Hyacinth (Eichhornia Crassipes) Phytoremediaition In Reducing The Bod Of Liquid Waste Of Tofu Industry

Sri Poerwati[1], Fadia Sabrina Al Nabira [1CA], Budi Yulianto[1], Dr. Faisal Rasheed anjum[2], Dr. Muhammad Luqman[3], Magarsa Abara[4]

[1]Environmental Health Departement of Polytechnic Kemenkes Surabaya
[2]The Pirbright Institute, United Kingdom
[3]Veterinary Population Department, University of Minnesota, USA
[4]Wollega University, University in Nekemte,Ethiopia, Afrika
Email : fadiasbrn12@gmail.com

Abstract. One of the industrial activities in Indonesia is the tofu industry which uses soybeans and water as raw materials. If the tofu industrial wastewater is not treated and disposed of directly into the river, it can have a negative impact on the environment. Tofu industry liquid waste has BOD levels (Biochemical Oxygen Demand) high can cause health problems. One effort to reduce BOD levels in waters is phytoremediation. One of the plants used for the phytoremediation method is water hyacinth (*Eichhornia crassipes*). The purpose of this study was to determine BOD levels before and after phytoremediation. This research is descriptive research. The subject of this study was the BOD content of tofu industrial wastewater using water hyacinth remediation (*Eichhornia crassipes*). This study used variations of days, namely 7, 10, 13, 16, 19 with 2 replications and a volume of 15 liters of wastewater. The results of the study were the BOD levels before treatment of 389 mg/l. Reduction of BOD levels of tofu industrial wastewater after water hyacinth (*Eichhornia crassipes*) phytoremediation on day 7 44.6%, day 10 49.9%, day 13 52.4%, day 16 57%, day 19 64%. The biggest decrease occurred on the 19th day and has met the requirements of Minister of Environment Regulation No. 15 of 2008. For the tofu industry concerned, this method can be used if there is no cost to build an WWTP. Meanwhile, for further research, it is possible to use waste taken from water bodies containing organic matter for the tofu industry.

Keywords: Liquid waste, Tofu industry, BOD levels, Phytoremediation, Water hyacinth (*Eichhornia crassipes*)

1 Introduction

Industry is an economic activity that processes raw materials, raw materials, semi-finished goods and or finished goods into goods with a higher value for their use, including industrial design and engineering activities (Law No. 5 of 1984 concerning Industry). Thus, the industry is part of the production process.

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Industrial resources are obtained directly or indirectly and then processed to create products with social added value. Production process activities in the industry is called industry.

One of the industrial activities in Indonesia is the tofu industry. The tofu industry is one type of industry engaged in the processing of soybeans and water as raw materials. The average tofu industry is developed in the house hold sector, so is called as Home Industry of tofu making. The opportunity for the tofu industry is very promising, in addition to being relatively easy to manufacture and relatively easy to market because tofu is a favorite food for all people. This tofu business absorbs a lot of manpower, this is a potential that has economic value for someone who wants to get involved in the tofu business. The business capital required is also not too large. This business is quite done with simple management. Due to the high cost associated with developing and managing it, the tofu business is a small sector that almost never has a wastewater treatment system. Due to limited funds, the tofu home industry often goes straight to the river when disposing of garbage. In addition, tofu waste will give off a foul odor which will damage the aesthetics and the surrounding environment [1].

The tofu industry produces 2 different types of waste, namely solid waste and liquid waste. Solid waste is in the form of dregs while liquid waste is in the form of vinegar. Tofu waste can be used for cattle feed, but if not used tofu waste will be thrown away. The liquid waste from the tofu industry will be disposed of directly into the river. These activities can have a negative impact on the environment. The liquid waste from the tofu industry that has too high a BOD (Biochemical Oxygen Demand) level can emit an unpleasant odor and also disturb the health of humans and animals around these waters.

One of the industries located in Panekan, Magetan does not yet have liquid waste treatment facilities and research has never been conducted on its liquid waste. Usually, tofu industrial wastewater is discharged directly into the river. This causes it to happen environmental pollution such as unpleasant odors and the muddy color of river water. Unpleasant odors can be disturbing both in terms of aesthetics and health.

Based on previous research by Haeranah Ahmad and Ridhayani Adiningaih (2019), untreated tofu industrial wastewater has a high BOD level of 805.1 mg/l. Most of the processing of wastewater produced by industrial activity processes can be a challenge in itself because wastewater consists of various dissolved and suspended materials [2].

