Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang

Soni Andriawan[1*], Anis Zubaidah[2], Mujiono[3], Fia Sulis Setiani[4], Alif Zidane Juni Wananda[5], Ahmad Uzair Baihaqi[6], Dimas Calvin[7]
[1,2,3,4,5,6,7] Department of Aquaculture, University of Muhammadiyah Malang, Jalan Raya Tlogomas 246, 65144 Malang, East Java, Indonesia
* Corresponding author: soniandriawan@umm.ac.id

ARTICLE INFO

Article history
Received September 26, 2021
Revised September 28, 2021
Accepted November 7, 2021
Available Online November 27, 2021

Keywords
Community
Fertilizer
Hydroponic
Tempe
Liquid waste

ABSTRACT

The tempe industry activity in Sanan Village, Purwantoro Village, Blimbing District, Malang City creates an unpleasant odor that disturbs residents around the industry. Generally, tempe producers dispose of liquid waste from tempe production activities directly into rivers. Therefore, this activity aimed to make the community more aware of the correct management of tempe liquid waste. Making organic fertilizer from tempe liquid waste (TLW) for hydroponic technology was the primary goal of this program. Organic waste is fermented with EM4 in TLW media. Other than that, our program supports implementing urban farming in the city center to produce individual food. It is hoped that, in the future, all communities in Sanan Village can produce independent food by utilizing organic fertilizer from fermented tempeh liquid waste. The result of this program was the increase in people's knowledge about the manufacture and setting of organic and hydroponic fertilizers. Second, the residents of Sanan Village have applied fertilizer for their hydroponics. Assistance is carried out periodically to Youth Organizations in Sanan Village, Purwantoro Village, Blimbing District, Malang City on September 9 - 20 December 2020.

1. Introduction

Industry is one of the strategic economic activities to increase people's income and economy. One of the processed soybean industrial products with good nutrition consumed by humans is tempeh [1]. Tempe is a fermented soybean food with a delicious taste and easy digestibility and contains high nutrients, especially protein [2-4]. Tempe productivity in Indonesia is relatively high because tempeh has a distinctive flavor, so that many people like to eat it [5]. Therefore, there has been a significant increase in tempe productions [3, 6], especially in the Sanan Region, Malang, East Java, Indonesia. Sanan is a village where most of its residents produce "Tempe Chips", so the name

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197

"Sanan Tempe Chips" is very well known and has become the basis for supplying souvenirs in tourist destination areas [7].

However, tempe industrial activities produce liquid waste that can pollute the environment around the tempe industrial [8, 9]. In the process, the household-scale tempe industry is estimated to produce 200 L to 300 L of liquid waste per day from 300 kg of soybeans [10]. The waste causes an unpleasant odor (H_2S, ammonia, and phosphate) in waters or rivers when not through a unique process due to the fermentation process [11]. The tempe industrial liquid waste is produced from the soybean washing process, the soaking, boiling, and cooking techniques during tempe productions [12]. According to Prasetio and Widyastuti [13], the tempe liquid waste (TLW) has potential as organic fertilizer by adding EM_4, based on carbon and phosphate content. The phosphate content in the tempe industrial wastewater can be used as one of the ingredients for struvite fertilizer. The trick is to react it with magnesium (Mg) and Ammonium (NH4) compounds. In addition, Tempe industrial wastewater contains a lot of high PO_4. This phosphate content is essential for plant's growth as nutrients. This waste's high phosphate levels could be recovered by reacting with Mg and NH_4 to become struvite with the chemical formula $MgNH_4PO_4.6H_2O$ [14]. Tempe liquid waste also has been used to boost the growth of *Lycopersicum esculentum* Mill [15].

