# USING AQUATIC PLANTS AS TREATMENT FOR SWINE-BREEDING WASTEWATER AFTER BIOGAS TECHNOLOGY

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## SUMMARY
The livestock industry is one of the important sectors of agriculture in Vietnam. The swine-breeding farms are mainly spontaneous, the common wastewater is treated by biogas technology. However, the actual operation at the farms, shows that the wastewater treatment by biogas has been high content and still exceeded the standards of national regulation QCVN 62-MT:2016/BTNMT of COD, $BOD_5$, TN, $PO_4^{3-}$, leading to affect the environment. An empirical study was carried out to treat swine-breeding wastewater after biogas technology using *Sagittaria sagittifolia* and *Enydra fluctuans*. The results showed that the swine-breeding farming wastewater treatment model with *Enydra fluctuans* has an efficiency of 73.3% of COD content, 89.2% of $BOD_5$, 88.3% of TN, and 89.6% of $PO_4^{3-}$. *Sagittaria sagittifolia* showed a yield of 66.7% of COD content, 78.7% of $BOD_5$, 69.5% of TN, and 85.1% of $PO_4^{3-}$. With the same conditions and the same experimental design method, *Enydra fluctuans* showed better treatment results than *Sagittaria sagittifolia*. However, wastewater is treated by *Sagittaria sagittifolia* and *Enydra fluctuans* meeting the regulations QCVN 62-MT:2016/BTNMT, column B for pH, COD, $BOD_5$, TN, $PO_4^{3-}$ parameters after 30 days. The treatmen model shows great potential for using aquatic plants to remove pollutants from swine-breeding wastewater. However, further studies should be carried out to evaluate the model's stability and applicability in practice.
**Key words: Aquatic plants, Enydra fluctuans, Sagittaria sagittifolia, swine-breeding, wastewater treatment.**

## 1. INTRODUCTION

The livestock industry is one of the important sectors of agriculture in Vietnam, and plays an important role in contributing to the national economic development (Vu Thi Nguyet et al., 2014). The total swine herd of the country in 2020 reached approximately 26.2 million. In the first months of 2021, African swine fever was basically controlled, only small outbreaks remained, and the total swine herd recovered quickly. It is estimated that in January 2021, the total number of pigs increased by 16.2% over the same period in the previous year, in February 2021, that figure increased by 15.5%. By March 2021, the number of pigs increased by 11.6% compared to the same period in 2020. It is estimated that the total number of pigs in the country as of the end of May 2021 increased by 11.8% over the same period in 2020 (General Statistics Office - GSO, 2021).

Wastewater from swine-breeding production is mainly generated from the process of bathing, washing the barn for pigs, fecal water, urine of pigs, wastewater… containing high content of organic matter, suspended solids, total nitrogen, and total phosphate, phosphorus, and microorganisms. On average, raising pig generates 30 liters of wastewater each day (Mai Quang Tuyen, 2020). Thus, if livestock wastewater is not controlled and treated effectively, it will cause heavy environmental pollution. In Vietnam, swine-breeding wastewater is mainly pre-treated through biogas and then discharged directly into the environment. However, the biogas digester can only handle the organic matter, the content of N and P in the wastewater is still high. Therefore, wastewater from households and swine-breeding farms is one of a source of environmental pollution and eutrophication for water bodies (Le Sy Chinh et al., 2018). Although livestock wastewater can be used to irrigate crops, it affects water quality due to the process of overflow. When livestock wastewater is used more than the uptake rate of crops, the excess can enter surface-and-ground water sources causing pollution (Singhal and Rai, 2003).

Currently, there are many methods to treat livestock wastewater such as biological methods (activated sludge technology, anaerobic, and aerobic decomposition) and physicochemical methods... that have been researched and applied. In particular, the method of treating livestock wastewater with aquatic plants is considered an environmentally friendly, inexpensive, and easy-to-operate method. Several other studies have used aquatic plants and filter to reduce TSS, COD, N and P to an environmentally acceptable level (Brix H.,

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1994; J. Vymazal, 2007). The use of aquatic plants also enhances the landcape of the treatment system (Brix H., 1994). The efficiency of plant treatment for wastewater depends largely on photosynthesis and plant growth. Some aquatic plants have been shown to be more efficient in using solar energy than some terrestrial plants (Singhal and Rai, 2003). It is advisable to incorporate different species in the treatment system to increase efficiency, giving preference to native species over exotic species (Greenway M., 2003). Wetland technology has been applied in many countries in the world. Specifically, it has been widely used to treat livestock wastewater in the United States, the Czech Republic, and Mexico (Hunt P.G. and Poach M. E., 2001; Vymazal J., 2002; González1 F.T et al., 2009).