There are several solutions that can be done to reduce BOD levels in waters due to tofu industrial wastewater. One of them is with phytoremediation. Phytoremediation is a technology for the process of destroying contaminants, removing, removing both organic and inorganic compounds in waste, soil, ponds by using vegetation. Wrong one aquatic plant that can be used for the phytoremediation method is water hyacinth (Eichhornia crassipes).

If the water is shallow, water hyacinth (Eichhornia crassipes) can live freely above the surface of the water and grow roots at the bottom of a pond or swamp. Water hyacinth (Eichhornia crassipes) can also grow in cloudy water and temperatures around $28^{O}C – 30^{O}C$. Due to the facility's capacity to treat household

emissions efficiently, the capability to process exhaust air is one of the capabilities most commonly used. Water hyacinth (Eichhornia crassipes) can reduce BOD levels, suspended particles biochemically [3].

2 Methods

In this study using the type of research Quasi – experiment. Where the researcher gave treatment to the sample by carrying out the adsorption process using the phytoremediation method on tofu industrial waste water which has high BOD levels using water hyacinth (*Eichhornia* crassipes). The research design was a nonrandomized control group pretest – posttest design where there were variations in the treatment in the form of phytoremediation days, namely for 7 days, 10 days, 13 days, 16 days, and 19 days. In this study, 2 replications were carried out where there were variations of days, namely 7 days, 10 days, 13 days, 16 days, and 19 days.

3 Research Procedure

in this research requires tools and materials among others 3 plastic tubs measuring 47 cm x 34 cm x 15 cm, water hyacinth plant (Eichhornia crassipes), and samples of tofu industrial waste water. Work Procedure in this research among others first, each tub is filled with 15 liters of tofu industrial liquid waste with a dilution of 25%. This dilution method is used to reduce the levels of any contaminant. Second, as many as 7 water hyacinth plants (Eichhornia crassipes) are put into each tub filled with tofu industrial wastewater. And then, do the treatment with time variations of 7 days, 10 days, 13 days, 16 days, and 19 days. And the last one is, checking the BOD level of tofu industrial wastewater after being treated for 7 days, 10 days, 13 days, 16 days, and 19 days. Examination of BOD (Biochemical Oxygen Demand) levels was carried out by the Magetan Campus Campus Environmental Health Study Program Laboratory.

4 Result

The result of a decrease in BOD levels in the tofu industry's liquid lime the highest was on the 19 th day variation with an average decrease was in the 7-day variation with an average decrease of 44,6%. So that the longer days used for the phytoremediation method affects the process of reducing BOD levels in tofu industrial wastewater as described in Table 1.

Table 1. Average Results Decrease in BOD Rate on liquid waste of tofu industry with variations of day

No	Day variations	Before Treatment (mg/l)	After Treatment (mg/l)	Decrease Average (mg/l)	Percetage (%)
1	7	389	215,5	173,5	44,6

2	10	389	195	194	49,9
3	13	389	185	204	52,4
4	16	389	167,5	221,5	57
5	19	389	141	248	64

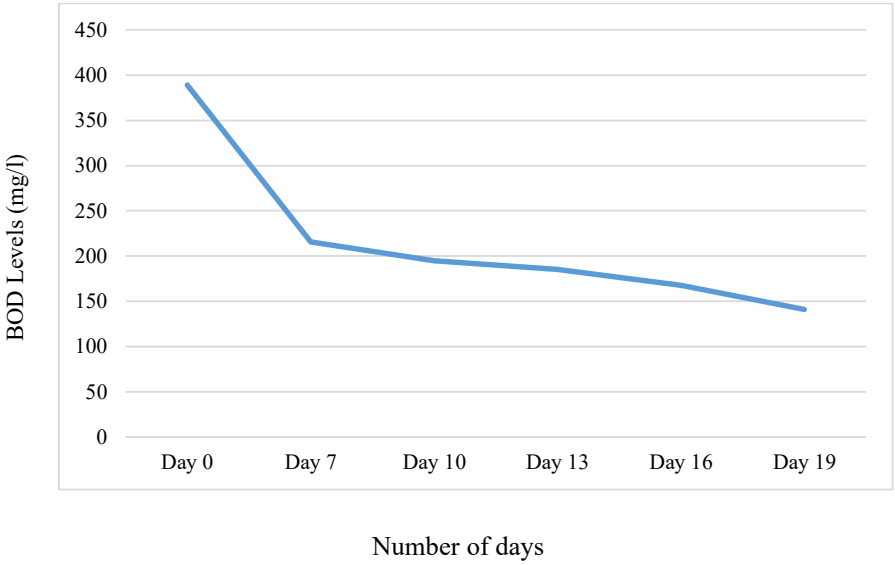

Fig. 1. Average Results for Reducing BOD Levels Using Day Variations

Based on Fig. 1 it can be seen that the highest reduction in BOD levels was on the 19th day of variation, namely 141 mg/l. So it can be concluded that the longer the day used for the phytoremediation method, the higher the decrease in BOD levels in tofu industrial wastewater.