Moreover, the problem of fresh vegetables is still an obstacle in the Sanan region and relatively has a high price. The area in the Sanan region does not support to make a chance for farming vegetables. This program wanted to introduce a potential technology to generate fresh vegetables and urban farming based on those issues. Urban agriculture has been suggested as a possible method to guarantee food stocks and minimize agricultural land [16, 17]. There are numerous examples and ways for urban farming, while alternatives including vertical and hydroponic farming have proven to be popular solutions worldwide in recent years [18, 19]. Hydroponics is a crop-growing system that effectively produces vegetables and flowers in nutrient pools, frequently indoors and without soil [20, 21]. Hydroponics offers the following advantages compared to conventional production systems: faster growth, more productivity, less handling difficulty, increasing water efficiency, and less reliance on fertilizers [22]. Hydroponic systems are classified into several categories. Deep flow technique (DFT) and nutrient film technique (NFT) are two variants of these techniques that have been commercially viable [18]. A hydroponic technique called Deep Flow Technique (DFT) employs water as a medium to supply plants with nutrient solutions of ponds [23]. Plants are grown in drainage channels filled with a nutritional solution (4 cm to 6 cm in height) that continually keeps the roots immersed. Nutrition liquids will be recovered and returned to the nutrient reservoir, after which they will be supplied constantly to the seeding pond through a delivery pipe [24].

Consequently, this program aimed to introduce Deep Flow Technique (DFT) hydroponic using alternative organic fertilizer from fermented tempe liquid waste. Moreover, this program also helped people in the Sanan region, Malang, East Java, Indonesia, to apply urban farming around their houses.

2. Methods

In overcoming the problems of the household-scale tempe industry in Sanan Village, Purwantoro Village, Blimbing District, it must be carried out appropriately by considering efficient, effective, and integrated activities to improve welfare and sustainability of the business that tempe artisans have initiated. The approach method based on an agreement with partners:

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197

1. The lecture method applies to the importance of knowing the processing of tempe liquid waste into independent liquid fertilizer by utilizing TLW raw materials around the partner's business area so that the production waste was not too burdensome for the surrounding environment.
2. Applying training methods for independent liquid fertilizer create and hydroponic management with the following stages:
   a) Training by improving partners' skills to utilize tempe liquid waste into organic fertilizer in use for hydroponics.
   b) Introduce the formulation of liquid organic fertilizer with TLW as raw material.
   c) Elaborate on the management of crop quality through controlling plant growth.
   d) Teach how to prevent and control pests and diseases during hydroponic application.
3. Assist tempe artisans regarding the making of organic fertilizers as essential nutrients in hydroponic plant cultivation.

Moreover, there were three stages of evaluation that were carried out, including:

1. Pre-evaluation
   At this stage, evaluation activities emphasized the readiness of training materials (tools and guide modules) to be adequate in implementation.
2. Evaluation Plan
   This evaluation was carried out simultaneously with the implementation of activities. The expected results of this section, including:
   a) The success of the lecture of theoretical material was seen from the enthusiasm and response of the participants.
   b) The practice's success was directly identified from the skills of fish artisans in making liquid organic fertilizer made from TLW.
3. Final Evaluation
   At this stage, it would assess the entire series of program activities, so it was hoped that from this program, all elements, including the association of tempe craftsmen and people in Sanan Village, could gain new knowledge and skills to utilize TLW for liquid organic fertilizer and its application to hydroponic plants.

2.1. Preparation of tools and materials

The University of Muhammadiyah Malang team that has compiled a detailed series of activities would prepare the tools and materials needed during program implementation. The tools and materials that have been obtained were formed and used as supporting media in the performance of activities.

2.1.1. Fertilizer preparation

Organic fertilizer from tempe waste followed Prasetio and Widyastuti [13], Hapiza, et al. [25], Supinah, et al. [26] with slight modifications. A total of 10 L of TLW was boiled and homogenized for 15-20 min. Afterwards, the hot TLW was put into a bucket and then cooled. After cooling, added EM4 starter as much as 5-10 % v/v. Following the next step, the TLW was stored at room temperature for 7 days. The organic fertilizer was successful if it smelled like urea or had a sweet smell when it was opened. If you wanted to add KCl, you could add coconut water (50: 50) for 5 days.

2.1.2. Hydroponic pack introduction

The program involved residents in the Karang Taruna Village of Sanan Village RT 1 and RT 2, Malang, and lectures from the Department of Fisheries, Faculty of Agriculture-Animal Husbandry, University of Muhammadiyah Malang. Two hydroponic

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197

 ISSN : 1693-3214 print | 2721-0111 online

systems were introduced, namely the WICK system and the NFT system. Those two hydroponic systems were bought online.

