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Treatment of tofu liquid waste using anaerobic-aerobic biofilm aeration system to reduce pollution

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Abstract

Background: Tofu derived from processed soybeans is popular among the public, but its production has an unfavourable effect. After all, it produces liquid waste that causes quite high pollution because it contains quite high organic components. The present study aimed to reduce the content of biochemical oxygen demand (BOD), chemical oxygen demand (COD), and ammonia (NH3) in the liquid waste of a tofu factory. The scope of this research is limited to reducing the content of BOD, COD, and NH3 using an anaerobic-aerobic biofilm aeration system.

Methods: This is an experimental study with a pre-post test only design and one group post-test design. The study population in this study is the tofu industry, and the sample in this study is partly water from the tofu waste. Sample examination was carried out at the Regional Health Laboratory of Jambi province, Indonesia.

Results: The results showed a decrease in BOD, COD, and NH3 after passing through a tofu waste treatment machine using anaerobic and aerobic biofilms with BOD, COD, and ammonia values of 64.6%, 49.6%, and 79.8%, respectively. Tofu waste treatment using anaerobic and aerobic biofilms can lower the temperature and increase the pH of the waste.

Conclusion: On the surface of the bioball used, the growth of the biofilm was found, and to increase the ability of the equipment, an initial treatment, such as filtration and sedimentation of waste, and reducing acidity with the help of quicklime was needed.

Keywords: Biofilm, Soy foods, Biological oxygen demand, Chemical oxygen demand, Ammonia

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Introduction

Tofu is a processed soybean product that is quite popular among the public (1). In the manufacturing process, the tofu industry produces much liquid waste that causes quite high pollution because it contains organic components that can harm the environment (2). Tofu liquid waste has a chemical oxygen demand (COD) concentration ranging from 10,000 to 20,000 ppm, caused by the protein content found in the tofu liquid waste. Liquid waste with a high COD value can cause the death of aquatic biota if directly discharged into the waters. Fish are usually used as an indicator of pollution in waters because they have a quick response to the environmental disturbances (3).

Tofu liquid waste treated aerobically requires a large cost in its production (4,5). The treatment of wastewater with a high COD value is generally carried out aerobically because it can be operated easily, the operating costs are low, and the *wastewater treatment plant* design is simple (6-8). In the manufacture of tofu, the resulting waste contains high protein, organic matter, and dissolved solids, with a low pH. In addition, it will also cause an unpleasant aroma that interferes with the aesthetics and life of the surrounding ecosystem (9,10).

Generally, tofu production ranges from 1200 kg to 1 500 000 kg per year, while the amount of liquid waste produced reaches approximately 2 m^3 for every one quintal of soybeans (11). Thus, the pollution load from the tofu industry is quite large, so it requires further handling to comply with the quality standards. Wastewater parameters that stand out from tofu waste are temperature, pH, suspended solids, dissolved solids, and biochemical oxygen demand (BOD) (2,3,12).

BOD measures the oxygen demand in wastewater or the oxygen required by microorganisms to oxidize chemical compounds (13,14). The oxidation process is very slow and theoretically takes infinite time. The BOD value is useful to determine whether the wastewater is biodegraded or not. The BOD parameter, in general, is widely used to determine the level of wastewater pollution (3,15). Determination of BOD is very important to trace the flow

of pollution from upstream. The determination of BOD is a bioassay procedure involving the measurement of the amount of oxygen used by organisms as long as these organisms decompose organic matter present in water, under conditions almost the same as those in the nature. During the BOD inspection, the sample being examined must be free from the outside air to prevent contamination from oxygen in the free air. The concentration of the wastewater (sample) must also be at a certain level of pollution to keep dissolved oxygen always present during the inspection. It is important to notethat the solubility of oxygen in water is limited and only around ± 9 ppm at a temperature of 27°C (2,3).

Tofu-making industrial waste is generally directly discharged into waterways, resulting in the pollution of the waters (10). Polluted waters are black waters that have a high BOD content, low pH, and a foul smell, so they cannot be used anymore. Liquid waste or tofu wastewater is disposed of and generally contains materials or substances that can harm human health and disturb the environment (16).

Currently various wastewater treatment methods and technologies have been found, and also, developed. The hope is to be able to prevent pollution that will have a fatal impact on the environment and health of humans and other living things, such as microbial fuel cells reactors, advanced oxidation process, electrocoagulation, microbiological film process (biofilm), rotating biological contactors, plasma dielectric barrier discharge, and membrane technology (17-20).