With a tropical climate and a rich and diverse flora, Vietnam is a country with great potential in using aquatic plants to treat livestock wastewater. There have been many studies using different species for wastewater treatment, typically *Eichhornia crassipes* (Mart.) Solms, *Ventiver zizanoides* L., *Phragmites australis* Cav.,… (Truong Hoang Dan et al., 2009; Vu Thi Nguyet et al., 2014; Bui Thi Kim Anh et al., 2019). Around the world, *Eichhornia crassipes* (Mart.) Solms, with their rapid growth, have been widely used to treat various types of wastewater (Singhal and Rai, 2003). This species is very sensitive to low temperatures and frost, so water treatment systems using *Eichhornia crassipes* are applied mainly in warm climates, typically in the southern part of the United States (Aoi T., Hayashi. T., 1996; U.S. EPA, 1988). *Eichhornia crassipes* is also widely used in Brazil, Egypt, and many other countries (Ghabbour E. A. et al., 2004; Mangabeira P. A. O. et al., 2004).

Therefore, this research was conducted to treat swine-breeding wastewater after biogas technology using *Sagittaria sagittifolia* and *Enydra fluctuans* to propose solutions to apply ecological technology using aquatic plants in livestock wastewater treatment.

## 2. RESEARCH METHODOLOGY

### 2.1. Materials

- Plants:

Plants were collected meeting the capable of treating wastewater with high organic matter, N and P content, and the ability to grow and develop in a good polluted environment, and available around the experimental area. Based on the growth characteristics of the plants, the plant samples of the species that are similar in size and growth stage, free from pests and diseases, fresh and healthy were selected from ponds and lakes around the area of Xuan Mai town and Chuong My in Hanoi. The species name are shown in Table 1.

**Table 1. Plant species used in the experiment**

| No. | Scientific name |
|---|---|
| 1 | *Sagittaria sagittifolia* L. |
| 2 | *Enydra fluctuans* Lour |

After being collected, plants were grown in the experimental area in clean water for 30 days to avoid contamination for the next experiments and to avoid shock when transferred to the new environment. After 30 days, healthy, well-developed plants were selected for experimental layout.

- Wastewater

Wastewater samples, which were collected from swine-feeding farms after biogas in Thuy Xuan Tien commune, Chuong My district, Hanoi city. After they were mixed well. The input water quality parameters are shown in Table 2.

**Table 2. Quality parameters of pig farming wastewater after input biogas**

| Parameters Sample | pH | COD (mg/L) | $BOD_5$ (mg/L) | N- Total (mg/L) | P- Total (mg/L) |
|---|---|---|---|---|---|
| Sample | 8.1 | 660 | 555 | 99 | 15.5 |
| C (column B, QCVN 62-MT:2016/BTNMT) | 5.5 - 9 | 300 | 100 | 150 | - |

## 2.2. Research Methods

### *2.2.1. Methods of sampling and analysis*

- The sampling procedure followed TCVN 6663-1:2011 (ISO 5667-1:2006) and TCVN 6663-3:2008 (ISO 5667-3:2003)

The input and output wastewater samples were analyzed according to the specific methods in Table 3.

**Table 3. Methods to analyze wastewater quality in laboratory**

| No. | Parameters | Methods |
|---|---|---|
| 1 | pH | TCVN 6492:2011 (ISO 10523:2008) |
| 2 | COD | TCVN 6491:1999 (ISO 6060:1989) |
| 3 | $BOD_5$ | TCVN 6001-2:2008 |
| 4 | T-N | TCVN 5988:1995 (ISO 5664:1984) |
| 5 | T-P | TCVN 6202:2008 (ISO 6878:2004) |
| 6 | $PO_4^{3-}$ | TCVN 6494-1:2011 (ISO 10304-1:2007) |

### *2.2.2. Experimental method*

The experiment was arranged in a sheltered place, with natural temperature and light in order to evaluate the efficiency of swine farming wastewater after biogas of the artificial tree planting field over time in actual conditions.