3. Results and Discussion

The community service program was carried out for one and a half months in RT 1 and RT 2, Sanan Village, Malang City. Activities that have been carried out included training and mentoring in fish cultivation, hydroponic training, fish farming management training, training on making liquid fertilizer from TLW, and hydroponic plant processing.

2.2. Socialization and mentoring of catfish farming and hydroponic training

The socialization training on hydroponics was carried out on September 24, 2020, at the TPQ RT building. 1 Sanan Village, Malang City with the speaker, Mr. Reza Rahman Hakim S.Pi, M.Sc, Lecturer in the Department of Fisheries, Faculty of Agriculture - Animal Husbandry, University of Muhammadiyah Malang. The residents' enthusiasm became the benchmark for these activities' achievement. Another indicator was marked by the number of questions from participants to presenters about the material that had been delivered.

Figure 1. Hydroponic training and delivery of hydroponic installations

2.3. Hydroponic plant nursery training

The hydroponic plant nursery training was held on October 1, 2020, at the RT. 2 Sanan Village. The training process was assisted by five students from the Department of Aquaculture, Faculty of Agriculture and Animal Science, University of Muhammadiyah Malang. Lettuce nurseries used Rockwool media as a nutrient supply medium. The number of people from RT. 2 Sanan Village was a benchmark for the residents' enthusiasm for hydroponic development initiation. One Rockwool media could accommodate at least nine plant seeds that grew for approximately 7 days before being transferred to a hydroponic installation.

Figure 2. Pokcoy nursery in hydropic growing media

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197

2.4. Liquid fertilizer training

The training on making fertilizer from TLW was carried out by involving residents of RT 1 and RT 2 of Sanan Village. The residents' enthusiasm could be seen from the positive response of people in the creation of the fertilizer, starting from preparation until the final result. Residents used the fertilizer as nutrients for hydroponic plants and plants planted in the ground.

Figure 3. Making organic fertilizer

2.5. Hydroponic installation assembly training

Aquaculture Department students carried out the hydroponic installation assembly on October 8, 2020, after the nursery process was completed. A total of 2 hydroponic installations were handed over to the residents of Sanan Village to support the Food Independent Village by producing food products in a narrow area. Hydroponics used the latest technology with the water recirculation of the growing media.

Figure 4. Hydroponic installation assembly

2.6. Transfer of lettuce seedlings to a hydroponic installation

After 7-10 days of seeding, the lettuce plants were transferred to a hydroponic facility with the assist of the residents of Sanan Village. The lettuce plants grew in good conditions for transplanting in more extensive media. In the process, liquid organic fertilizer from the tempe waste was applied and flowed using a water pump.

2.7. Hydroponic plant harvesting

In the process, residents of RT 1 and RT 2 of Sanan Village handled hydroponic cultivation independently by utilizing organic fertilizer from TLW. Based on Figure 5. The lettuce growth in the hydroponic system the lettuce could grow well by absorbing the resident's Sanan village's organic fertilizer. Moreover, this finding proved that applying organic fertilizer from TLW worked well in the hydroponic system.

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197

ISSN : 1693-3214 print | 2721-0111 online

Figure 5. The lettuce growth in the hydroponic system

4. Conclusion

The University of Muhammadiyah Malang carried out the Community Service Program to help the community optimally utilize the waste from tempe processing to reduce environmental pollution. This program also guided the Sanan people to produce organic vegetables from hydroponic on a home scale and be more alert about the importance of maintaining health and hygiene during this Covid-19 pandemic. In this program, RT 1 and 2/RW 16, Sanan Village, Purwantoro sub-district, Blimbing sub-district, Malang city were chosen because of the industrial sector. In Tempe production, waste is not used in the manufacturing process and will eventually be disposed of for nothing.

Acknowledgments

The author thanks the Sanan people that provide a place for conducting a community service program for 2 months. Moreover, the University of Muhammadiyah Malang funded this program from the beginning until the end of the period.