For the processed water to meet the quality standards, the water processed from the anaerobic biofilter process is then processed using an aerobic biofilter (21). Using the biofilter process, the remaining aerobic organic pollutants will decompose into carbon dioxide gas (CO_2) and water (H_2O), ammonia will be oxidized to nitrite, which will then become nitrate, while H_2S gas will be converted into sulfate (22).

This biofilm process has several advantages over the other waste water treatment processes. These include being effortless to operate, effective in treating wastewater with low to high concentrations, resistant to fluctuations in wastewater or concentration fluctuations, and decreasing temperature on a small-scale treatment efficiency.

This study aimed to treat tofu liquid waste using an anaerobic-aerobic biofilm aeration system in reducing the content of BOD, COD, and ammonia.

Materials and Methods

Instruments and materials

The primary material used in the research is liquid waste from the tofu industry. The leading equipment needed was a fixed bed digester reactor from PVC pipes, influent feed tank, effluent tank, storage tank, liter jerry can, 5-L jerry can, biofilter, silicone pipe glue, air blower, water pump, and a pH meter.

The research procedure begins with conducting biofilter processing experiments to treat industrial tofu waste. Parameters tested before and after the experiment was BOD, COD, and ammonia to obtain data on the characteristics of tofu waste by testing biofilters.

Procedure

A biofilm or biofilter is an aggregate collection of microorganisms or extracellular polymer products adhering to a solid surface or an inert organic solid in an aqueous environment. For 14 days, microorganisms (biofilm) were grown by attaching to the biofilter media. The tofu wastewater treatment experiment without dilution with wastewater mass was conducted for 9 days in a biofilter. The tofu wastewater was entered into the biofilter reactor through the influent. The tofu wastewater flow was carried out through down flow in the reactor by the gravity passing through the biofilter media. The tofu wastewater exits through the pipe. Then, the waste output was accommodated in a container for sample testing.

In simple terms, aerobic biofilm can be described as a biofilm system consisting of a buffer medium, a biofilm layer attached to the medium, a wastewater layer, and an air layer located outside. The pollutant compounds diffuse in the biofilm layer. These compounds consist of organic compounds (BOD and COD), and ammonia. Then, at the same time, these pollutant compounds will be broken down by microorganisms in the biofilm layer using oxygen dissolved in the waste, and the energy produced will turn into biomass. When the microorganism layer is thick enough, the outer part of the biofilm will be in anaerobic condition.

Meanwhile, the inside of the biofilm will be under anaerobic conditions. H_2S gas will form under anaerobic conditions, and then, the H_2S gas will be converted into sulfate by sulfate bacteria contained in the biofilm if the dissolved oxygen concentration is large enough. In addition, ammonium nitrogen will convert into nitrite and nitrate in the aerobic zone. Then, the nitrate denitrification process will occur, and nitrate will convert into nitrogen in the anaerobic zone. Therefore, aerobic and anaerobic conditions can co-occur in the biofilm system to remove nitrogen compounds easier.

Making modifications of tofu waste treatment equipment can using anaerobic and aerobic biofilms. This tool is made as simple as possible with the materials and equipment around, especially the widely used drums in the market. Some materials must be purchased from abroad because there is no production here like Bio ball. The tools were made in the workshop of the Environmental Health Department, Poltekkes, Ministry of Health, Jambi.

Data analysis was carried out after measurement of the test data for each BOD, COD, and ammonia parameter before and after processing. Data analysis also aimed to

determine the effect of the anaerobic-aerobic treatment system on decreasing the parameters of BOD, COD, ammonia, and processing efficiency, which is affected by the hydraulic residence time treatment and to determine the optimal hydraulic residence time. The efficiency of BOD, COD, and ammonia levels was calculated to determine the level of reduction in the BOD, COD, and ammonia levels before and after the use of the combined anaerobic-aerobic system processing. The efficiency value was calculated using the following equation:

$$Efficiency = \frac{a-b}{a} \times 100\% \quad (1)$$

Where a is the BOD, COD, and ammonia concentrations values before being processed for each treatment and b is the BOD, COD, and ammonia concentration values after processing for each treatment.

A schematic diagram of the reactor is shown in Figure 1.