Wastewater after biogas was diluted two times and mixed to form a homogeneous mixture in styrofoam containers which was sized of 54 x 39 x 27 cm, wrapped with plastic inside, rinsed with diluted livestock wastewater.

- Each experimental formula was repeated three times, designed completely randomly, the monitoring parameters were pH, COD, $BOD_5$, content of TN, and $PO_4^{3-}$.
- The wastewater in the containers was collected and analyzed periodically every 10 days according to the experimental time in order to examine the absorption capacity as well as the concentration of pollutants after the experimental time.

Water samples before and after the experiment were analyzed at the Environmental Analysis Department, Center for Environmental Analysis and Geospatial Technology Application, Forestry University. The experimental layout is shown in Table 4.

**Table 4. Experimental content**

| Treatment by *Enydra fluctuans* Lour | | Treatment by *Sagittaria sagittifolia* L. | | Non-treatment |
|---|---|---|---|---|
| Tank B0 | Tank B1 | Tank C0 | Tank C1 | Non-treatment Tank |
| 20 liters of livestock wastewater + 2.5 kg of gravel | | | | |
| 10 individuals | 20 individuals | 10 individuals | 20 individuals | No plant |

The treatment efficiency of the experiments was calculated according to the following formula:

$$H_n(\%) = \frac{C_{y,n} - C_{x,n}}{C_0} \times 100$$

Where:

$H_n$: Treatment efficiency of plants at the experimental samples up to day n (%);

$C_{x,n}$: Concentrations of parameters in non-treatment samples up to day n (mg/l);

$C_{y,n}$: Concentrations of parameters at the experimental sample up to day n (mg/l);

$C_0$: Initial concentration of experimental parameters (mg/l).

The results after calculation were compared between the times of analysis, and compared with the standards of the national regulations on the quality of wastewater before being discharged into the environment. The results the pollution level of the water source in the study site and the treatment capacity of the target aquatic plants.

## 3. RESULTS AND DISCUSSION

### 3.1. Effects of *Enydra fluctuans* density on the treatment capacity

The results of the analysis of samples according to the density of *Enydra fluctuans* to the ability to treat livestock wastewater are shown in the following table 5.

**Table 5. pH value according to the density of *Enydra fluctuans***

| Sample | pH | COD | $BOD_5$ | N-total | $PO_4^{3-}$ |
|---|---|---|---|---|---|
| Non-treatment | 7.2 | 600 | 380 | 131.7 | 99.3 |
| From tank B0 | 8.1 | 240 | 90 | 53.5 | 22.5 |
| From tank B1 | 7.5 | 192 | 80 | 20.8 | 16.9 |

Table 5 shows that the change of pH is insignificant. The analyzed samples increased slightly. After a period of treatment using *Enydra fluctuans*, the pH increased to 8.1 for sample B0 and 7.5 for sample B1 and the non-treatment sample was 7.2.

The results also show a sharp decrease in chemical oxygen demand. The non-treatment sample COD was 4.1 times higher than the standard. In the experimental sample B0, the COD content decreased to 240 mg/l but was still 1.6 times higher than the standard. In the experimental sample B1, the COD content decreased, but was also 1.3 times higher than the standard. Thus, it can be seen that sample B1 is better treated than sample B0 and treated with aquatic plants much better than untreated.

The $BOD_5$ content still exceeded the Cmax standard, but in general, the $BOD_5$ content was much reduced compared to the non-treatment sample. Specifically, the non-treatment sample had a $BOD_5$ content 4.2 times higher than that of sample B0 and 4.8 times higher than that of sample B1. This shows that sample B1 handles $BOD_5$ better than sample B0.

Total N content still exceeded Cmax standard, but in general, Total N content also decreased much compared to the non-treatment sample. Specifically, the nitrogen content of the non-treatment sample was 6.3 times higher than that of sample B1 and 2.4 times higher than that of sample B0. This shows that the B1 multiple sample reduced Total N better than the B0 sample.

