

Research Article

Treatment Technology of Microbial Landscape Aquatic Plants for Water Pollution

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With the rapid development of industrial and agricultural production, the rapid growth of population, and the acceleration of urbanization, the problem of water pollution is becoming more and more serious. Water shortages and pollution disrupt the balance of ecosystems and seriously limit people's health and rapid economic development. Nowadays, the method of repairing sewage bodies using microbial landscape aquatic plants is attracting more and more attention, and it is a big challenge to maintain the sustainable development of human beings and nature. This paper uses floating rafts to combine microorganisms and landscape aquatic plants to conduct sewage treatment experiments. According to microorganisms, landscape aquatic plants absorb nutrients in the water body, examine the changes in water quality during the restoration of microorganisms' landscape aquatic plants, and establish the growth of microorganisms' landscape aquatic plants. The relationship with changes in water quality aims to provide a theoretical basis for the treatment of slow-flowing water bodies such as lakes, reservoirs, large artificial ponds, and rivers. In this paper, the experiments are divided into four groups (*A* (experimental sewage + microbial inoculant), *B* (experimental sewage + plant), *C* (experimental sewage + microbial inoculant + plant), and *D* (experimental sewage)). It can be divided into the total nitrogen content, total phosphorus content, and COD value data, and chromaticity detection of each group of the test is continuously monitored weekly to comprehensively detect and observe the repair effect on contaminated water bodies. The experiment proved that the water quality of the three treatment groups was significantly clearer than that of the blank control group, and its clarity: microorganism + plant > microorganism > plant > blank control group. This shows that the combination of microorganisms and landscape aquatic plants can effectively reduce the various pollutants contained in sewage and reduce the color of sewage. Treating sewage using plant technology that combines microorganisms is feasible and promising.

1. Introduction

Water is an important resource for human survival, and it is closely related to people's lives. With the continuous development of the society and the increase of industrial production, a large number of pollutants discharged have caused serious damage to drinking water resources, and people's drinking water safety has great hidden dangers. According to monitoring, the groundwater in most domestic cities is currently polluted by point and nonpoint sources to varying degrees, and the degree of pollution is getting worse. For this reason, it has always been a research focus to find a drinking water treatment process with stable effluent and strong applicability. As a major decomposer of ecosystems,

microorganisms play an important role in maintaining a stable balance and material cycle of ecosystems. The active growth of microorganisms promotes the decomposition of various pollutants in the water area, optimizes the water environment, and leads to the growth of plants. The two synergies in treating water pollution have good prospects for improving available nutrients.

The use of microbial landscape aquatic plant treatment technology abroad to treat water pollution is much faster than in China, and the development and renewal of water pollution treatment technology are rapid. Water pollution prevention methods have been significantly improved and developed. In the near future, the use of microbial landscape aquatic plants is expected to be an important breakthrough.

Broussard and Devkota found that the turbidity of the effluent of the process was stabilized below 0.1 NTU through the coagulation/ultrafiltration process treatment of a micropolluted water source, and it was not affected by the turbidity of the raw water, and it had strong impact load resistance [1]. Beale et al. have conducted experiments to study the combined process of suspension production biological treatment and ultrafiltration to treat artificially simulated micropolluted source water. The experiment shows that when the hydraulic retention time is 2–4 h, the average removal rate of ammonia nitrogen by the combined process can reach more than 85% [2]. Zheng and Rong conducted indoor simulation experiments using four aquatic plants, targeting water bodies with severe eutrophication. The results show that the four submerged plants have a good reducing effect on total nitrogen and total phosphorus, and the COD content tends to decrease overall [3].

The use of microbial landscape aquatic plant treatment techniques to treat water pollution began in Western countries. Compared to Western countries, our country's water pollution treatment technology started late, and its development is relatively slow. With the continued development of science and technology and the gradual increase in people's awareness of environmental protection, the use of microbial landscape aquatic plants can improve the progress of water pollution research. Stepanov et al. compared direct ultrafiltration and coagulation-ultrafiltration processes on the treatment of micropolluted water containing high ammonia nitrogen. It is found that the direct filtration of ultrafiltration membranes has a poor removal rate of ammonia nitrogen, with a removal rate of only about 7%. This is because the ultrafiltration membrane is only a pure physical filtration process, and it is difficult to remove the soluble ammonia nitrogen in the water [4]. Sokolova et al. used plant floating beds for water environment management. Experiments were conducted for three groups of controls, and different plants were used for control treatment, respectively, showing that the three plants have good degradation effects on total nitrogen, total phosphorus, and COD [5]. Astsaturov et al. used 6 different aquatic plants to treat polluted waters. Studies have shown that six plants have a better phosphorus-removing effect than nitrogen-removing, with no apparent reduction in COD content [6].

This study adopts microbial landscape aquatic plant treatment technology, takes the sewage from the suburban sewage ditch as the target, uses floating raft fixation technology to organically combine microorganisms and landscape aquatic plants to carry out the indoor simulation test of sewage treatment, and uses water exchange to simulate the actual suburban sewage; the discharge of new pollutants into the ditch has been continuously monitored for two weeks. The test achieved good results. At the same time, this article

uses fast digestion spectrophotometry to detect the content of major pollutants in sewage and further test other metrics in sewage. It analyzes the quality of the sewage under the test, screens aquatic plants in the microbial landscape, and provides rationale and reference indicators.