Study design and sample

In this study, a quantitative research design with an experimental approach was used. The study population was the tofu industry, and the study sample was the water from the tofu waste, totally 36 samples consisting of samples for examination of 2 BOD samples before and after treatment with 6 repetitions, so that it became 12, 2 samples of COD before and after treatment with 6 repetitions, so that it became 12, 2 samples of ammonia before and after with 6 repetitions, so that it became 12. Each parameter consists of 12 samples, meaning that the total sample was 36.

Data were collected by conducting a preliminary survey of the tofu industry in Jambi city, then, conducting interviews using a questionnaire, taking samples of tofu waste, and checking the content of BOD, COD, and ammonia.

In addition, the test results data on the parameters were processed for analysis using t-test by SPSS version 16.0, with the assessment criteria if $P < 0.05$, then, there was a significant difference in the decrease in the concentration before and after passing through the tofu waste treatment tool.

Results

The results of the study began with the construction of an anaerobic and aerobic tofu waste treatment plant, as shown in Figure 2. Figure 3 shows the appearance of a biofilm on a Bioball.

Figure 4 shows that the average temperature data before processing using the tofu waste processing equipment using anaerobic and aerobic biofilms was 36.16°C, and the average temperature after processing tofu waste was 32°C. Anaerobic and aerobic biofilms before tofu waste treatment were pH 3.8, and the average pH after tofu waste treatment was 6.25.

Figure 5 shows that the average BOD data before processing using tofu waste treatment by anaerobic and aerobic biofilms was 616 mg/L, and the average BOD after tofu waste treatment was 218 mg/L with an average decrease of 63.5%. The results of the statistical test showed the $P < 0.05$.

Figure 6 shows that the average COD before processing using tofu waste treatment by anaerobic and aerobic biofilms was 1124 mg/L, and the average COD after tofu processing was 566 mg/L with an average percentage decrease of 54.3%. The results of the statistical test showed the $P < 0.05$.

Figure 7 shows that the average concentration of ammonia before processing using tofu waste treatment equipment was 0.76 mg/L, while after filtering using anaerobic and aerobic biofilms, the ammonia concentration decreased to 0.16 mg/L. The results of the statistical test showed the $P < 0.05$.

Discussion

Based on the research results, the BOD concentration in tofu waste was high and exceeded the quality standard of liquid waste set by the government, which is 150 mg/L. The presence of high BOD concentration cannot be separated from the amount of protein and other organic substances present in tofu waste. Based on the results of the UI statistic, the P-value of 0.027 means that there is a significant decrease in the concentration of BOD in

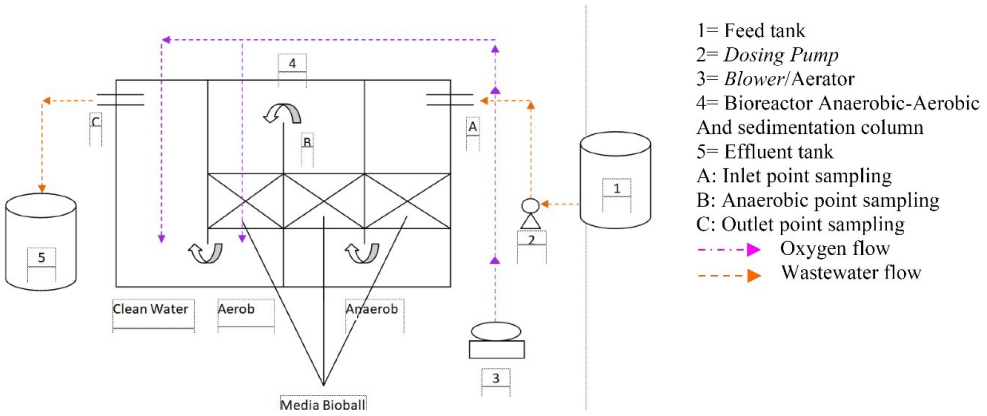

Figure 1. Bioreactor Anaerobic-Aerobic Media Bioball

Figure 2. Blower and water pump

Figure 3. The use of Bioball

tofu waste after passing through the tofu waste treatment equipment with inorganic and organic biofilms.