The results of the study showed that the $PO_4^{3-}$ content was reduced. However, the $PO_4^{3-}$ content is still higher than the standard. For the non-treatment sample, the $PO_4^{3-}$ concentration was the highest at 99.3, 16.7 times higher than the standard. The non-treatment sample's P content was 4.41 times higher than that of sample B0 and 5.9 times higher than that of sample B1. This shows that sample B1 also was treated better than sample B0 in terms of Total P.

### 3.2. Effects of *Sagittaria sagittifolia* density on the treatment capacity

The results of the analysis of samples according to the density of *Sagittaria sagittifolia* to the ability to treat livestock wastewater are shown in the following table 6.

**Table 6. pH value according to the density of *Sagittaria sagittifolia***

| Sample | pH | COD | $BOD_5$ | N-total | $PO_4^{3-}$ |
|---|---|---|---|---|---|
| Non-treatment | 7.2 | 600 | 380 | 131.7 | 99.3 |
| From tank C0 | 7.4 | 240 | 110 | 71.2 | 27.5 |
| From tank C1 | 7.7 | 240 | 100 | 54.4 | 24.2 |

Table 6 shows that the change of pH is insignificant. The analyzed samples increased slightly. After a period of treatment by *Sagittaria sagittifolia*, the pH increased to 7.4 for C0 and 7.4 for C1 and 7.2 for the non-treatment experiment.

The results showed that the chemical oxygen demand decreased sharply. In the experimental samples, C0 and C1 were reduced COD content to 240 mg/l. Thus, samples C1 and C0's COD values were reduced at the same level.

$BOD_5$ content was greatly reduced compared with the non-treatment sample. Specifically, the non-treatment sample's $BOD_5$ content was 3.5 times higher than that of C0 and 3.8 times higher than C1. This shows that sample C1 reduced $BOD_5$ better than sample C0.

Total N content was greatly reduced compared with the non-treatment sample. Specifically, the nitrogen content of the non-treatment sample was 1.8 times higher than that of the C0 sample and 2.4 times higher than that of the C1 sample. This shows that the C1 sample reduced Total N better than the C0.

From the results, the $PO_4^{3-}$ content was reduced. However, the $PO_4^{3-}$ content is still higher than the standard. For the non-treatment sample, the $PO_4^{3-}$ concentration was the highest at 99.3, 16.7 times higher than the standard. The nitrogen content of the non-treatment sample was 4.1 times higher than that of sample C1 and 3.6 times higher than that of the sample C0. This shows that the C1 sample also reduced P better than the C0 sample.

### 3.3. Effect of time on the treatment ability of *Enydra fluctuans*

The evolution of monitored parameters over the experimental process is shown in Figure 1.