2. Treatment Technology of Microbial Landscape Aquatic Plants for Water Pollution

2.1. Support Vector Machine Algorithm to Predict the Degree of Water Pollution Control

2.1.1. *Support Vector Regression Algorithm.* (1) *Linear Support Vector Regression Machine.* Suppose that the sample dataset is denoted as $\phi: R^n \rightarrow H\{x_k, y_k\}_{k=1}^N$, where N is the number of samples, the input data $x_k \in R^n$ is n dimensional, and the output data $y_k \in R^n$ corresponds to the input data x_k . Suppose that the linear regression function is

$$f(x) = w^T x + b, \quad (1)$$

where $w \in R^n, b \in R$, and w are normal vectors. The loss function is used as follows:

$$|y - f(x)|_\varepsilon = \begin{cases} 0, & \text{if } |y - f(x)| \leq \varepsilon, \\ |y - f(x)| - \varepsilon, & \text{otherwise.} \end{cases} \quad (2)$$

Among them, ε is the preset tolerable loss function, and the distance between the two dotted lines is $2/\|w\|$. The optimization goal of the algorithm is to maximize the distance, that is, minimize the reciprocal of the logarithmic distance [7, 8]. Finally, the process of finding the most suitable regression function is transformed into

$$\min \frac{1}{2} \|w\|^2. \quad (3)$$

The penalty parameter C and the relaxation factor ξ_i and ξ_i^* are introduced, and the optimization problem corresponding to the regression estimation is transformed into

$$\min_{w,b} P = \min \frac{1}{2} \|w\|^2 + C \sum_{i=1}^N (\xi_i + \xi_i^*). \quad (4)$$

The constraints that should be met are

$$\begin{cases} y_i - w^T x_i - b \leq \varepsilon + \xi_i, & i = 1, \dots, N \\ w^T x_i + b - y_i \leq \varepsilon + \xi_i, & i = 1, \dots, N \\ \xi_i, \xi_i^* \geq 0, & i = 1, \dots, N \end{cases} \quad (5)$$

Lagrangian dual functions are usually introduced to solve the above convex quadratic programming problem. The Lagrangian dual function is constructed as follows:

$$L(w, b, \xi_i, \xi_i^*, a, a^*, \eta, \eta^*) = \frac{1}{2} \|w\|^2 + C \sum_{i=1}^N (\xi_i + \xi_i^*) - \sum_{i=1}^N a_i (\varepsilon + \xi_i - y_i + w^T x_i + b) - C \sum_{i=1}^N (\eta_i \xi_i + \eta_i^* \xi_i^*). \quad (6)$$

The Lagrangian multiplier is introduced, which turns the problem into a solution:

$$\max_{a, a^*, \eta, \eta^*} \min_{w, b, \xi, \xi^*} L(w, b, \xi, \xi^*, a, a^*, \eta, \eta^*). \quad (7)$$

Taking the Lagrangian dual function to differentiate w, b, ξ , and ξ^* and equal to zero, this dual problem can be transformed into a convex quadratic programming problem:

$$\begin{aligned} \max_{a, a^*} J_D(a, a^*) = & -\frac{1}{2} \sum_{k,i=1}^N (a - a^*) (a_k - a_k^*) x_i^T x_k \\ & - \varepsilon \sum_{i=1}^N (a_i + a_i^*) + \sum_{i=1}^N y_i (a_i - a_i^*). \end{aligned} \quad (8)$$

The conditions are

$$\sum_{i=1}^N (a_i - a_i^*) = 0, \quad a_i a_i^* \in [0, c]. \quad (9)$$

The final target-fitting regression function is expressed as

$$f(x) = \sum_{i=1}^N (a_i - a_i^*) x_i^T x + b. \quad (10)$$

Through deduction, it can be seen that the number of support vectors in SVM is limited. It is the input sample x_i corresponding to those a_i which is not zero. Only the input vector that meets this condition can contribute to the SVM model. This is the sparsity of the SVM solution [9, 10].

(2) *Nonlinear Support Vector Regression Machine.* Polynomial kernel functions are highly generalized and belong to global kernel functions, but the price paid is inadequate in adapting to nonlinear problems. The nonlinear SVM problem can be described as solving the following problem:

$$\begin{aligned} \max_{a, a^*} J_D(a, a^*) = & -\frac{1}{2} \sum_{k,j=1}^N (a_i - a_i^*) (a_k - a_k^*) K(x_i, x_k) \\ & - \varepsilon \sum_{i=1}^N (a_i + a_i^*) + \sum_{i=1}^N y_i (a_i - a_i^*). \end{aligned} \quad (11)$$

The conditions are

$$\sum_{i=1}^N (a_i - a_i^*) = 0, \quad a_i a_i^* \in [0, c]. \quad (12)$$

The final target-fitting regression function is expressed as

$$f(x) = \sum_{i=1}^N (a_i - a_i^*) K(x_i, x) + b. \quad (13)$$

When there is a lack of prior knowledge in the relevant fields of sample data, the radial basis kernel function is generally selected as the kernel function, which can better balance the fitting effect and generalization ability than other kernel functions [11, 12]. The expression of the radial basis kernel function is as follows:

$$K(x', x) = \exp\left(\frac{-\|x - x'\|^2}{\sigma^2}\right), \quad (14)$$

where σ is a parameter that characterizes the width of the core.

2.1.2. *Entropy Method for Weight.* With m evaluation objects and n evaluation indicators, the original data matrix $X = (x_{ij})_{m \times n}$ can be formed:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & x_{ij} & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix}. \quad (15)$$

In the formula, x_{ij} is the evaluation value of the i evaluation object on the j index.

(1) *Standardized Processing of Raw Data.* In the evaluation index system of the new smart city, due to the different meanings of different indicators and different quantification units, it is impossible to directly carry out weighting calculations, and a standardized matrix $Y = (x'_{ij})_{m \times n}$ can be obtained:

$$x'_{ij} = \frac{x_{ij} - \min\{x_{ij}\}}{\max\{x_{ij}\} - \min\{x_{ij}\}}, \quad i = 1, 2, \dots, m, \quad (16)$$

where x'_{ij} represents the normalized value of the i evaluation object on the j evaluation index and x_{ij} represents the original data value of the i evaluation object on the i evaluation index.

