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Development of SaTRU (Tofu Filter) as a Tofu Liquid Waste Treatment Tool in Tinalan Village

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Abstract

The tofu processing industry in Tinalan, Pesantren Subdistrict, Kediri produces massive amounts of wastewater with high level of Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD). The toxic substance in the wastewater can potentially endangers the environment in the long term. Government policy in the Ministry of Environment Regulation (Permen LH) No. 05 of 2014 concerning Quality Standards for Soybean Processing Business and/or Activities to minimize the impact of environmental pollution urges the society to take serious action to overcome these problems. In addition, the society also faces obstacles in the form of limited places to process waste. This then becomes a challenge for the government to provide processing facilities for the community while minimizing the impact on environmental sustainability. Reviewing these problems, the author has an innovation in the design of SaTRU (Biofilter as a Sustainable Utilization of Tofu Wastewater Treatment). SaTRU technology was chosen because of its high efficiency and installation that does not require large areas. This activity uses a quasi-experimental design with pretes-posttest design. The results showed that the filter with silica sand, zeolite and charcoal media was able to increase the pH level from 2 to pH 5 and had effectiveness in reducing the pollutant content in the water.

Keywords: *Tofu Processing Industry; Wastewater; Environmental Pollution; Design of Satru*

Introduction

The processing industry is the leading contributor to Indonesia's Gross Domestic Product (GDP). According to information collected from the Central Statistics Agency (BPS), the manufacturing sector will be the largest contributor to the National GDP in 2021, contributing as much as 19.25% based on current pricing (ADHB) 2021, which reached 16.97 IDR quadrillion (Statistik, 2020). The government supports the contribution from the processing industry by providing an assurance that the industry will continue to function. Soybean processing, specifically tofu production, is one of the processing sectors seeing expansion.

Figure 1. Average Consumption of Tofu and Tempe per Capita (2010-2021).
Source: Central Bureau of Statistics

Tofu is one of the Indonesian dishes that is well-known and frequently consumed by the population (Ananda et al., 2018). Soybeans are fermented with yeast to form tofu, and the resulting liquid is then extracted (Setiawan & Rusdjijati, 2014). Tofu has a high nutritional value and consumption of tofu provides numerous health benefits (Chua & Liu, 2019; Xiao et al., 2015). The average consumption of tofu in Indonesia increased by 3.75 percent between 2020 and 2021, as indicated in Figure 1. It is anticipated that its value will continue to rise (Swastika, 2015), as a result of government support, particularly as stated by the Ministry of Agriculture that to restore production national capacity of soybeans in order to achieve productivity and consistency in production.

According to Pradana et al. (2018), small-scale firms now dominate the tofu industry in Indonesia. As in Tinalan Village, especially Gang IV, which is renowned as a center for tofu production, is a location that continues to see growth. There are as many as 25 tofu-processing homes in Tinalan Village, with an average workforce of three to five persons per home. The growth of the tofu processing business and the rise in tofu consumption in Tinalan Village, Pesantren District, Kediri City correspond with the increase in industrial wastes produced by this industry.

Throughout the production process, the tofu manufacturing sector generates liquid and solid waste (Sato et al., 2015). Tofu processing generates solid waste in the form of tofu dregs and liquid waste in the form of residual water from cooking, washing, soaking, and boiling soybeans. Tofu pulp is composed of up to 20.93% protein, 21.43% fiber, 10.31% fat, 0.72% calcium, 0.55% phosphorus, and 36.69% other elements (Faisal et al., 2016). Due to its high protein content, tofu making waste is reprocessed into rural animal feed or cattle. In the meanwhile, the liquid waste is not processed and is instead released directly into the river in front of the residents' homes.