5 Discussion

The activity of microorganisms present in the waste can be the cause of the decrease in the BOD value. The water evaporation evapotranspiration cycle can be accelerated by using water hyacinth as a biofilter. The evapotranspiration process accelerates the absorption of nutrients and organic matter needed for photosynthesis through the mechanism of water absorption by root hairs. The amount of dissolved oxygen in the effluent will increase due to the intense photosynthetic activity that produces oxygen. The amount of dissolved oxygen in wastewater is increased by water hyacinth by adding oxygen through the roots, which encourage microorganisms to work to degrade toxins [4].

The decrease in the BOD value that occurs can also be caused by the adsorption activity or deposition of pollutants by the roots, or Rhizofiltration is the place where the phytoremediation process begins in water hyacinth plants. The ability of water hyacinth to absorb pollutants is also a result of rhizosphere bacteria that live in their roots and collect pollutants. Rhizosphere microorganisms are a form of symbiosis between bacteria and fungi. Rhizosphere microorganisms can consume organic and inorganic elements contained in water and use them as a source of nutrition [5].
On the 13th day of treatment new shoots appeared in both replicas, this proved that there was a mutualism symbiosis. Plants can grow in tofu industrial wastewater and water hyacinth plants can also reduce levels pollutant (BOD) in tofu industrial wastewater. After the rhizofiltration process, there are phytodegradation processes or natural foreign compounds that are retained by entering plant roots and experiencing degradation through metabolic processes that take place there which can be the source of the decrease in the BOD value that occurs. After phytodegradation, a sophisticated process called phytovolatilization impacts on the reduction of pollutants. After experiencing phytodegradation, pollutants are absorbed by plants through a phytovolatilization process, where these pollutants are released into the environment as water vapor. This interaction works perfectly to keep the natural ingredients in place [6].

On the 19th day of treatment, the decrease that occurred may have been due to the long time alone. Nutrients and industrial waste containing tofu also have organic content reduce. So, plants only absorb the organic content according to their needs. The condition of the plants on the 19th day was also almost the same as the condition on the previous day. This also has an effect on reducing BOD levels because plants cannot maximize their photosynthetic activity.

6 Conclusion

The decrease in BOD levels of tofu industrial wastewater with the phytoremediation method was greatest on the 19th day, which was 141 mg/l which complied with the Regulations of the Minister of Environment Life Number 15 of 2008 concerning Wastewater Quality Standards for Soybean Processing Businesses and/or Activities. Changing the variables used such as parameters, plant types, time variations, plant variations, and number of plants.

References

1. Febriningrum, P.N., Nur, M.S.M.: The Addition Effect of Chitosan and Bacillus amyloliquefanciens Bacteria in the Tapioca Liquid Waste Phytoremediation Process. Indones. J. Chem. Sci. 10, 1–7 (2021).
2. Artiyani, A.: Penurunan kadar N-Total Dan P-Total pada limbah cair tahu dengan metode fitoremediasi aliran batch dan kontinyu menggunakan tanaman hydrilla verticillata. Spectra. IX, 9–14 (2011).
3. Arthur, E.L., Rice, P.J., Rice, P.J., Anderson, T.A., Baladi, S.M., Henderson, K.L.D.,