(2) *Calculate Indicator Weight.* Transform the standardized value of each evaluation index in the standardized matrix $Y = (x'_{ij})_{m \times n}$ to calculate the contribution Z_{ij} of the j index and the i evaluation object:

$$Z_{ij} = \frac{x'_{ij}}{\sum_{i=1}^m x'_{ij}}. \quad (17)$$

Calculate the information entropy of each indicator:

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^m Z_{ij} \ln Z_{ij}. \quad (18)$$

Among them, when defining $Z_{ij} = 0$, $Z_{ij} \ln Z_{ij} = 0$. Calculate information entropy redundancy:

$$d_j = 1 - e_j. \quad (19)$$

Calculate the weight of the indicator:

$$\omega = \frac{d_j}{\sum_{j=1}^n d_j} = \frac{(1 - e_j)}{n - \sum_{j=1}^n e_j}, \quad j = 1, 2, \dots, n. \quad (20)$$

2.2. *Water Pollution Treatment Technology.* As an important element of production and life, water resources are directly related to the sustainable development of mankind. The

water body has a certain purification ability. Through a series of physical, chemical, and biological reactions, the concentration of pollutants in the water body is reduced, and the toxic and harmful substances are decomposed or reduced. When the degree of pollution is greater than the self-purification energy of the water body, the ecological environment of it is damaged, and it is necessary to use appropriate technical means for sewage treatment [13–15].

2.2.1. Water Diversion and Pollution Flushing Technology. Water conversion flushing technology uses engineering techniques to transfer large amounts of clean water to polluted waters and dilute pollutants. Introduced clean water generally has a high dissolved oxygen content, which allows the body of water to flow, reduces the concentration of pollutants, and increases the oxygen content of the body of water to improve its self-purification capacity [16, 17]. No complicated operation techniques or equipment systems are required, and sewage can be treated quickly. It is commonly used for emergency treatment of small contaminated water. However, while flushing the body of water, sedimented pollutants are reintroduced into the body of water, causing two secondary pollutions, affecting the water bodies of the downstream basins and causing specific pollution in the downstream water bodies. On this basis, due to the introduction of a large amount of new water into the water body, the original river water level rise is very likely to cause the river to divert, and the project cost is huge, which further shows that this method cannot solve the fundamental problem [18, 19].

2.2.2. Sediment Dredging Technology. Use the relevant mechanical equipment to discharge the mud at the bottom of the river, and reduce the harmful substances and precipitated pollutants in the water through the mud removal method. Since the rock-containing substances are generally deposited on the surface of the river bottom mud, the mud removal by this method can also effectively reduce the mud and the total rock content and further expand the water capacity of rivers and lakes [20, 21]. It can effectively reduce pollution of rivers and lakes and improve the water quality of rivers and lakes and the surrounding environment. However, this technology has many limitations. It is necessary to consider the depth and area of excavation. Large-scale specialized equipment should be equipped during construction. Narrow rivers cannot be built and require a lot of financial support. Reducing endogenous pollution and controlling pollution in rivers and lakes cannot achieve good results, especially in the treatment of eutrophic lakes, especially when external pollution is not effectively managed.

2.2.3. Masking Isolation Technology. By using sand, clay, and high-aggregate physical materials to cover the bottom mud, it prevents the organic matter and heavy metal pollutants in the bottom mud of the river from entering the upper water body due to the flow of river water and the accumulation of bottom mud, effectively removing the water and polluting

mud from the mud. Isolation has a more obvious effect on improving the quality of water bodies [22, 23]. Masking separation technology is relatively easy to operate, does not require complicated process equipment, and has less potential harm to the surrounding environment. However, adding material originally based on rivers and lakes reduces the effective water capacity of rivers and lakes. Structures that cover and isolate shallow river bottom mud can change the topography of the riverbed. Riverbed mud is an integral part of the entire aquatic ecosystem and is part of the aquatic environment. It is quarantined by the coverage of other sources. Abandoning sediment purification capacity destroys the normal ecological circulation system of the entire body of water, increases the amount of engineering, and requires enormous financial support. Therefore, it is not suitable for uneconomical areas or waters with shallow rivers and small lakes. Its technical limits are better suited for the treatment and repair of deep-sea sediments.

2.2.4. Artificial Oxygen Enhancement Technology. By using the original natural conditions of the river or existing building facilities, on the basis of the pollution and hypoxia of the water body, artificial means are used to increase the amount of dissolved oxygen in the water body, accelerate the metabolism of animals, plants, and microorganisms in the water body, and strengthen the improvement of the purification ability of the water body, thus achieving the purpose of improving water quality [24, 25]. Through mechanical means, adding aeration and oxygenation equipment and improving the purification ability of the polluted water body and the surrounding ecological circle greatly increase the dissolved oxygen content of the water body and have a good effect on the reduction of total nitrogen, total phosphorus, and COD content. The effect is also conducive to the loosening of the river bottom silt to become tighter and to prevent the pollutants in the bottom sludge from entering the upper water body. However, this technology has certain limitations, and the larger energy consumption is not suitable for the pollution control of more water bodies.

2.2.5. Mechanical Algae Removal Technology. This technology uses various mechanical methods to control water pollution caused by the explosive growth of algae. Generally, the technical methods used include artificial arching, ultrasonic method, air flotation technology, and mixed method. This technology method is generally used for the excessive growth of algae. For rivers and lakes that cause eutrophication, the mechanical methods, processes, and equipment vary greatly [26]. It can directly change the growth of algae caused by nutritional temples and effectively avoid secondary pollution. However, the operation cost is expensive and can only be applied to the treatment of small polluted water bodies. It has obvious limitations and serves as an emergency removal. Algae technology cannot fundamentally solve the eutrophication of water bodies caused by algae outbreaks.