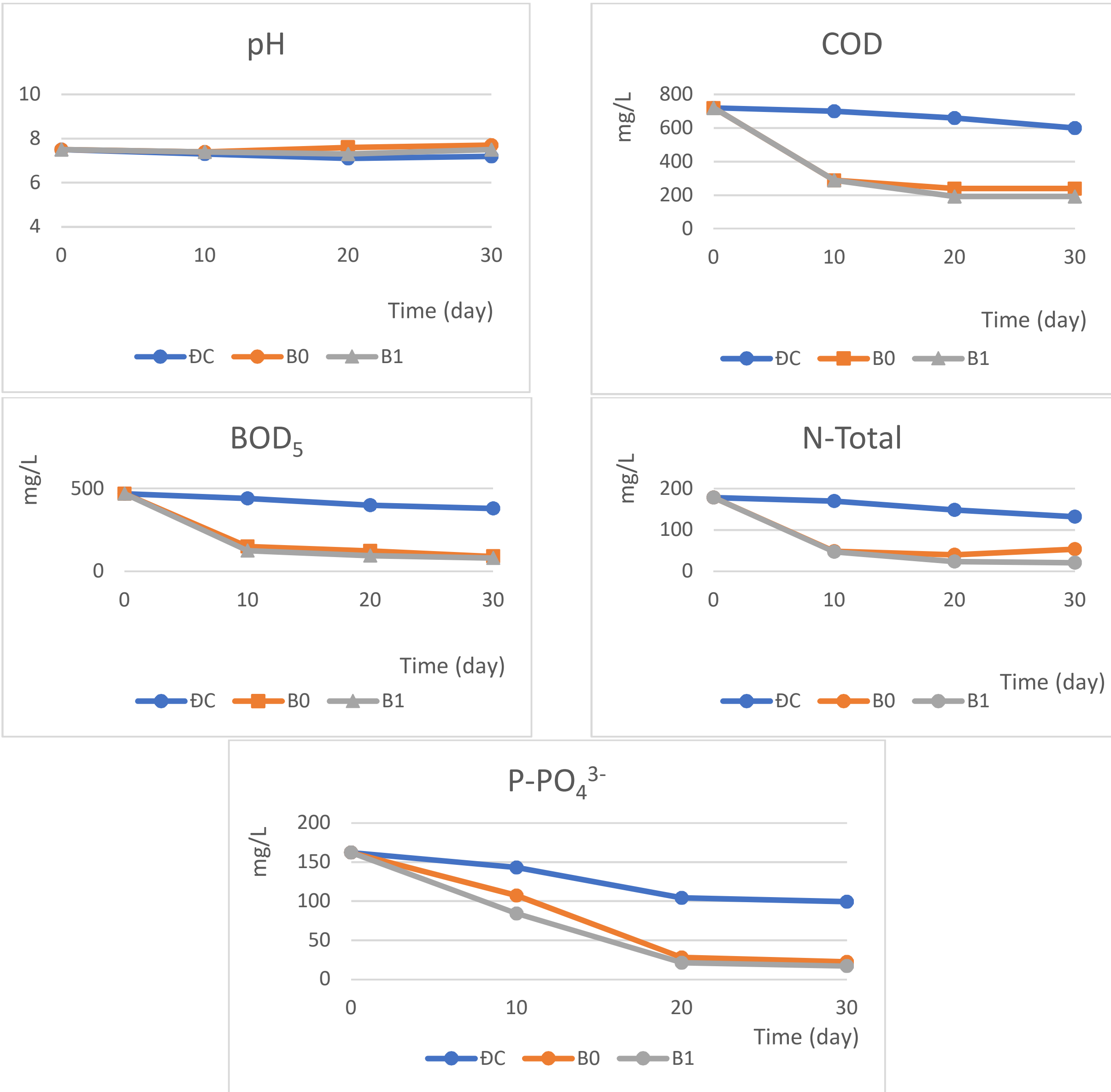


**Figure 1. Values of monitored parameters by time using *Enydra fluctuans***

The results in figure 1 show that pH parameters after the first 10 days of the experiment, decrease slighly while there is a slight increase on the 20 days to 30 days. However, the pH value fluctuates in the range of 7-8, within the allowable threshold of QCVN 62-MT:2016/BTNMT.

COD parameters decrease sharply in the first 10 days of the experiment, the next period continued to decrease slightly, the efficiency in the $10^{th}$ day of both experimental samples, B0 and B1, reached 60%; in day 30, the treatment efficiency of B0 reached 66.7%, B1 reached 73.3%.

$BOD_5$ parameter in the non-treatment decrease over the time. After 30 days, the $BOD_5$ content was still higher than QCVN 62-MT:2016/BTNMT. The results showed that the $BOD_5$ content in the experimental samples decreased over time. In the non-treatment sample, after 30 days, the average $BOD_5$ content decreased from 89 mg/1 to 380 mg/l, a small decrease. However, in samples B0 and B1, the $BOD_5$ content decreased significantly with 15 days of testing (reduced from 346 - 374 mg/1). After 30 days, the level decreased from 379 to 389 mg/l. In general, $BOD_5$ content in wastewater is treated at a fast rate and it proved the great ability of $BOD_5$ treatment of the plants.

N-total parameter: the total nitrogen treatment capacity of *Enydra fluctuans* in general decreased over time, only sample B0 increased slightly from day 20 to day 30. In the first 10 days, the N-total content of B0 and B1 decreased from 178.4 mg/l to 48.6 mg/l and 46.7 mg/l, achieving treatment efficiency of 72.8% and 73.8%. The results show that *Enydra fluctuans* uses a lot of nutrients to grow and develop, helping to reduce the concentration of pollution in the wastewater.

