Phythotechnology of Touch Industrial Waste Treatment in Sidoarjo using Typha Latifolia Plant to Reduce TDS and Ammonia Levels

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Abstract
Sidoarjo Regency is a buffer zone for industrial estates in Surabaya, East Java Province. Therefore, the economic growth of the Sidoarjo Regency is increasing along with the development of trade and industrial potential. One of the industries that have grown well in Sidoarjo Regency is the tofu factory. Many tofu craftsmen industry causes an increase in the volume of liquid waste which also flows into water bodies. The purpose of this study was to determine the reduction of TDS and ammonia levels in the tofu factory wastewater treatment in the Sepande area, Sidoarjo Regency, by using a wetland construction with a Typha latifolia remediator. The research stages will be carried out using a laboratory scale using acclimatization as the adaptation stage of Typha latifolia and a constructed wetland reactor as a phytoremediation process. Based on the results and discussion, it can be concluded that there was a decrease in TDS and ammonia levels in the tofu industrial wastewater in Sidoarjo with the Constructed Wetland system. The largest decline in TDS content was in soil media with three Typha latifolia stems and a detention time of four days by 76%. Meanwhile, the most considerable percentage reduction in ammonia levels occurred in sand media with three stems of Typha latifolia and a detention time of four days by 70%.

***Keywords*:** *Ammonia, Tofu Liquid Waste, TDS, Typha Latifolia*.

Abstrak
Kabupaten Sidoarjo merupakan daerah penyangga kawasan industri di Surabaya, Provinsi Jawa Timur. Oleh karena itu, pertumbuhan ekonomi Kabupaten Sidoarjo meningkat seiring perkembangan potensi perdagangan dan industri. Salah satu industri yang telah tumbuh dengan baik di Kabupaten Sidoarjo adalah pabrik tahu. Besarnya jumlah industri pengrajin tahu menyebabkan peningkatan volume limbah cair yang juga mengalir ke badan air. Tujuan penelitian ini adalah

untuk mengetahui penurunan kadar TDS dan Amonia pada pengolahan air limbah pabrik tahu di kawasan Sepande Kabupaten Sidoarjo dengan menggunakan kontruksi lahan basah dengan remediator Typha latifolia. Tahapan penelitian akan dilakukan menggunakan skala laboratorium dengan menggunakan aklimatisasi sebagai tahap adaptasi Typha latifolia dan reaktor lahan basah berkonstruksi sebagai proses fitoremediasi. Berdasarkan hasil dan pembahasan dapat disimpulkan bahwa terjadi penurunan kadar TDS dan Amoniak pada limbah cair industri tahu di Sidoarjo dengan sistem Constructed Wetland. Persentase penurunan kadar TDS terbesar pada media tanah dengan tiga batang tanaman Typha latifolia dan waktu detensi empat hari sebesar 76%. Sedangkan persentase penurunan kadar amonia terbesar terjadi pada media pasir dengan tiga batang tanaman Typha latifolia dan waktu detensi empat hari sebesar 70%.

Kata Kunci: Amoniak, Limbah Cair Tahu, TDS, *Typha Latifolia*.

1. Introduction

Sidoarjo Regency is a buffer zone for industrial estates in Surabaya, East Java Province. Therefore, the economic growth of the Sidoarjo Regency is increasing along with the development of trade and industrial potential. One of the industries that are often found in the Sidoarjo Regency is a tofu factory. The rapid number of tofu craftsmen has led to an increase in liquid waste volume, which also flows into water bodies. Generally, tofu factories in Sidoarjo Regency do not have a proper IPAL. As a result, the liquid waste is discharged directly into water bodies without any treatment to reach the government's threshold.

Tofu liquid waste comes from the soaking process, washing soybeans, filtering, printing tofu, and cleaning production equipment. The resulting liquid waste is usually thick, separated from the clumps of tofu. This liquid has high levels of organic, BOD, COD, TDS, and even ammonia. According to Sugianti and Fathoni (2019), the tofu industry effluent's organic material exceeds the set threshold. Besides, it is known that the resulting liquid waste has a high temperature and low pH. The impact of high organic matter on tofu factories' effluent disrupts biotic life and decreases water quality. Pollution by tofu liquid waste also causes damage to aquatic ecosystems and will cause a decrease human health (Adack, 2013).