3. Experimental Design of Treatment Technology of Microbial Landscape Aquatic Plants

3.1. Test Subject. In order to avoid the difference in the test water samples between the groups, the test water sample selected in this paper is the sewage from the suburban sewage ditch in a district. Through the investigation of the landscape aquatic plant resources, it is better to adapt and purify. The principle of high operability, good landscape effect, and high reuse value comprehensively considers the cost issue, adjusts measures to local conditions, conducts screening tests on the growth characteristics and pollution tolerance of aquatic plants, and checks the domestic and foreign research on the use of aquatic plants to control water pollution. Literature data and analysis select the following 4 common landscape aquatic plants for this test plant, and the types and growth characteristics of the 4 test plants are shown in Table 1. First, each plant was used as a group and a blank control group to conduct a comparative experiment. The total nitrogen content, total phosphorus content, and COD value data of each group were continuously monitored for two weeks. At the same time, this article again divides the experiment into 4 groups (*A* (experimental sewage + microbial inoculants), *B* (experimental sewage + plants), *C* (experimental sewage + microbial inoculants + plants), and *D* (experimental sewage)) for comparison experiments. Continuously monitor the total nitrogen content, total phosphorus content, COD value data, and color detection of each group for two weeks, and comprehensively detect and observe its repair effect on polluted water bodies.

3.2. Experimental Method

3.2.1. Plant Pretreatment. Before the phytoremediation test, the test plant must be pretreated. Divide the four plants into plants, and rinse the root soil with tap water. Based on ensuring the integrity of the root system, the plant should be skillfully pruned to reduce dead branches and leaves to ensure the healthy growth of the plant. The treated plants were cultivated in plastic buckets with sewage, depending on the species. The duration was 3 days, and we chose vibrant plants for the phytoremediation test.

3.2.2. Test Various Indicators. The test was conducted in a room that could be exposed to sunlight. The test time is from November 15th to November 30th, 2020. Room temperature is maintained at 25–30°C for 2 weeks. On the first day of the test, 100 L of fresh sewage was added to each test group in order to simulate that new pollutants were discharged into the actual sewage ditch everyday. After that, each test group changes 10 L of water daily. Total nitrogen, total phosphorus, COD levels, and chromaticity are tested every two days. The sampling time is 8:00 am, and the water is changed after sampling (if there is no sampling test on the water exchange day, the water exchange time is 8:00 am).

TABLE 1: Test plant species and growth characteristics.

Plant	Family name	Ecological habits
<i>Eichhornia crassipes</i>	Yujihuaceae	Perennial floating leaf type
<i>Cyperus alternifolius</i>	Sphagaceae	Perennial emergent
<i>Phragmites communis</i>	Gramineae	Perennial emergent
<i>Scirpus validus vahl</i>	Sphagaceae	Perennial emergent

3.3. Establish a Model Evaluation Index System. A metric is a specific metric that is determined according to several metric goals and can reflect some of the basic characteristics of the valuation target. Indicators are concrete, measurable, and target observation points. By actually observing the object, you can draw clear conclusions. In general, a metric system contains three levels of metric that are related to gradual decomposition and improvement. Among them, the 1st level and 2nd level metrics are relatively abstract and cannot be used as a direct basis for assessment. Third-level metrics need to be concrete, measurable, and behavior-oriented and can be used as a direct basis for teaching assessment.

3.4. Statistical Processing. Statistical analysis was performed with SPSS 13.0 statistical software. The significance test of the difference was performed by one-way analysis of variance. The difference between the two groups was tested by LSD-*t*. The results of total nitrogen, total phosphorus, and COD in sewage were performed by the group *t*-test. $P < 0.05$ is considered to be significant and statistically significant.

4. Treatment Technology of Microbial Landscape Aquatic Plants

4.1. Results of Treatment of Sewage by Experimental Plants

4.1.1. Change Trend of Total Nitrogen Content of Each Group in the Experiment. Through the continuous monitoring of the total nitrogen content of each group of test water bodies for a period of one month, the results are shown in Table 2.

It can be seen from Figure 1 that compared with the blank control group, the four plants all have different degrees of degradation effects on the total nitrogen in the sewage: among them, the water hyacinth group has the best degradation effect on the total nitrogen in the sewage, which is obviously ahead of that in the other groups; after two weeks of the test, the total nitrogen content decreased from 12.2 mg/L at the beginning of the test to 6.78 mg/L, and the degradation rate was 44.43%; the reed group had a better degradation effect on the total nitrogen in the sewage. The content was reduced to 7.62 mg/L, and the degradation rate was 37.54%; then, the water onion group had a poor degradation effect on the total nitrogen in the sewage, the total nitrogen content was reduced to 8.37 mg/L, and the degradation rate was 31.39%; the last was drought. The umbrella grass group reduced the total nitrogen content in the sewage, the total nitrogen content was reduced to 8.73 mg/L, and the degradation rate was 28.44%. The analysis of variance showed that the four treatment groups with added plants had significant differences in the removal effect of total nitrogen in sewage from the blank control group ($P < 0.05$).