$PO_4^{3-}$ parameters: After 30 days of experiment, the concentration of $PO_4^{3-}$ tended to decrease. Especially in the first 20 days, the concentration of $PO_4^{3-}$ decreased sharply, reaching the treatment efficiency of 82.7% to 82.7%. 86.9%. After 30 days, the processing efficiency continued to decrease to 86.1% to 89.5%. Compared with the non-treatment sample, the content of $PO_4^{3-}$ was reduced more than 5 times.

### 3.4. Effect of time on the treatment ability of *Sagittaria sagittifolia*

After 30 days of experiment, the concentration of pollutants in the wastewater tanks of the husbandry and vegetable production of *Sagittaria sagittifolia* fluctuated significantly (Figure 2).

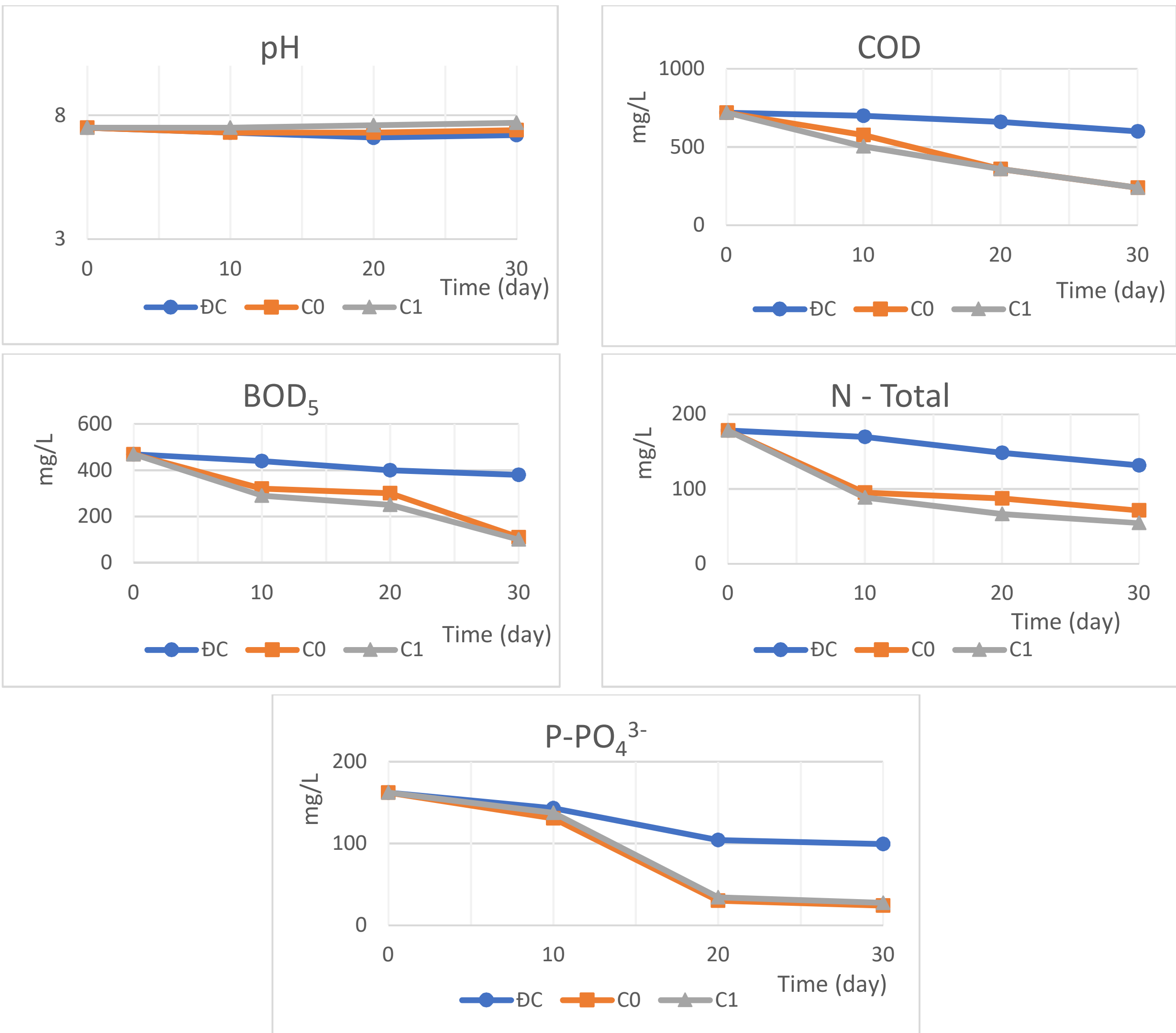


**Figure 2. Values of monitored parameters by time using *Sagittaria sagittifolia***

The results in figure 2 show that pH value is relatively stable, fluctuating between 7 and 8.5, meeting the regulations of QCVN 62-MT:2016/BTNMT while the COD concentration decreased sharply over time. On the first 10 days, the COD concentration in the C1 sample decreased the most, but after 20 days, the treatment efficiency of C0 was equal to the C1. Specifically, on the $10^{th}$ day, the COD treatment efficiency of C0 was 20%, C1 was 30%. But on the 20th day, the COD removal efficiency of both samples reached 50%; on the 30th day, the efficiency reached 66.7%.

The results show that the plant has the ability to reduce $BOD_5$ concentration in swine farming wastewater significantly. On the $20^{th}$ day, the $BOD_5$ removal efficiency of C0 reached 36%, which of C1 reached 46.7%. By the $30^{th}$ day of experiment, the $BOD_5$ removal efficiency of both samples was approximately equal, reaching 76.5% - 78.7%. In the non-treatment sample, the $BOD_5$ concentration decreased slightly over time, the highest efficiency was only 18.9%.

The results of Figure 2 show that the concentration of N-total tends to decrease over time. The experimental formula gave the highest N-total treatment efficiency, after 30 days reaching 69.5%. In the first 10 days, the treatment speed of C0 and C1 was approximately equal, however, in the next time, C1 gave better treatment efficiency than C0.