The wetland system is a good treatment option for treating liquid waste tofu, especially for small scale tofu factories. Plants also produce organic material that can increase the biodegradability ratio called exudates (Mangkoedihardjo and Samudro, 2010). One of the plants that can reduce organic matter well is the Typha latifolia plant. According to Jesus et al. (2014), Typha latifolia could adsorb 29% TDS for 7 days in a saline water environment. Also, Typha latifolia is known to absorb chromium metal contamination in the soil (Goudarzi and Afrous, 2012). Therefore, this study aims to treat liquid waste originating from tofu factories to meet environmental-safe thresholds.

2. Methodology

The research was carried out at the Environmental Engineering Laboratory, Nahdlatul Ulama University Sidoarjo. Samples were taken from the tofu factory in Sepande Village, Sidoarjo District. The location of the implementation is close to the sampling location so that it facilitates the process of taking liquid waste and the process of conducting research. The data used to compile this research is primary data. Primary data obtained from laboratory analysis results from both internal and external laboratories.

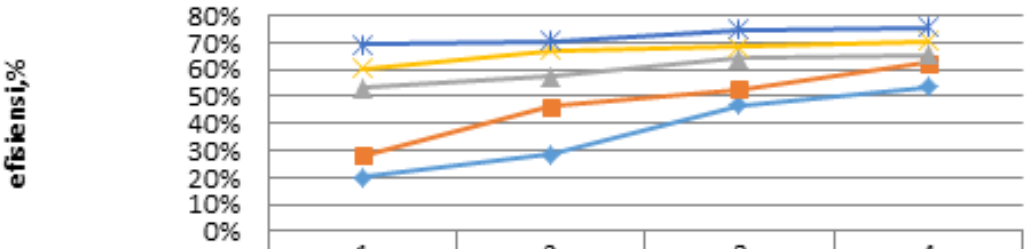
The material needed in this research is the tofu factory liquid waste produced from the Tofu Factory in the Sepande area, Sidoarjo. The tofu factory liquid waste treatment in the Sepande area of Sidoarjo is still ineffective, so the liquid waste produced is directly made into water bodies. In addition, Typha latifolia plants and wetland media in soil, gravel, and sand are needed. Meanwhile, the equipment needed in this study includes a laboratory-scale mini-plan reactor in the form of a constructed wetland reactor, a collection tank, an effluent reactor, pipes and taps, sample boxes, and sample bottles. The reactor design is shown in Figure 1. The planned residence time is 2 hours, and the planned discharge is 15 L / day. The preliminary test was carried out by taking a sample of 1 L from the tofu factory's effluent reactor in the Sepande area, Sidoarjo, then analyzing the TDS and ammonia levels in the laboratory.

At the acclimatization stage, Typha latifolia plants taken from the wetland around Nahdlatul Ulama University Sidoarjo were placed in the tank for one week. Furthermore, the plants are watered every day using tap water. Then the Typha latifolia plants that live after the acclimatization process will be used for research. After the acclimatization stage was carried out, the phytoremediation test was then carried out for one week with various TDS concentrations and ammonia concentrations. Typha latifolia was planted 10 cm from the surface of the media. Furthermore, parameter analysis is performed every day for up to 5 days to determine TDS and ammonia concentrations fluctuation. The parameters analyzed in this study were TDS and ammonia. Parameter analysis is carried out every day. TDS analysis using TDS meter. Meanwhile, Ammonia analysis uses the spectrophotometer method. The data obtained will be presented in tables and graphs. A discussion is then carried out by evaluating, describing, and investigating the results obtained by comparing previous studies.