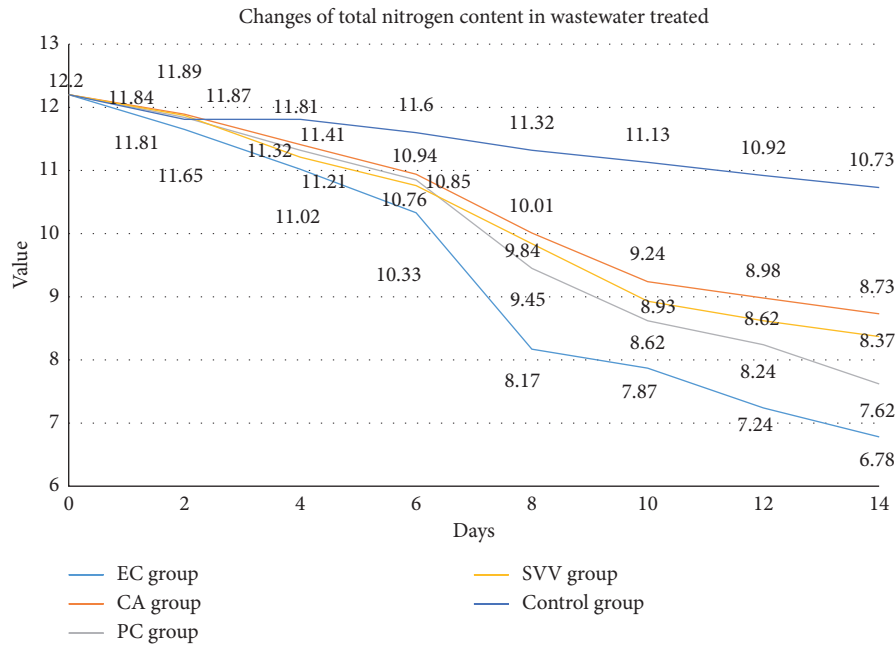


FIGURE 1: Changes of total nitrogen content in wastewater treated by plants.

TABLE 2: Data table of changes in total nitrogen content of wastewater treated by plants.

Day	EC group	CA group	PC group	SVV group	Control group
0	12.20	12.20	12.20	12.20	12.20
2	11.65	11.89	11.84	11.87	11.81
4	11.02	11.41	11.32	11.21	11.81
6	10.33	10.94	10.85	10.76	11.60
8	8.17	10.01	9.45	9.84	11.32
10	7.87	9.24	8.62	8.93	11.13
12	7.24	8.98	8.24	8.62	10.92
14	6.78	8.73	7.62	8.37	10.73

TABLE 3: The change data table of the total content of each plant treated sewage.

Day	EC group	CA group	PC group	SVV group	Control group
0	1.72	1.72	1.72	1.72	1.72
2	1.65	1.68	1.63	1.67	1.72
4	1.59	1.64	1.53	1.62	1.70
6	1.52	1.58	1.40	1.56	1.67
8	1.42	1.52	1.31	1.45	1.71
10	1.30	1.49	1.17	1.34	1.78
12	1.18	1.42	1.09	1.23	1.86
14	1.01	1.35	0.92	1.29	1.95

Therefore, the addition of plants effectively promoted the reduction of total nitrogen in sewage.

4.1.2. *The Change Trend of the Total Phosphorus Content of Each Group in the Experiment.* Through continuous monitoring of the total phosphorus content of each group of test water bodies for two weeks, the results are shown in Table 3.

Figure 2 shows that all four plants have different levels of degradation effect on total phosphorus in sewage compared to the blank control group. Among them, the reed group has the most decomposing effect on total phosphorus in sewage. Sewage is significantly more advanced than the other groups. Two weeks after the test, the total phosphorus content decreased from 1.72 mg/L at the start of the test to 0.92 mg/L, with a degradation rate of 46.51%. Second, the water hyacinth group showed a better degradation effect on total phosphorus in sewage. The content was reduced to 1.01 mg/L, and the degradation rate was 41.28%. After that, the onion group had a low decomposition effect on total phosphorus in the sewage, the total phosphorus content decreased to

1.29 mg/L, and the decomposition rate was 25.00%. The last was a drought. The umbrella glass group reduced the total phosphorus content in the sewage, the total phosphorus content was reduced to 1.35 mg/L, and the degradation rate was 21.51%. Analysis of variance showed that the four treatment groups with the addition of plants had a significant difference in the effect of removing total phosphorus in sewage from the blank control group ($P < 0.05$). Therefore, the addition of plants effectively helped reduce the total phosphorus content of the sewage.

4.1.3. *Test the COD Value Change Trend of Each Group.*

Through continuous monitoring of the COD value of each group of test water bodies for two weeks, the results are shown in Table 4.

It can be seen from Figure 3 that compared with the blank control group, the four plants all have different degrees of degradation effects on COD in sewage: among them, the water hyacinth group has the best degradation effect on COD in sewage, which is significantly ahead of the other

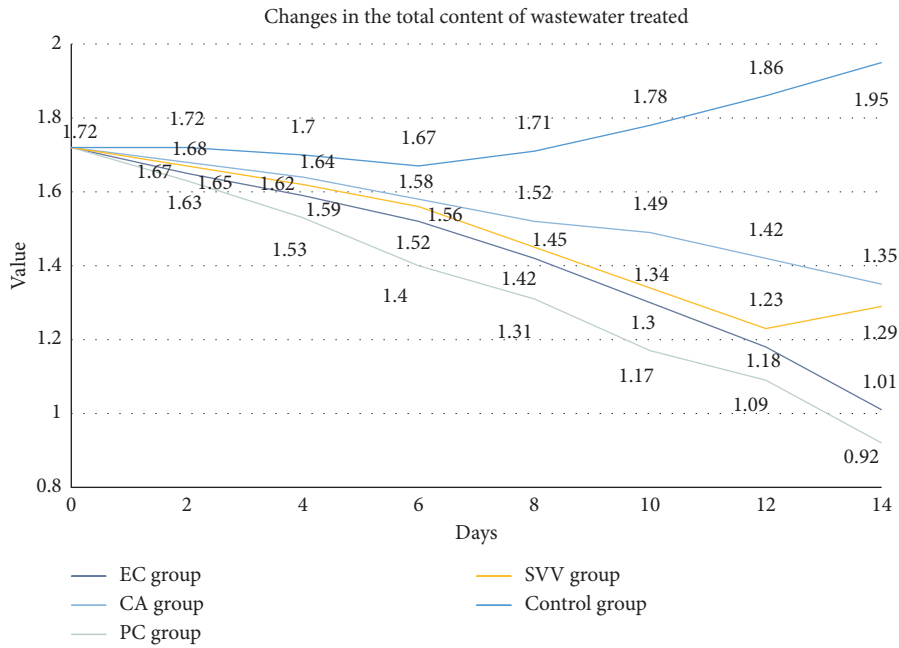


FIGURE 2: Changes in the total content of wastewater treated by plants.