Table 1. Soybean Processed Wastewater Quality Standard

<table>
<tr><th rowspan="2">Parameter</th><th colspan="2">Soybean Tofu Processing</th></tr>
<tr><th>Content *) (mg/L)</th><th>Weight (kg/ton)</th></tr>
<tr><td>BOD</td><td>150</td><td>3</td></tr>
<tr><td>COD</td><td>300</td><td>6</td></tr>
<tr><td>TSS</td><td>200</td><td>4</td></tr>
<tr><td>pH</td><td colspan="2">6-9</td></tr>
<tr><td>The highest quantity of wastewater (m^3/ton)</td><td colspan="2">20</td></tr>
</table>

(Environmental Services, 2014)

Tofu liquid waste by industry can pollute the environment in the center of settlements, which has a negative impact on the surrounding environment, such as the emergence of an unpleasant odor from tofu liquid waste discharged into water bodies (Suseno & Sukmawati, 2018). The liquid waste formed by the production of tofu comprises suspended or dissolved materials that induce physical, chemical, and biological changes and have a severe influence on human health, creating a breeding ground for harmful compounds. Pathogens and other germs that have a harmful effect (Wijayanti et al., 2021). Hamidah et al. (2022) highlighted that liquid waste disposed of directly without treatment to riverbanks has the potential to contaminate the ecosystem due to the presence of pollutant substances such as Total Suspended Solid (TSS), Chemical Oxygen Demand (COD), and Biological Oxygen Demand (BOD) which demonstrates a high value and has beyond the set value or Threshold Value (NAV) established in the Regulation of the Minister of the Environment of the Republic of Indonesia Number 5 of 2014 concerning Quality Standards for Processed Soybean Wastewater.

If compounds that produce pollution are present in wastewater, oxygen levels will fall, which will disrupt the growth of aquatic life and lead the water to become disease-carrying (Pradana et al., 2018). The environment and the water are also quite acidic due to the presence of vinegar water in the liquid waste. This will undermine the sustainability of marine life and can have negative effects on human health.

The government's policy to reduce the negative effects of environmental pollution encourages the public to take decisive action to address these issues. Consequently, the government faces the difficulty of providing processing facilities for the community while limiting the impact on environmental sustainability. In light of these issues, the author has developed an original design for SaTRU (Tofu Filter) with the theme Biofilter as a Sustainable Utilization of Tofu Waterwaste Treatment.

Method

The method used in this research was qualitative method which consists of several stages of activities carried out indicated by a flowchart as shown in Figure 2.

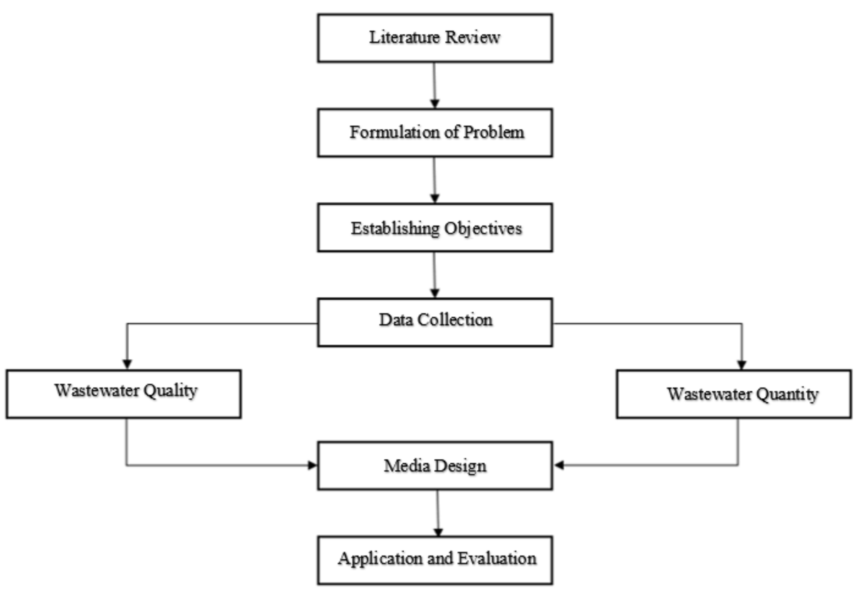


Figure 2. Activity Flowchart

The steps of the activities carried out are interconnected with one another. The method used is as follows:

1. Initial Identification

In this stage, the researchers investigated the current literature and gathered information from the Internet and a number of scholarly journals in order to collect theoretically accurate data. The following phase is to define the context that underlies the creation of the paper and the formulation of the topic to be investigated in this research, followed by the objectives to be reached.