References

[1] W. Haliza, E. Y. Purwani, and R. Thahir, "Pemanfaatan kacang-kacangan lokal sebagai substitusi bahan baku tempe dan tahu," *Buletin Teknologi Pasca Panen,* vol. 3, no. 1, pp. 1-8, 2016.

[2] S. Hartini, F. Letsoin, and A. Kristijanto, "Productive Liquid Fertilizer from Liquid Waste Tempe Industry as Revealed by Various EM4 Concentration," in *IOP Conference Series: Materials Science and Engineering*, 2018, vol. 349, no. 1: IOP Publishing, p. 012059.

[3] M. Nout and J. Kiers, "Tempe fermentation, innovation and functionality: update into the third millenium," *Journal of applied microbiology,* vol. 98, no. 4, pp. 789-805, 2005, doi: https://doi.org/10.1111/j.1365-2672.2004.02471.x.

[4] A. Nurdini, L. Nuraida, and A. Suwanto, "Microbial growth dynamics during tempe fermentation in two different home industries," *International Food Research Journal,* vol. 22, no. 4, p. 1668, 2015.
[5] B. Sarwono, *Usaha membuat tempe dan oncom*. PT Niaga Swadaya, 2010.
[6] M. Gunawan-Puteri, S. Fortunata, E. Mursito, and C. Wijaya, "Application of quick tempe technology for production of overripe tempe," in *IOP Conference Series: Earth and Environmental Science*, 2019, vol. 292, no. 1: IOP Publishing, p. 012060.
[7] M. Faidah, "Sertifikasi Halal Produk Keripik Tempe pada Sentra Industri Sanan Untuk Mendukung Malang Menjadi Kota Wisata Syariah," in *Proseding Seminar Nasional Hasil Penelitian Dan Pengabdian Kepada Masyarakat (SEMNAS PPM 2016), LPPM-UNESA. https://www. researchgate. net/publication/328732449_Sertifikasi_Halal_Produk_Keripik_Tempe_Pada_Sentra_Industri_Sanan_Untuk_Mendukung_Malang_Menjadi_Kota_Wisata_Syariah*, 2016.
[8] M. Azhari, "Pengolahan Limbah Tahu dan Tempe dengan Metode Teknologi Tepat Guna Saringan Pasir sebagai Kajian Mata Kuliah Pengetahuan Lingkungan," *Media Ilmiah Teknik Lingkungan,* vol. 1, no. 2, pp. 1-8, 2016.
[9] A. Ihsan, S. Bahri, and M. Musafira, "Produksi biogas menggunakan cairan isi rumen sapi dengan limbah cair tempe," *Natural Science: Journal of Science Technology,* vol. 2, no. 2, 2013.
[10] N. Hikma, M. Alwi, and U. J. B. Umrah, "POTENSI LIMBAH CAIR TEMPE SECARA MIKROBIOLOGIS SEBAGAI ALTERNATIF PENGHASIL BIOGAS," vol. 8, no. 1, 2014.
[11] D. Dahruji, P. F. Wilianarti, and T. T. Hendarto, "Studi Pengolahan Limbah Usaha Mandiri Rumah Tangga dan Dampak Bagi Kesehatan di Wilayah Kenjeran, Surabaya," *Aksiologiya: Jurnal Pengabdian Kepada Masyarakat,* vol. 1, no. 1, pp. 36-44, 2016, doi: http://dx.doi.org/10.30651/aks.v1i1.304.
[12] L. Edahwati and R. R. Anggriawan, "Pembentukan Pupuk Struvite dari Limbah Cair Industri Tempe dengan Proses Aerasi," *Jurnal Teknologi Lingkungan,* vol. 22, no. 2, pp. 215-221, 2021.
[13] J. Prasetio and S. Widyastuti, "Pupuk Organik Cair Dari Limbah Industri Tempe," *WAKTU: Jurnal Teknik UNIPA,* vol. 18, no. 2, pp. 22-32, 2020.
[14] S. Hamzah, F. Ulum, S. Sutiyono, and L. Edahwati, "KINETIKA REAKSI PEMBENTUKAN PUPUK STRUVITE DARI LIMBAH CAIR TEMPE SECARA BATCH," *Seminar Nasional Soebardjo Brotohardjono,* vol. 16, 09/21 2020. [Online]. Available: http://snsb.upnjatim.ac.id/index.php/snsb/article/view/22.
[15] R. Rosalina, "Pengaruh konsentrasi dan frekuensi penyiraman air limbah tempe sebagai pupuk organik terhadap pertumbuhan dan hasil tanaman tomat (Licopersicum esculentum Mill.)," Universitas Islam Negeri Maulana Malik Ibrahim, 2008.
[16] M. Martin and E. Molin, "Environmental Assessment of an Urban Vertical Hydroponic Farming System in Sweden," *Sustainability,* vol. 11, no. 15, 2019, doi: 10.3390/su11154124.
[17] K. Specht *et al.*, "Urban agriculture of the future: an overview of sustainability aspects of food production in and on buildings," *Agriculture and Human Values,* vol. 31, no. 1, pp. 33-51, 2014/03/01 2014, doi: 10.1007/s10460-013-9448-4.
[18] T. Kozai, G. Niu, and M. Takagaki, *Plant factory: an indoor vertical farming system for efficient quality food production*. Academic press, 2019.