TABLE 4: Data table of changes in COD content of sewage treated by plants.

Day	EC group	CA group	PC group	SVV group	Control group
0	196	196	196	196	196
2	189	194	191	194	200
4	181	188	185	188	195
6	172	183	179	181	190
8	157	179	164	176	188
10	144	174	162	170	186
12	140	170	156	166	185
14	137	168	151	163	183

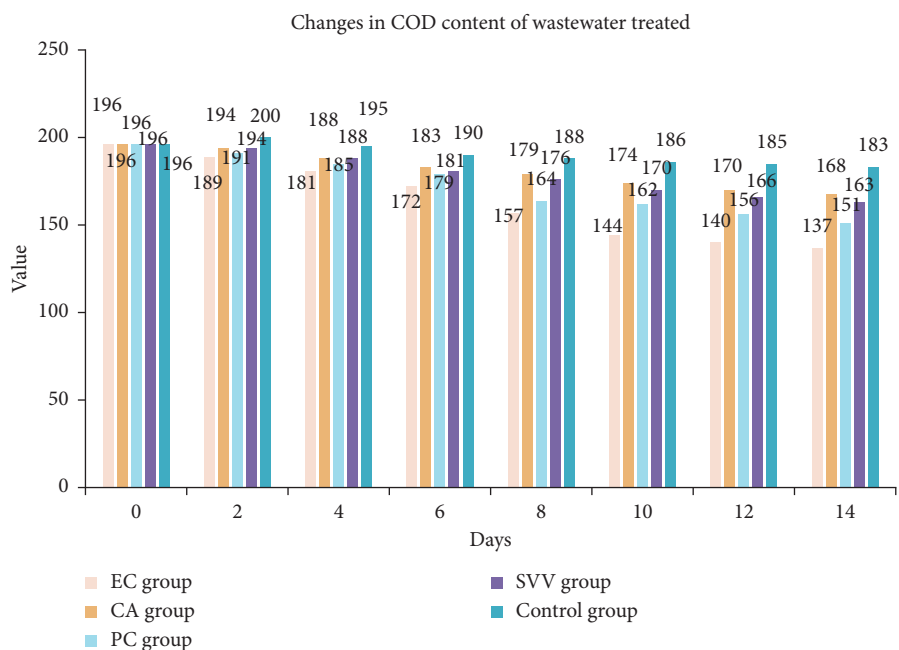


FIGURE 3: Changes in COD content of wastewater treated by plants.

TABLE 5: Microbial-plant combined treatment wastewater total nitrogen content change data table.

Day	A	B	C	D
0	12.20	12.20	12.20	12.20
2	11.54	11.76	11.41	11.81
4	10.13	10.95	9.63	11.81
6	9.06	10.48	8.21	11.60
8	7.72	9.08	6.57	11.32
10	6.34	8.25	5.16	11.13
12	5.12	7.87	3.52	10.92
14	4.29	7.25	2.73	10.73

groups. After two weeks of the test, the COD value was reduced from 196 mg/L at the beginning of the test to 137 mg/L, and the degradation rate was 30.10%; secondly, the reed group had a better degradation effect on COD in sewage, and the COD value was reduced to 151 mg/L. The degradation rate is 22.96%; then, the water onion group has a poor degradation effect on the COD in the sewage, the COD value is reduced to 163 mg/L, and the degradation rate is 16.84%; the last is the dry umbrella grass group on the COD value in the sewage. The COD value is reduced to 168 mg/L, and the degradation rate is 19.39%. The analysis of variance showed that the removal effect of the four treatment groups with plants on the removal of COD in sewage was significantly different from that of the blank control group ($P < 0.05$). Therefore, the addition of plants effectively promoted the reduction of COD in sewage.

4.2. Results of Microbial-Plant Combined Treatment of Sewage

4.2.1. Variation Trend of Total Nitrogen Content in Each Group of Microbial-Plant Joint Test. Through two weeks of continuous monitoring of the total nitrogen content of each group of test water bodies in the microbial-plant joint test, the results are shown in Table 5.

It can be seen from Figure 4 that compared with the blank control group, the degradation effect of each treatment test group is significantly different. The total nitrogen degradation effect: microorganism + plant > microorganism > plant > blank control group, and the final degradation rates are 77.67%, 64.85%, and 40.61%, respectively; the combined treatment of sewage with microorganisms and plants has a significantly better effect on reducing the total nitrogen content in sewage than using microorganisms and plants alone, and the effect of microorganisms in reducing the total nitrogen content in sewage is better than that of plants.

4.2.2. Variation Trend of Total Phosphorus Content in Each Group of Microbial-Plant Joint Test. Through continuous monitoring of the total phosphorus content of each group of test water bodies in the microbial-plant joint test for two weeks, the results are shown in Table 6.

It can be seen from Figure 5 that compared with the blank control group, the degradation effect of each treatment test group is significantly different. The total phosphorus degradation effect: microorganism + plant > microorganism > plant > blank control group, the final degradation rates are 71.97%, 61.56%, and 39.23%, respectively; the combined

treatment of sewage with microorganisms and plants has a significantly better effect on reducing the total phosphorus content in sewage than using microorganisms and plants alone, and the effect of microorganisms in reducing the total phosphorus content in sewage is better than that of plants.