3. Result and Discussion

The research has been completed and the results have been successfully obtained that in the form of TDS and ammonia parameter values using a constructed wetland reactor with variations in the number of Thypa latifolia plants (2 stems and 3 stems) and media variations using filter media in the form of sand and clay. The effluent results obtained from the TDS parameter, namely the TDS parameter value without media from the detention time of 1-4 days respectively, are 20%, 29%, 47%, and 54% as in Figure 1. Then the TDS parameter value with sand media and Thypa latifolia stems showed efficiencies of 28%, 47%, 53%, and 63%. As for the sand medium with a variation of the number of Thypa latifolia plants, as many as 3 stems, respectively, were 53%, 58%, 64%, and 66%. In soil media with 2 stems of Thypa latifolia plants, the efficiency of reducing TDS with a detention time of 1-4 days were 60%, 67%, 68%,

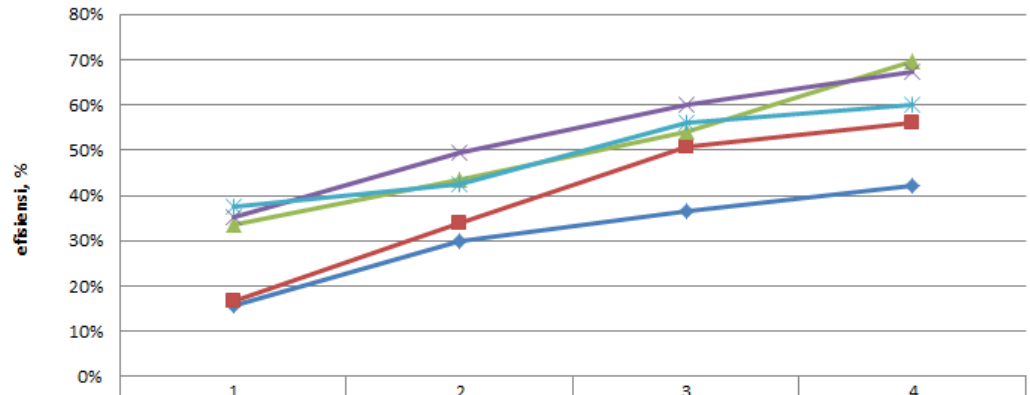
and 71%, respectively. Meanwhile, for the variation in the number of Thypa latifolia plants as many as 3 stems, the efficiency of reducing TDS was 69%, 71%, 75%, and 76%.



	1	2	3	4
TANPA MEDIA	20%	29%	47%	54%
PASIR (2)	28%	47%	53%	63%
PASIR (3)	53%	58%	64%	66%
TANAH(2)	60%	67%	68%	71%
TANAH (3)	69%	71%	75%	76%

Figure 1. Percentage of TDS Decreasing Efficiency

The effluent results obtained from the ammonia parameter, namely the parameter value of ammonia without media from the detention time of 1-4 days respectively, are 16%, 30%, 36%, and 42%, as shown in Figure 2. Then the parameter value of ammonia with sand media and 2 sticks Thypa latifolia plants showed efficiencies of 17%, 34%, 51%, and 56%. As for the sand medium with a variation of the number of Thypa latifolia plants as many as 3 stems, respectively, 34%, 43%, 54%, and 70%. In soil media with 2 stems of Thypa latifolia plants, the efficiency of reducing ammonia with a detention time of 1-4 days was 35%, 50%, 60%, and 67%, respectively. The variation of the number of Thypa latifolia plants as many as 3 stems showed the efficiency of reducing ammonia by 38%, 42%, 56%, and 60%.



	1	2	3	4
tanpa media	16%	30%	36%	42%
pasir, 2	17%	34%	51%	56%
pasir, 3	34%	43%	54%	70%
tanah,2	35%	50%	60%	67%
tanah,3	38%	42%	56%	60%

Figure 2. Percentage of Ammonia Decrease Efficiency

Tofu liquid waste is waste generated in making tofu, washing soybeans, and washing production equipment. The waste from the tofu factory produced is in the form of solid and liquid waste. The waste contains organic material. If it is directly disposed of to the water body without any treatment process, it will cause water pollution. Contamination, which is carried out continuously, will result in the death of aquatic organisms. This is due to changes in conditions to become anaerobic.

Efforts to treat liquid waste from tofu factories, in general, have been developed between physical, chemical, and biological methods. Physical waste treatment can be done by filtration and sedimentation. Meanwhile, chemical processing can be done by coagulation and flocculation. Both physical and chemical processing requires higher costs than biological processing. Biological processing can be done with plants as a remediation agent, in this case, using the Thypa latifolia plant.