Organic materials contained in tofu industrial effluents are generally very high. Organic compounds in the wastewater can be proteins, carbohydrates, fats, and oils (23). Among these compounds, protein and fat have the highest concentration, reaching 40-60% protein, followed by carbohydrates (25%-50%), and fat (10%). One indicator to assess the content of organic matter is to test the concentration of BOD in water. The high content of BOD in water will make it difficult for the decomposition done by natural microorganisms present in tofu waste. The BOD concentration is one of the key parameters in wastewater, meaning that its presence and amount in wastewater will affect the concentration of other pollutants, especially organic waste such as tofu waste (24,25).

The average BOD concentration before treatment with tofu waste treatment equipment using anaerobic and aerobic biofilms had an effect on the reduction of the average BOD from 616 mg/L to 218 mg/L with an average decrease of 64.6%, which is still above the wastewater quality standard (150 mg/L). It is a parameter to assess the amount of dissolved organic matter and shows the amount of oxygen required by the activity of microorganisms in decomposing organic substances biologically in the liquid waste. The liquid waste of the tofu industry contains high concentrations of dissolved organic materials.

Consistent with the results of a study by Anwar (26), who reported a decrease in the BOD levels before treatment using an anaerobic biofilter for 9 days, the mass of wastewater in the biofilter was 4,097.34 to 725.43 mg/L with a treatment effectiveness level of tofu industrial liquid waste using biofilter has a BOD-5 value of 46%.

According to a study by Sayow et al (27), BOD is the number of oxygen organisms needed to break down organic waste in the waters. The higher the BOD concentration, the more oxygen is needed to oxidize organic matter. A high BOD value indicates that there are many organic compounds in the waste, so microorganisms need that much oxygen to decompose organic compounds. A low BOD value indicates the decomposition of organic waste by microorganisms (28,29).

The average COD level before processing using tofu waste treatment by anaerobic and aerobic biofilms was

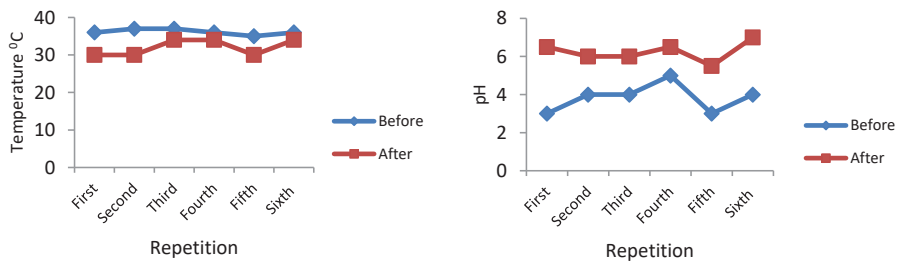

Figure 4. Tofu wastewater temperature and pH data

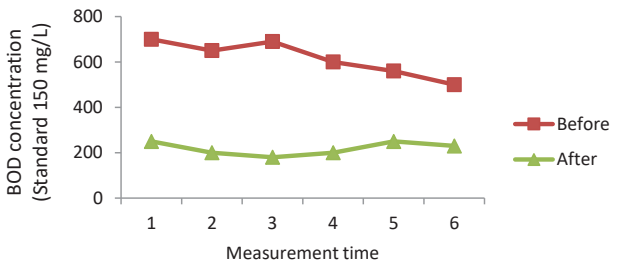

Figure 5. The BOD concentrations before and after passing through tofu waste treatment equipment using anaerobic and aerobic Biofilm

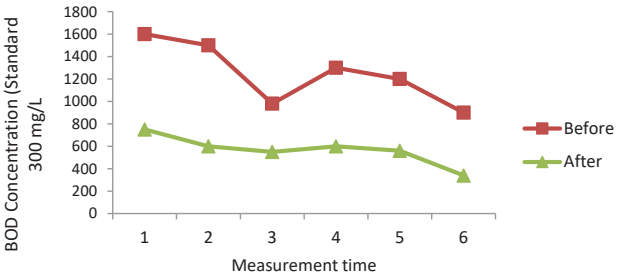

Figure 6. The COD concentrations before and after passing through the tofu waste treatment tool