4.2.3. The COD Value Change Trend of Each Group in the Microbial Plant Joint Test. Through two weeks of continuous monitoring of the COD value of each group of test water bodies in the microbial-plant joint test, the results are shown in Table 7.

It can be seen from Figure 6 that compared with the blank control group, the degradation effect of each treatment test group is significantly different. The COD degradation effect: microorganism + plant > microorganism > plant > blank control group, and the final degradation rate is 85.95%, 78.64%, and 30.43%, respectively; the combined treatment of sewage with microorganisms and plants has a significantly better effect on reducing the COD value of sewage than using microorganisms and plants alone, and the effect of microorganisms on reducing the COD value of sewage is better than that of plants.

4.2.4. The Color Change of Each Group of Samples in the Microbial-Plant Joint Test. Since sewage contains a lot of pollutants such as organic substances, inorganic substances, and algae that cause sewage turbidity, it is possible to judge the turbidity of the water area by detecting the turbidity of the water area. Water bodies become more turbid, less transparent, and vice versa. The clearer the water, the more transparent it is. Figure 7 shows the results of monitoring the chromaticity of the test water of each group in the joint microbial and plant test for two consecutive weeks.

It can be seen from Figure 7 that the water quality of the three treatment test groups is clear than the blank control group, and its clarity is: microorganism + plant > microorganism > plant > blank control group. In the blank control, the chromaticity of the sewage slightly decreased, which was the result of natural precipitation. In the other treatment groups, the chromaticity of the sewage was reduced. Compared with the blank control, the chromaticity of the plant group was significantly reduced. Therefore, the addition of plants effectively improved the turbidity of the sewage; the microbial chromaticity test results were compared with those of the blank control. The chromaticity is obviously reduced; therefore, the addition of microorganisms is also

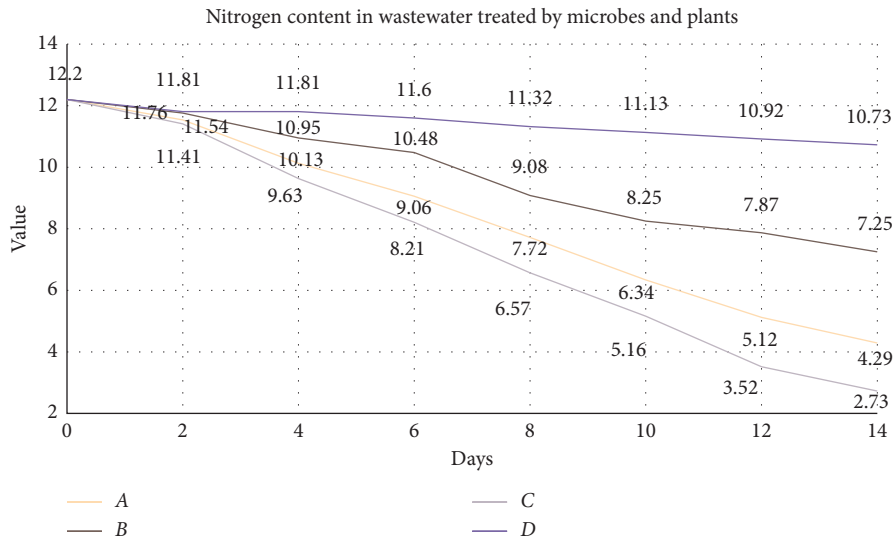


FIGURE 4: Changes of total nitrogen content in wastewater treated by microbes and plants.

TABLE 6: Microbial-plant combined treatment wastewater total phosphorus content change data table.

Day	A	B	C	D
0	1.72	1.72	1.72	1.72
2	1.58	1.69	1.51	1.72
4	1.36	1.63	1.27	1.70
6	1.15	1.56	1.03	1.67
8	0.98	1.46	0.86	1.71
10	0.85	1.34	0.62	1.78
12	0.74	1.22	0.53	1.86
14	0.66	1.05	0.48	1.95

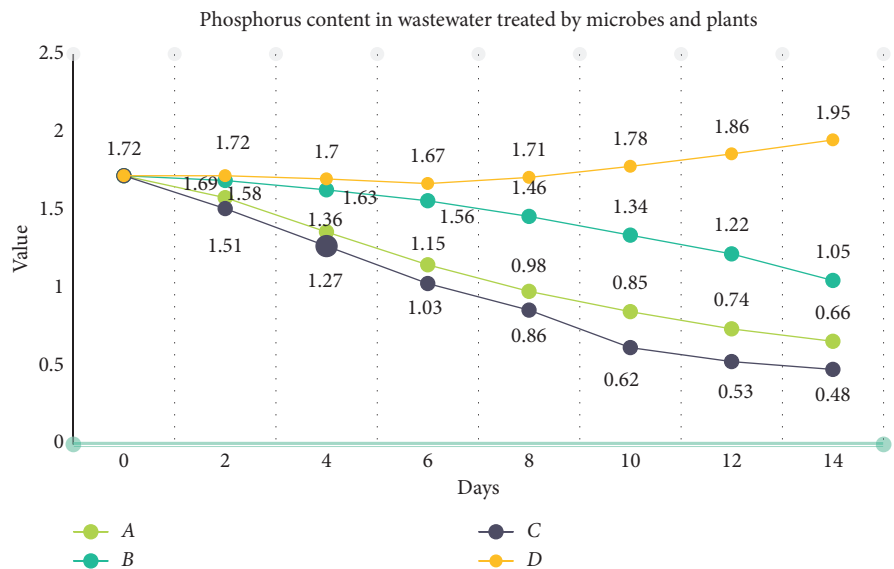


FIGURE 5: Changes of total phosphorus content in wastewater treated by the microbe plant.

TABLE 7: The COD value change data table of the combined treatment of microorganisms and plants.