Coats, J.R.: Phytoremediation - An overview. CRC. Crit. Rev. Plant Sci. 24, 109–122 (2005). https://doi.org/10.1080/07352680590952496.
4. Moosavi, S.G., Branch, B., Seghatoleslami, M.J.: Phytoremediation : a review Phytoremediation : A review. Adv. Agric. Biol. 1, 5–11 (2021).
5. Epa, U.S.: Introduction to Phytoremediation. 1–7 (2019). https://doi.org/10.4018/978-1-5225-9016-3.ch001.
6. Schnoor, J.L.: Phytoremediation: Technology Evaluation Report. Gwrtac E Ser. TE-98-01, 43 (1997).
7. Dietz, A.C., Schnoor, J.L.: Advances in phytoremediation. Environ. Health Perspect. 109, 163–168 (2001). https://doi.org/10.1289/ehp.01109s1163.
8. Ali, H., Khan, E., Sajad, M.A.: Phytoremediation of heavy metals-Concepts and applications. Chemosphere. 91, 869–881 (2013). https://doi.org/10.1016/j.chemosphere.2013.01.075.
9. Chaney, R.L., Malik, M., Li, Y.M., Brown, S.L., Brewer, E.P., Angle, J.S., Baker, A.J.M.: Phytoremediation of soil metals. Curr. Opin. Biotechnol. 8, 279–284 (1997). https://doi.org/10.1016/S0958-1669(97)80004-3.
10. Cunningham, S.D., Ow, D.W.: Promises and prospects of phytoremediation. Plant Physiol. 110, 715–719 (1996). https://doi.org/10.1104/pp.110.3.715.
11. Cunningham, S.D., Shann, J.R., Crowley, D.E., Anderson, T.A.: Phytoremediation of Contaminated Water and Soil. ACS Symp. Ser. 664, 2–17 (1997). https://doi.org/10.1021/bk-1997-0664.ch001.
12. Ansari, A.A., Gill, S.S., Gill, R., Lanza, G.R., Newman, L.: Phytoremediation: Management of environmental contaminants. Phytoremediation Manag. Environ. Contam. 6, 1–476 (2019). https://doi.org/10.1007/978-3-319-99651-6.
13. Etim, E.E.: Phytoremediation and Its Mechanisms: A Review. Int. J. Environ. Bioenergy Int. J. Environ. Bioenergy J. homepage www.ModernScientificPress.com. 2, 120–136 (2012).
14. Padmavathiamma, P.K., Li, L.Y.: Phytoremediation technology: Hyper-accumulation metals in plants. Water. Air. Soil Pollut. 184, 105–126 (2007). https://doi.org/10.1007/s11270-007-9401-5.
15. Gomes, H.I.: Phytoremediation for bioenergy: challenges and opportunities. Environ. Technol. Rev. 1, 59–66 (2012). https://doi.org/10.1080/09593330.2012.696715.
16. Pandey, V.C., Bajpai, O.: Phytoremediation: From Theory Toward Practice. (2018). https://doi.org/10.1016/B978-0-12-813912-7.00001-6.
17. Schnoor, J.L., Licht, L.A., McCUTCHEON, S.C., Wolfe, N.L., Carreira, L.H.: Phytoremediation of Organic and Nutrient Contaminants. Environ. Sci. Technol. 29, 318–323 (1995). https://doi.org/10.1021/es00007a002.
18. Mackova, M., Dowling, D., Macek, T., Komives, T., Gullner, G.: Phytoremediation Rhizoremediation Edited by DENDROREMEDIATION: THE USE OF TREES IN CLEANING UP POLLUTED SOILS. (2006).
19. Susarla, S., Medina, V.F., McCutcheon, S.C.: Phytoremediation: An ecological solution to organic chemical contamination. Ecol. Eng. 18, 647–658 (2002). https://doi.org/10.1016/S0925-8574(02)00026-5.
20. Gerhardt, K.E., Huang, X.D., Glick, B.R., Greenberg, B.M.: Phytoremediation and rhizoremediation of organic soil contaminants: Potential and challenges. Plant Sci. 176,

20–30 (2009). https://doi.org/10.1016/j.plantsci.2008.09.014.
21. Glick, B.R.: Using soil bacteria to facilitate phytoremediation. Biotechnol. Adv. 28, 367–374 (2010). https://doi.org/10.1016/j.biotechadv.2010.02.001.
22. Zhao, F.J., McGrath, S.P.: Biofortification and phytoremediation. Curr. Opin. Plant Biol. 12, 373–380 (2009). https://doi.org/10.1016/j.pbi.2009.04.005.
23. Jabeen, R., Ahmad, A., Iqbal, M.: Phytoremediation of heavy metals: Physiological and molecular mechanisms. Bot. Rev. 75, 339–364 (2009). https://doi.org/10.1007/s12229-009-9036-x.
24. Gupta, D.K., Huang, H.G., Corpas, F.J.: Lead tolerance in plants: Strategies for phytoremediation. Environ. Sci. Pollut. Res. 20, 2150–2161 (2013). https://doi.org/10.1007/s11356-013-1485-4.
25. Ahmad, H., Adiningsih, R.: Efektivitas Metode Fitoremediasi Menggunakan Tanaman Eceng Gondok Dan Kangkung Air Dalam Menurunkan Kadar Bod the Effectiveness of Phytoremediation Method Using Hyacinth Plant and Ipomoea Aquatica in Reduce Levels of Tss and Bod in Tofu Industry Liquid Wa. J. Farmasetis. 8, 31–38 (2019).