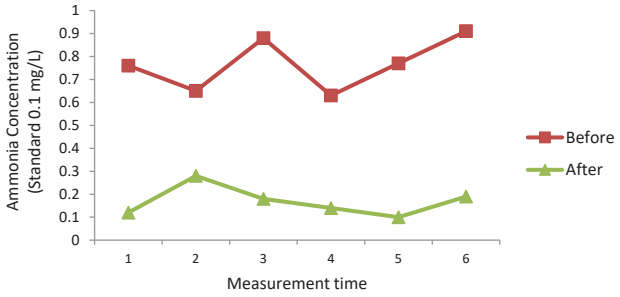

Figure 7. The results of measurement of Ammonia concentration before and after passing through the tofu waste treatment equipment

1.124 mg/L, and the average COD level after tofu waste treatment was 566 mg/L, with an average percentage decrease of 49.6%. It shows that the bacteria that grow in the drum reactor with PVC pipe biofilter media effectively reduce COD levels of tofu waste and are effective up to 62.2%.

Consistent with the results of the present study, Anwar (26) reported that the treatment of tofu waste with an anaerobic biofilter using gravel and coral media with COD effectiveness is 47%. The COD value before treatment was 9.523.20 mg/L that was reduced to 1.648.32 mg/L. Pandia (30) also reported that the COD reduction efficiency reached 38.97% with the mass of wastewater in an anaerobic biofilter for 12 hours.

The initial high concentration of tofu waste occurred due to the adaptation process of microorganisms that grew and reproduced in the fishnet biofilter media and bio ball in the drum (bio filter reactor) to the new Tofuliquid waste. High COD values occur because of environmental factors that influence such as the dissolved oxygen content in the reactor is can help bacteria decompose pollutant compounds in the reactor. Furthermore, tofu contains high protein, so liquid tofu waste will also contain high organic materials. It proves that the concentration of pollutants in tofu waste is still high (31).

Currently, the management of tofu and fermented soybean industrial wastewater is generally carried out by making a wastewater reservoir so that an anaerobic process occurs. With the anaerobic biological process, the organic pollutant content in the wastewater can be reduced, but with this process, the treatment efficiency is only around 50%-70%. Thus, if the COD concentration in wastewater is 7000 ppm, then, the level of COD that comes out is still quite high, around 2100 ppm, so this is still a source of environmental pollution (32-34).

The value of ammonia concentration before using anaerobic and aerobic biofilms was 0.76 mg/L, and then, decreased to 0.16 mg/L with an average reduction efficiency of 77.4% after tofu waste treatment. In general, the tofu industry only accommodates waste in one tub or even earthen ponds and some even discharge directly into public channels or rivers without any storage or treatment.

By increasing the operational time of the biofilter reactor, the effectiveness of the ammonia content also increased. The micro-organisms in the biofilter reactor grew and were reproduced and formed a thicker biofilm layer than before so that the organic compounds in the liquid waste can be decomposed.

Conclusion

After going through a waste treatment device using anaerobic and aerobic biofilms, the liquid waste of the tofu factory showed a decrease in the content of BOD, COD, and ammonia, therefore, the tool can be used to treat the liquid waste of the tofu factory using anaerobic and aerobic biofilms.

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Ethical issues

The study was approved by the Health Research Ethics Committee of Health Polytechnic of Jambi (Ethical code: LB.02.06/2/161/2021).

Competing interests

The authors declare that there are no competing interests.

Authors' contributions

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Supriatna Supriatna.
Data curation: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Formal Analysis: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Funding acquisition: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Investigation: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Methodology: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Project administration: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Resources: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Software: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Supervision: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Validation: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Visualization: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Writing – original draft: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.
Writing – review & editing: Zunidra Zunidra, Sondang Sondang, Supriatna Supriatna.