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197

[19] T. Kozai, "Resource use efficiency of closed plant production system with artificial light: Concept, estimation and application to plant factory," *Proceedings of the Japan Academy, Series B,* vol. 89, no. 10, pp. 447-461, 2013, doi: 10.2183/pjab.89.447.
[20] L. Cifuentes-Torres, L. G. Mendoza-Espinosa, G. Correa-Reyes, and L. W. Daesslé, "Hydroponics with wastewater: a review of trends and opportunities," *Water and Environment Journal,* vol. 35, no. 1, pp. 166-180, 2021.
[21] R. Aldrich and J. Bartok, "Greenhouse Engineering (NRAES 33)," ed: Northeast Regional Agricultural Engineering Service (NRAES), 1994.
[22] G. L. Barbosa *et al.*, "Comparison of Land, Water, and Energy Requirements of Lettuce Grown Using Hydroponic vs. Conventional Agricultural Methods," *Int J Environ Res Public Health,* vol. 12, no. 6, 2015, doi: 10.3390/ijerph120606879.
[23] W. Gunawan, S. Firdaus, and B. Ali, "CULTIVATION OF VEGETABLES AND FISH USING THE AQUAPONICS SISTEM (DFT MODEL) IN CV TMR," *ABDIKARYA: Jurnal Pengabdian Dan Pemberdayaan Masyarakat,* vol. 3, no. 1, pp. 95-102, 2021.
[24] S. Pramono, A. Nuruddin, and M. H. Ibrahim, "Design of a hydroponic monitoring system with deep flow technique (DFT)," *AIP Conference Proceedings,* vol. 2217, no. 1, p. 030195, 2020/04/13 2020, doi: 10.1063/5.0000733.
[25] M. R. Hapiza, T. Sabrina, and P. Marbun, "Pengaruh Pemberian Limbah Cair Industri Tempe dan Mikoriza Terhadap Ketersediaan Hara n dan p Serta Produksi Jagung (Zea Mays L.) Pada Tanah Inceptisol," *Agroekoteknologi,* vol. 2, no. 3, 2014.
[26] P. Supinah, W. F. Setiawan, and S. P. Mulya, "Sosialisasi Pemanfaatan Limbah Tempe Sebagai Pupuk Organik Cair untuk Pengelolaan Berkelanjutan di Desa Kuripan Kertoharjo," *Jurnal Pusat Inovasi Masyarakat,* vol. 2, no. 4, pp. 642–646-642–646, 2020.

Please cite this article as: Andriawan, S., Zubaidah, A., Mujiono, M., Sulis Setiani, F., Zidane Juni Wananda, A., Uzair Baihaqi, A., & Calvin, D. (2021). Tempe Liquid Waste as Hydroponic Fertilizer in Sanan Village, Malang. Jurnal Dedikasi, 18(2), 12-19. doi:https://doi.org/10.22219/dedikasi.v18.i2.18197