Thypa latifolia is a perennial plant that can reach 2.5-3 meters in height. Propagation is assisted by wind because the resulting flowers are monoecious. This plant has a stem that grows in the soil or what is called a rhizome. Based on Guedes et al. (2009) research, Typha latifolia was able to degrade urothelial contamination in the soil. Besides being able to degrade urothelium, Typha latifolia reduced the concentrations of COD, BOD, and TSS by 50.15%, 56.72%, and 88.83% in domestic waste, respectively (Andriani and FAjriana, 2012). According to Jesus et al. (2014), Typha latifolia could adsorb 29% TDS for 7 days in a saline water environment.

Tofu industrial waste treatment can be carried out using an artificial wetland system (constructed wetland system). The constructed wetland consists of one or more processing cells in the reactor and is influenced by the design model. Constructed wetlands have been used to treat many types of liquid waste. Wetlands are divided into two types: subsurface flow (SSF) and free surface flow (FSF). SSF is designed by creating a subsurface flow. FSF is intended to improve natural wetlands' performance by draining wastewater that is above ground level in shallow depths. The FSF is suitable for high-temperature areas, such as Saudi Arabia (Sheikh, 2011). In general, wetlands are designed to remove more than 90% of BOD, COD, SS, and bacteria in wastewater. Wetlands can also remove N and P up to 50% (Wassen et al., 1998). Apart from organic contaminants, wetlands can also remove inorganic pollutants, such as heavy metals (Chen et al., 2009). Arivoli & Mohanraj (2013) reported decreased TDS levels of 84.66% using Typha angustifolia plants using the Constructed Wetland method.

The wetland used in this study contains gravel, sand, and small stones overgrown with water plants. Sand is an important wetland medium because it can filter small particles passing through the gravel layer. The sand layer is also able to withstand bacteria and other microorganisms contained in the waste. Besides, sand helps prevent mosquitoes from forming (Nguyen, 2020). According to Białowiec et al. (2013), a mixture of sand or gravel can increase phosphorus absorption in the wetland. Therefore, the media's composition determines the amount of removal (Sirianuntapiboon et al., 2006). As the results of this study, there was an increase in the efficiency of removing TDS and ammonia at a detention time of four days compared to without media.

This study shows that the use of soil media gives better results than sand media at TDS separation. Meanwhile, the best result for ammonia separation is by using sand media rather than soil media. The system used in this study is a batch system with a discharge of 10 liters/day and a residence time of 24 hours.

The variation in the number of Thypa latifolia plants also determines the ability to remove TDS and ammonia content in tofu industrial waste. The results showed that the highest TDS removal efficiency was using soil media with 3 stems of Thypa latifolia plants and 76% detention time of four days. This shows that the more plants the more efficiency in a constructed wetland reactor increases. While the highest efficiency of ammonia removal using sand media with three stems of Thypa latifolia plants and a detention time of four days was 70%. This shows that the sand medium is more efficient in filtering and removing organic pollutants in the form of ammonia in tofu industrial wastewater. In addition, the increasing number of Thypa latifolia plants will increase the efficiency of ammonia removal in a constructed wetland reactor.

Meanwhile, the effect of pH and temperature on processing is quite significant, where the liquid waste of soy tofu is more acidic at temperatures above 30ºC. This is because the processing process uses vinegar to preserve and the boiling process. The resulting waste water tends to react heat as a form of exothermic energy release. Based on the results of the study, it is known that the number of plants dramatically affects the efficiency of reducing TDS and ammonia parameters. On the other hand, it can be explained that in the four reactors from the first to the fourth day of the study, the efficiency of decreasing chemical parameters increased.

4. Conclusion

Based on the results and discussion, it can be concluded that there was a decrease in TDS and ammonia levels in the tofu industrial wastewater in Sidoarjo using the Constructed Wetland System. The percentage of the largest reduction in TDS levels was in soil media with three stems of Thypa latifolia plants and a detention time of four days of 76%. While the largest percentage reduction in ammonia content was in sand media with three stems of Thypa latifolia plants and a detention time of four days of 70%.

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