Figure 2 also shows that the treatment capacity of $PO_4^{3-}$ of C0 and C1 did not have much difference. The treatment efficiency of both experimental treatments on the 20th day was approximately 78.8% - 81.4%, on the 30th day it was 83% - 85%.

Thus, time has affect considerably the ability to treat livestock wastewater: the longer the time, the more different treatment results. However, when aquatic plants have been treated to a certain limit, the level of impact will be reduced.

### 3.5. Comparison of treatment capacity of aquatic plants

The treatment efficiency of aquatic plants in the experimental tanks is shown in Table 7.

**Table 7. Treatment efficiency of aquatic plants for experimental parameters**

*Unit: %*

| No | Parameter | Treatment by *Enydra fluctuans* | Treatment by *Sagittaria sagittifolia* | Non-treatment |
|---|---|---|---|---|
| 1 | COD | 73.3 | 66.7 | 16.7 |
| 2 | $BOD_5$ | 82.9 | 78.7 | 18.9 |
| 3 | N-total | 88.3 | 69.5 | 26.2 |
| 4 | $PO_4^{3-}$ | 89.6 | 85.1 | 38.8 |
| | **Average** | **83.6** | **74.9** | **25.2** |

In the tank containing *Enydra fluctuans*, the COD treatment efficiency is 73.3%, whereas, which of *Sagittaria sagittifolia* treatment is 66.7%, and finally the non-treatment sample has the treatment efficiency of only 25.2%.

The treatment efficiency of aquatic plants with $BOD_5$ content is quite high, in which the highest efficiency is 82.9% in the tank containing *Enydra fluctuans* and gradually decreases in the treatment efficiency with the *Sagittaria sagittifolia*'s tank. The treatment efficiency of the non-treatment sample was very low, only 18.9%. Thus, it is confirmed that treatment with aquatic plants brings very high treatment efficiency.

Similar to the above criteria, the highest total nitrogen treatment efficiency was still in the experimental sample treated by *Enydra fluctuans* with an efficiency of 88.3%, following by *Sagittaria sagittifolia* with a treatment efficiency of 69.5 %. The yield without treatment with aquatic plants was very low at only 26.2%.