References

1. Faisal M, Gani A, Mulana F, Daimon H. Treatment and utilization of industrial tofu waste in Indonesia. Asian J Chem. 2016;28(3):501-7. doi: 10.14233/ajchem.2016.19372.
2. Widyastuti D, Suprayitno D. Decreasing COD and TSS levels of tofu liquid waste using Kangkungan (Ipomeacracicaulis) with phytoremediation method. IOSR J Environ Sci Toxicol Food Technol. 2020;14(11):1-5. doi: 10.9790/2402-1411020105.
3. Singh RS, Kaur N, Kennedy JF. Pullulan production from agro-industrial waste and its applications in food industry: a review. Carbohydr Polym. 2019;217:46-57. doi: 10.1016/j.carbpol.2019.04.050.
4. Effendi H, Seroja R, Hariyadi S. Response surface method application in tofu production liquid waste treatment. Indones J Chem. 2019;19(2):298-304. doi: 10.22146/ijc.31693.
5. Seroja R, Effendi H, Hariyadi S. Tofu wastewater treatment using vetiver grass (*Vetiveria zizanioides*) and zeliac. Appl Water Sci. 2018;8(1):2. doi: 10.1007/s13201-018-0640-y.
6. Brito AG, Peixoto J, Oliveira JM, Oliveira JA, Costa C, Nogueira R, et al. Brewery and winery wastewater treatment: some focal points of design and operation. In: Oreopoulou V, Russ W, eds. Utilization of By-Products and Treatment of Waste in the Food Industry. Boston, MA: Springer; 2007.p. 109-31. doi: 10.1007/978-0-387-35766-9_7.
7. Foladori P, Vaccari M, Vitali F. Energy audit in small wastewater treatment plants: methodology, energy consumption indicators, and lessons learned. Water Sci Technol. 2015;72(6):1007-15. doi: 10.2166/wst.2015.306.
8. Hellinga C, Schellen AA, Mulder JW, van Loosdrecht MCM, Heijnen JJ. The Sharon process: an innovative method for nitrogen removal from ammonium-rich waste water. Water Sci Technol. 1998;37(9):135-42. doi: 10.1016/s0273-1223(98)00281-9.
9. Huang X, Zhao J, Xu Q, Li X, Wang D, Yang Q, et al. Enhanced volatile fatty acids production from waste activated sludge anaerobic fermentation by adding tofu residue. Bioresour Technol. 2019;274:430-8. doi: 10.1016/j.biortech.2018.12.010.
10. Putro PG, Hadiyanto H. Water quality parameters of tofu wastewater: a review. IOP Conf Ser Mater Sci Eng. 2021;1156(1):012018. doi: 10.1088/1757-899x/1156/1/012018.
11. Faisal M, Machdar I, Mulana F, Daimon H. Potential renewable energy from tofu processing waste in Banda Aceh city, Indonesia. Asian J Chem. 2014;26(19):6601-4. doi: 10.14233/ajchem.2014.16728.
12. Gunam IB, Natalia FE, Arnata IW, Putnarubun C, Setiyo Y, Anggreni AA, et al. Combination of filter media to reduce total suspended solids, biochemical and chemical oxygen demand in wastewater using installation of horizontal roughing filter. Asian J Microbiol Biotechnol Environ Sci. 2016;18(4):867-73.
13. Philia J, Wibisono J. Cultivation of Microalgae Chlorella sp on Fresh Water and Waste Water of Tofu Industry. In: E3S Web of Conferences. EDP Sciences; 2018. p. 4009. Available from: https://www.e3s-conferences.org/articles/e3sconf/pdf/2018/06/e3sconf_icenis2018_04009.pdf.
14. Wulansarie R, Chafidz A, Pratikno H, Rengga WDP, Afrizal FJ, Dwipawarman A, et al. Effectiveness of ozonation process on treating tofu industrial liquid waste: effect of pH conditions. Mater Sci Forum. 2020;891:336-41. doi: 10.4028/www.scientific.net/MSF.981.336.
15. Soeprijanto S, Tristanto VA, Revandra M, Rohmah ER, Febrianto HE. The Use of Liquid Waste of Tofu Industry for Biogas Production Using an Anaerobic Digester. In: Seminar Nasional Teknik Kimia Kejuangan. 2019. p. 1-5. Available from: http://103.23.20.161/index.php/kejuangan/arti.
16. Saxena G, Chandra R, Bharagava RN. Environmental pollution, toxicity profile and treatment approaches for tannery wastewater and its chemical pollutants. Rev Environ Contam Toxicol. 2017;240:31-69. doi: 10.1007/398_2015_5009.
17. Liu H, Ramnarayanan R, Logan BE. Production of electricity during wastewater treatment using a single chamber microbial fuel cell. Environ Sci Technol. 2004;38(7):2281-5. doi: 10.1021/es034923g.
18. Munter R. Advanced oxidation processes-current status and prospects. Proc Estonian Acad Sci Chem. 2001;50(2):59-80. doi: 10.3176/chem.2001.2.01.
19. Sirianuntapiboon S. Treatment of wastewater containing Cl2 residue by packed cage rotating biological contactor (RBC) system. Bioresour Technol. 2006;97(14):1735-44. doi: 10.1016/j.biortech.2005.07.030.
20. Khoiriyah A, Utami MC, Istadi I. Studi reaktor plasma dielectric barrier discharge (DBD) planar to planar untuk pre-treatment konversi limbah plastik polipropilen menjadi bahan bakar cair. Jurnal Teknologi Kimia dan Industri. 2012;1(1):213-21. [Indonesian].
21. Moradgholi M, Massoudinejad M, Aghayani E, Yazdanbakhsh A. Performance of electrical stimulated