2. Data Collection

In this step, the authors collect data by employing data collection methodologies in the library and performing field surveys directly with a number of tofu production enterprises. The study is conducted by looking for data in the library and using data and studying it from books, the Internet, or other media that will be used as material for the author's consideration and to expand the author's understanding of the scope of actions and concepts covered by the research. Table 2 presents the findings of a field survey about the quantity of wastewater.

Table 2. Liquid Waste Quantity

Location	Waste Source	Amount of Waste per day (L)
Wijaya Kusuma	Acidification	120
	Washing	270
Populer	Acidification	150
	Washing	450
MJS	Acidification	150
	Washing	450

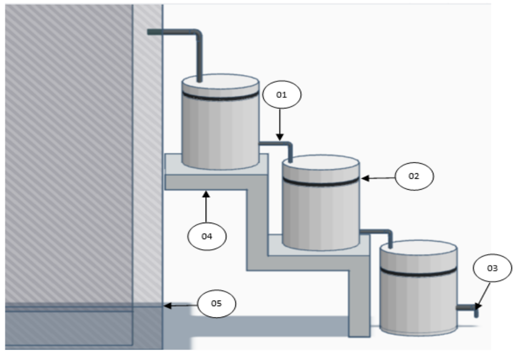
Table 3 shows the wastewater quality data. TSS and BOD parameters were obtained through literature studies from several scientific journals, while pH was obtained through measurements with a pH meter.

Table 3. Liquid Waste Quality

Parameter	Concentration (mg/l)			Quality standards (mg/l)
	Wijaya Kusuma	Populer	MJS	
TSS	5603	5603	5603	200
BOD	491.52	491.52	491.52	150
pH	2	2	2	6 – 9

3. Media Development

The media design phase started with the design process using TinkerCad program, as depicted in Figure 3. The design of SaTRU is founded on several references to literary research and systematic idea planning. The WWTP installation type was chosen as a reference design because it has a solid operational history and adheres to the sustainability philosophy (Jumhur et al., 2021; Wolsing et al., 2021). SaTRU is created with longevity in mind and an installation idea that makes it simple to operate.



PART LIST			
ITEM	QTY	PART	DESCRIPTION
1	7	PVC	½"
2	3	FILTER NYLON	FILTERING MEMBRANES
3	4	KNEE L	MODIFIED FOR ROTATION
4	1	STAIRS	SUPPORTING PART
5	-	HOUSING	RETAIN WATER

Figure 3. SaTRU Installation

The SaTRU was developed to have the optimal size, which is depicted in Figure 4, while still taking into account the placement position, which is specifically in the houses of the residents. The SaTRU is designed with a white bucket to minimize its visibility. There are three media containers containing zeolite stone, silica sand, and activated carbon as charcoal. In the first phase, the waste travels through the filter media in the form of fibers that serve as a filter for tofu dregs, then through the filter media and into the river.

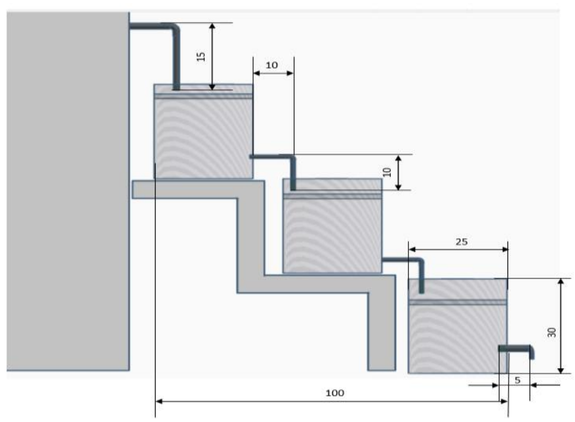


Figure 4. SaTRU Dimension Parameter

SaTRU requires 1 cm^2 of space in the manufacturer's residence. Installation of equipment can be performed within or outside the residence, namely in the waste disposal area with a pipe connecting to the filter unit. The installation of the instrument necessitates a support mechanism comprised of wood placed in accordance with the height of each filtration container. This tool has the benefit of being simple to operate. In addition, SaTRU has a lid so that it can resist changes in wastewater and remove suspended particulates.

