} and \textit{Chlorophytum} together, which competing resources and space,
producing certain inhibition for the growth of their own \textsuperscript{[12]}.

![Figure 1. PH of sewage from artificial wetland.](image1)

![Figure 2. COD of sewage from artificial wetland (mg/L).](image2)

![Figure 3. EC of sewage from artificial wetland (µS/cm).](image3)
The Removal Efficiency to Ammonia Nitrogen under Different Treatment

![Graph showing ammonia nitrogen concentration over time for different treatments.]

The concentration of ammonia nitrogen decreased in four treatments except the effect of the control group. The content of ammonia nitrogen decreased from 0.841mg/L to 0.078mg/L in the mixed planting system that gets the first and the largest decline; The second is *Chlorophytum* separately planted, down to 0.081mg/L at the 5th day in experiment; The least obvious is planted *Hydrilla verticillata* separately, down to 0.167mg/L. The results showed higher removal efficiency of ammonia nitrogen in water under mixed planting of *Hydrilla verticillata* and *Chlorophytum* than that of separate planting obviously as shown on Figure 4.

![Graph showing accumulated removal rates of ammonia nitrogen over time for different treatments.]

The maximum efficiency of removal of ammonia nitrogen in water was 83.82% at the 3rd day of the experiment under mixed planting *Hydrilla verticillata* and *Chlorophytum* while that of the maximum at the 4th day were 41.61% and 56.22% under separate planting, respectively. The order of the efficiency in ammonia nitrogen removal under different treatment is that mixed planting (90.73%) > *Chlorophytum* separate planting (90.37%) > *Hydrilla verticillata* separate planting (80.14%) as shown in Figure 5.

**Conclusions**

The artificial wetland system has played an important role in purification of water of Yellow River passing after wetland park, which makes pH increased, COD and EC decreased, eventually leading to the water is more cleaner. The removal rate of ammonia nitrogen was 80.14% and 90.37% by *Hydrilla*
verticillata and Chlorophytum planted separately and mixed 90.73%, respectively. These two kinds of plants can not only cooperate with the artificial wetland system to purify the polluted water, but also have certain landscape and good ecological benefits.

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References