anaerobic baffled reactor for removal of typical pollutants from low-strength municipalwastewater at low temperatures. Environ Health Eng Manag. 2019;6(2):121-8. doi: 10.15171/ehem.2019.14.
22. Said NI. Teknologi biofilter anaerob-aerob untuk pengolahan air limbah domestik. Pros Semin Nas dan Konsult Teknol Lingkung 2018:99-108. [Indonesian].
23. Ajijah N, Tjandra BC, Hamidah U, Sintawardani N. Utilization of tofu wastewater as a cultivation medium for *Chlorella vulgaris* and *Arthrospira platensis*. IOP Conf Ser Earth Environ Sci. 2020;483(1):012027. doi: 10.1088/1755-1315/483/1/012027.
24. El-Shemy H. Soybean and Nutrition. Jakarta, PT: Gramedia; 2011.
25. Novita E, Hermawan AA, Wahyuningsih S. Komparasi proses fitoremediasi limbah cair pembuatan tempe menggunakan tiga jenis tanaman air. J Agroteknologi. 2019;13(1):16-24. doi: 10.19184/j-agt.v13i01.8000. [Indonesian].
26. Anwar A. Pengolahan Limbah Cair Inudstri Tahu dengan Menggunakan Biofilter. Universitas Islam Negeri AR-RANIRY BANDA ACEH; 2020. Available from: https://repository.ar-raniry.ac.id/id/eprint/14783/1/AuliyaAnwar%2C150702038%2CFST%2CTL%2C082249126475.pdf. [Indonesian].
27. Sayow F, Polii BV, Tilaar W, Augustine KD. Analisis kandungan limbah industri tahu dan tempe rahayu di Kelurahan Uner Kecamatan Kawangkoan Kabupaten Minahasa. Agri-Sosioekonomi. 2020;16(2):245-52. doi: 10.35791/agrsosek.16.2.2020.28758. [Indonesian].
28. Faisal M, Mulana, Alam. F, Daimon, PN H. Wastewater characteristics from tofu processing facilities in Banda Aceh. In: Proceedings of The Annual International Conference, Syiah Kuala University-Life Sciences & Engineering Chapter. 2014. p. 18-21. Available from: http://www.jurnal.unsyiah.ac.id/AICS-SciEng/.
29. Irianto IK, Arygunarth GY. Evaluating of food waste handling to use trios monitoring system method of soy industry at Bali. Int J Adv Sci Eng Inf Technol. 2019;9(6):2074-81. doi: 10.18517/ijaseit.9.6.9.
30. Pandia S. Pengolahan Limbah Cair Industri Tahu Dengan Biofiltrasi Anaerob Dalam Reaktor Fixed–Bed. Universitas Sumatera Utara; 2008. [Indonesian].
31. Famurewa JA, Raji AO. Effect of drying methods on the physico-chemical properties of soyflour. Afr J Biotechnol. 2011;10(25):5015-9. doi: 10.5897/ajb10.998.
32. Rahmalia I, Nisa SK, Palupi V, Putri A, Suryawan IW. A study of the tofu industry environmental impact condition and scenario treatment using life cycle assessment approach. EPI Int J Eng. 2021;4(1):7-13. doi: 10.25042/epi-ije.022021.02.
33. Xue Z, Wang C, Cao J, Luo J, Feng Q, Fang F, et al. An alternative carbon source withdrawn from anaerobic fermentation of soybean wastewater to improve the deep denitrification of tail water. Biochem Eng J. 2018;132:217-24. doi: 10.1016/j.bej.2018.01.025.
34. Mufarida NA, Setiawan OD. Socialization of tofu liquid waste management (whey tofu) becomes biogas as alternative energy reserves in the framework of creating an environmentally friendly industry. Kontribusia (Research Dissemination for Community Development). 2020;3(2):326-32. doi: 10.30587/kontribusia.v3i2.1452.