In the filtration room, the maintenance method for SaTRU consists of replacing the filter media, washing the bucket container, and cleaning the inner pipe. Cleaning the filter involves removing the foam and washing the filter. The dirt on the filter media is removed and the media is washed or replaced. According to the processing method and frequency of usage, equipment maintenance time is necessary. Volumes greater than 270 L are collected every six months, whereas volumes greater than 450 L are collected every month. Table 4 contains the specifications of the tools and materials required to facilitate the implementation of producing SaTRU.

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Table 4. Tools Requirements

NO	Explanation	Weight (gram)	Specification
			A. Tools Required
1	Pail Bucket	15000	A bucket with a volume of 15 liters used as a media storage
2	Pipe	40	Pipe with a thickness of inch is used as a reservoir for water flow
3	Knee L	50	Used for connecting pipes
4	Filter Nylon	10	Cut according to the diameter of the bucket as a separator between the fibers and the filtering media
5	Glue	10	Aluminum adhesive for gluing tools
6	Wood	5000	Bucket holder/bucket containing filter media
7	Driller	-	Tool for punching holes in pail buckets
8	Saw	-	Used to cut PVC pipe
			B. Materials
1	Zeolit	5000	Molecular mesh has a negative charge to bind cations
2	Silica Sand	5000	Contains silica (Si02) with a hardness of 7 on the Mohs scale to filter out physical contaminants
3	Activated Carbon	2000	Activated carbon for odor absorption or filtering and filtering metals
4	Broom Fibers	500	Its texture and density are used to filter tofu dregs from liquid waste.

Results and Discussion

The activities outlined in Table 5 will be put into practice, beginning with the planning stage and continuing all the way through to the reporting phase. Due to internal and external circumstances, there are various stages of activities that deviate from the intended timeframe in practice.

Table 5. Activity Implementation

No.	Explanation	June		July			
		3	4	1	2	3	4
1	Planning - Literature Study - Site Survey - Design Planning						
2	Designing - Material Selection - Mechanical Design						
3	Trial - Trial Error - Progress Consolidating						
4	Reporting - Output products in the form of reports - External products in the form of finished goods						

The results of waste treatment activities are in the form of 2 types of output: reports and finished goods. In the process of working on the finished goods, namely the SaTRU tool, a mechanical design is carried out as shown in Figure 5.

Figure 5 . SaTRU Processing Equipment Design

In the third prototype, it was checked using pH paper and obtained the results as shown in Figure 6.

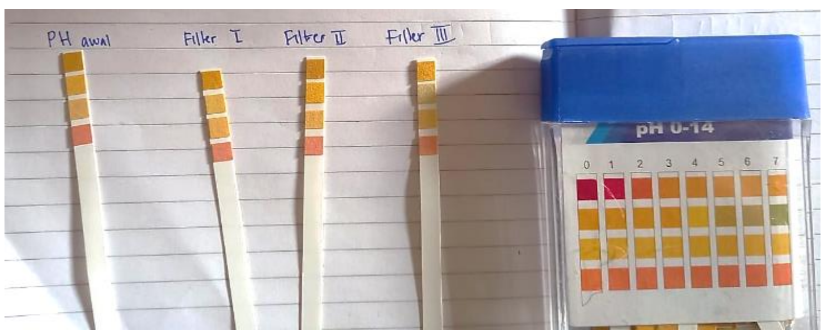

Figure 6. Prototype Waste Treatment Results

The PH reading is done by scanning the color on the universal indicator table between pH 1 to pH 14. Wastewater obtained from the production process has a pH of 2, then after going through the processing process through filtering media 1 the results are pH 3, then the value for filtering media 2 is obtained pH 4. In the last filtering media obtained a pH value of 5

Conclusion

1. A filter using a mixture of silica sand, zeolite, and charcoal media is effective in lowering the contents that can pollute the water and raising the pH so that it can be used as an option to minimize waste pollution.
2. Liquid waste from tofu production can be treated with a biofilter capable of reducing the pH value from 2 to 5, but this has not been able to reduce the pH value to meet the quality standard requirements, which is 6-9 according to applicable regulations.
3. The design of SuTRA as a filtration tool is the right solution to reduce the impact of river pollution by the soybean tofu processing industry, especially for the people of Tinalan Village, Kediri, East Java.
4. It is necessary to conduct further research by adding other important parameters in order to obtain a more valid measurement.

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