For Phosphorus, the treatment efficiency of aquatic plants was different in all samples. Specifically, the processing capacity of *Enydra fluctuans* is the highest with the treatment efficiency of 89.6%, followed by *Sagittaria sagittifolia* at 85.1%. The self-cleaning ability of wastewater with the non-treatment sample is not high, at only 38.8%.

## 4. CONCLUSION

Livestock wastewater in Chuong My district, after the biogas technology, has been discharged directly into the environment without any treatment. The analysis results showed parameters COD exceeded 2-3 times, $BOD_5$ exceeded 6-7 times; P-total and N-total is within the allowable range in comparison with QCVN 62-MT:2016/BTNMT. However, the values of the P-total and N-total are very high, approximately the threshold specified by the standard.

The study was conducted 2 experimental models for treatment of swine-breeding wastewater using two aquatic plant species after biogas technology, including *Enydra fluctuans* and *Sagittaria sagittifolia*. The results showed that the treatment of swine-breeding wastewater with the aquatic plants awarded high efficiency, reducing a large amount of pollutants before being discharged into the environment. With the same conditions and the same experimental design method, *Enydra fluctuans* showed better treatment results than *Sagittaria sagittifolia*. However, wastewater is treated by *Sagittaria sagittifolia* and *Enydra fluctuans* meeting the regulations QCVN 62-MT:2016/BTNMT, column B for pH, COD, $BOD_5$, TN, $PO_4^{3-}$ parameters after 30 days. The swine farming wastewater treatment system using *Enydra fluctuans* has an efficiency of 73.3% for COD, 89.2% for $BOD_5$, 88.3% for N-total and 89.6% for $PO_4^{3-}$. For *Sagittaria sagittifolia,* the affect treatment was 66.7% COD, 78.7% $BOD_5$, 69.5% N-total, and 85.1% $PO_4^{3-}$.

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# NGHIÊN CỨU SỬ DỤNG MỘT SỐ LOÀI THỰC VẬT ĐỂ XỬ LÝ NƯỚC THẢI CHĂN NUÔI LỢN SAU CÔNG NGHỆ BIOGAS

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*Trường Đại học Lâm nghiệp*

## TÓM TẮT

Ngành chăn nuôi của Việt Nam là một trong những ngành quan trọng trong nông nghiệp. Các trang trại nuôi lợn chủ yếu là tự phát, công nghệ xử lý nước thải phổ biến là mô hình biogas. Tuy nhiên, qua thực tế vận hành tại các trang trại cho thấy, nước sau xử lý bằng hầm biogas có hàm lượng COD, $BOD_5$, TN, $PO_4^{3-}$, vẫn còn cao và vượt quy chuẩn cho phép gây ảnh hưởng đến môi trường xung quanh. Nghiên cứu đã tiến hành thử nghiệm xử lý nước thải chăn nuôi lợn sau hầm biogas bằng cây rau Mác (*Sagittaria sagittifolia L.*) và cây rau Ngổ (*Enydra fluctuans Lour*). Kết quả cho thấy hệ thống xử lý nước thải chăn nuôi lợn bằng cây rau ngổ cho hiệu suất 73,3% hàm lượng COD, 89,2% $BOD_5$, 88,34% TN và 89,6% $PO_4^{3-}$. Cây rau Mác cho hiệu suất 66,7% hàm lượng COD, 78,7% $BOD_5$, 69,51% TN và 85,1% $PO_4^{3-}$. Với cùng điều kiện và phương pháp bố trí thí nghiệm như nhau, cây rau Ngổ cho thấy kết quả xử lý tốt hơn cây rau Mác. Tuy nhiên, nước sau quá trình xử lý đều đạt QCVN 62-MT:2016/BTNMT đối với các thông số pH, COD, $BOD_5$ và TN sau 30 ngày xử lý. Kết quả nghiên cứu cho thấy triển vọng trong quá trình loại bỏ chất ô nhiễm từ nước thải chăn nuôi lợn bằng phương pháp sử dụng thực vật thủy sinh. Tuy nhiên, cần tiến hành các nghiên cứu sâu hơn để đánh giá tính ổn định và khả năng áp dụng của hệ thống này trong thực tế.

**Từ khóa: Cây rau Mác, cây rau Ngổ, chăn nuôi lợn, thực vật thủy sinh, xử lý nước thải.**

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