Day	A	B	C	D
0	196	196	196	196
2	175	188	168	200
4	152	180	139	195
6	120	171	118	190
8	98	156	88	188
10	77	143	69	186
12	58	139	46	185
14	42	136	28	183

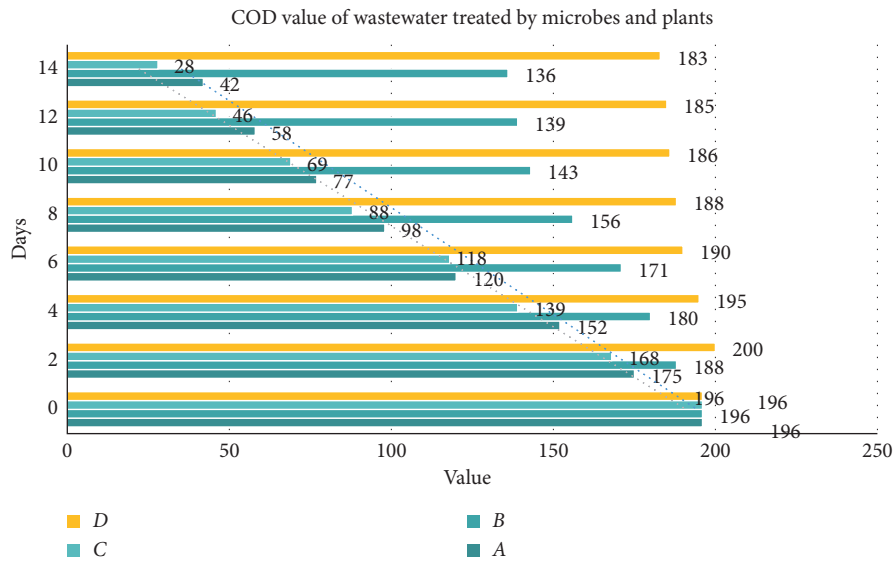


FIGURE 6: Changes of the COD value of wastewater treated by microbe plants.

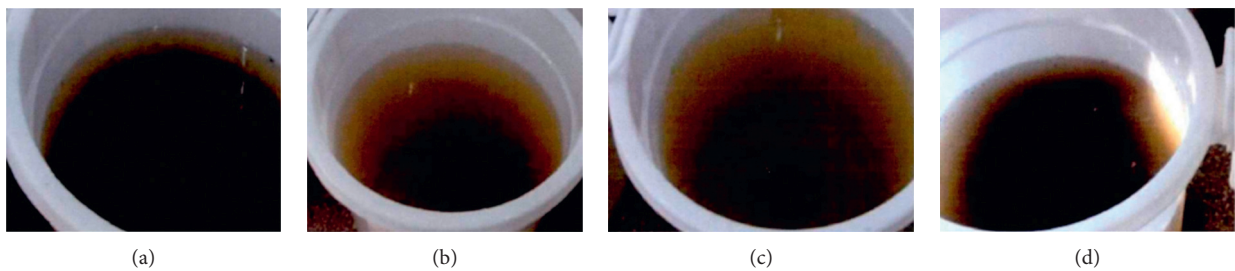


FIGURE 7: Intuitive chart of changes in water quality of each group (<https://image.baidu.com/>). (a) Microorganisms + plants. (b) Microorganisms. (c) Plants. (d) Control group.

conductive to improving the turbidity of sewage; the combination of microorganisms and plants repairs the sewage to further improve the chromaticity of the sewage.

5. Conclusions

On the basis of a more comprehensive analysis of the pollution of the sewage ditch in the suburbs, a simulation test of microorganism-landscape aquatic plants for sewage treatment was selected to provide a certain theoretical basis for actual sewage treatment on site. In view of the

degradation effect of total nitrogen, total phosphorus, and COD in sewage, the effect of combined microorganisms and plants to repair sewage is obviously better than that of using microorganisms and phytoremediation alone, and the effect of microbial repair of sewage is better than phytoremediation of sewage. For the improvement of sewage chroma, the two groups of microorganisms combined with plants have the best effect, followed by the microbiome, and finally the two groups with added plants. By observing the bottom and inner wall of the sewage treatment system, the two groups of microbiome and microbiome combined plant

group, a large number of substances precipitate and attach, which effectively improves the chroma of sewage and makes the test water sample clearer.

In this study, combining the selected microorganisms with landscape aquatic plants for sewage treatment research, the effect of degrading pollutants is good, and the sewage water quality is obviously improved, but there are still many problems that need to be studied in depth. The room temperature is stable and maintained at a temperature where microorganisms can actively reproduce and metabolize. It is impossible to fully analyze the degradation effects of microorganisms and plants under different climatic conditions. At the same time, the growth of plants is limited by the climate. The indoor simulation with the small test scale and low time span cannot meet the requirements. The actual sewage treatment construction needs to be on site. In the indoor simulation test, microorganisms combined with landscape aquatic plants for sewage treatment have the best effect. No in-depth research has been carried out on the mechanism of water purification. In future research projects, attention should be paid to the interaction between microorganisms and plants. The mechanism of water purification is studied and analyzed.

Planting plants in waters not only beautifies the water environment but also purifies the water quality. The subject of this paper's research is sewage from around sewage ditches. Sewage is treated by microorganisms in combination with landscape aquatic plants. By measuring changes in nutrients in water areas, nutrient removal in a combination of microorganisms and landscape aquatic plants has been studied, the nitrogen and phosphorus content of plants and the distribution of microorganisms outside the root zone of plants have been studied, and how to remove nitrogen and phosphorus in water can be studied. The results show that the use of microorganisms and plants alone to treat sewage effectively reduces total nitrogen, total phosphorus, and COD levels in sewage. The combination of these two effects effectively reduces sewage pollutants and reduces chromaticity.

Data Availability

No data were used to support the findings of this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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