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The Effect of Starter Ratio on Tofu-processing Wastewater Fermentation into Fertilizer

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ABSTRACT: The process of tofu manufacturing produces solid (slurry) and liquid wastes with high protein content. Tofu-processing Wastewater can be used as the primary material for liquid NPK fertilizer production. The process of converting tofu-processing wastewater into liquid fertilizer was simple and requires a short fermentation time. The fermentation process was carried out by mixing of EM 4 (starter for fermentation liquid), alcohol as solvent and organics matter. The selection of organic matter that is used as the primary ingredient of liquid fertilizer would affect the content of N, P and K substances in the product. Banana peel and cabbage are organic matter with a high calcium and phosphorus content. This research was conducted to determine the effect of the addition ratio of cabbage and banana peel to time duration of fermentation on the tofu- wastewater processing into liquid fertilizer. The results showed that increasing the ratio of cabbage to the starter increased the levels of N and P along with the length of fermentation time. However, increasing the cabbage ratio in the starter causes a decrease of K in liquid fertilizer.

KEYWORDS: Tofu wastewater, fertilizer, fermentation

I. INTRODUCTION

Tofu is a source of vegetable protein for the people of Indonesia. The process of making tofu is done by mixing soybean essence with vinegar. This process causes the protein to coagulate and become denser when pressed [1]. The solid waste generated from making tofu is in the form of wet dregs (pulp) with a fairly high protein content of 23.5% [2]. The solid waste generated in this process can be used as secondary products such as "tempe gembus," animal feed, and processed into crackers, shredded, and dry bread [3]. However, solid waste processing must be done quickly because tofu dregs rotten rapidly. The soybean-based tofu-making industry produces liquid waste that has the potential to pollute the environment and is one of the industries that produces organic liquid waste [4]. The chemical content of the liquid waste from the tofu manufacturing process contains Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), and high pH (acidity). Tofu-processing Wastewater has a BOD of 5643-6870 mg/l (standard 300 mg/l) and a COD content of 6870-10,500 mg/l (standard COD 600 mg/l) [5]. These substances can pollute the environment and produce a very pungent odor. Water pollution can also kill aquatic organisms, cause disease, and become a breeding ground for mosquitoes [6]. The wastewater treatment process can be carried out using wastewater treatment technology or an Oxidation Reactor [7]. However, the technology is expensive and complicated to be applied in the small household industry [8]. The wastewater purification process can be carried out by filtration-absorber process using vetiver grass and zeliac [9] or coagulation – filtration using Polyaluminum Chloride (PAC) – Active filtration matter (quartz, activated carbon, and zeolite) [10]. However, the process of handling tofu-processing water waste using filtration is considered less effective because it still has noticeable content of BOD and COD beyond the water quality standard and takes a long time [6, 9–11]. Several studies were conducted to increase the economic value of tofu-processing wastewater by processing the waste into biogas [12] and liquid fertilizer [13]. The Anaerobic Digestion process in biogas processing produces gas and liquid that can be used as fuel. The residual sludge from biogas processing can cause soil contamination and water eutrophication if released directly into the environment. Biogas slurry contains high content of organics matter (79–11480 mg/L), nitrogen (~111–3691 mg/L) and phosphorus (11–95 mg/L). Biogas Slurry can be reprocessed into liquid fertilizer [14]. Tofu processing water waste also has a high level of NH3, so it can be fermented into a component of NPK fertilizer [15].

Converting tofu-processing wastewater into liquid fertilizer is simple and requires a short fermentation time. The fermentation process is carried out by adding EM 4 (fermentation liquid), alcohol solvent and organic matter. Alcohol solvent is added as an antiseptic [16]. The fermented tofu-processing wastewater can be directly applied to plants. Liquid fermentation of tofu-processing wastewater and AB

mix nutrients (NH_4, NO_3, H_3PO_4, and K) can be used at low levels in hydroponic plants and increase lettuce growth [17]. Applying the mixture at high levels did not change the plant growth. Some organic matter such as coconut water [16], rice husk [18], and manure [19] is added during anaerobic tofu-processing wastewater fermentation to increase the levels of N, P and K content. The Addition of organic matter and manure at the proper percentage in the fermentation of tofu-processing wastewater significantly affects the growth of plant roots [19]. The anaerobic reactions in the tofu-processing wastewater fermentation process can be increased by setting the organic co-substrate used, adjusting the temperature, C/N (carbon/Nitrogen) ratio and pH during the fermentation process [20]. The manufacture of liquid fertilizer can be done from the leaves and fruit of Kersen by extraction and fermentation processes [21]. Several other researchers used a mixture of organic vegetable waste with animal waste, such as mustard greens with crab waste [22] or tofu dregs with goat urine [23]. Fruit peel waste, such as pineapple and dragon fruit, can also be fermented for three months to become liquid organic fertilizer [24]. Generally, the duration of fermentation required to convert liquid organic waste into liquid fertilizer using EM4 is 14 days [25]. However, the duration of this fermentation is also determined by the organic matter used. The process of fermenting household organic waste (solid waste) into liquid waste using the EM4 bio activator takes 17 days [26].

The fermentation process can also be improved by increasing the phosphorus and calcium content in the mixture [27]. Banana peel and cabbage are organic matter with a high calcium and phosphorus content. Making organic NPK fertilizer with the addition of banana peel can increase the content of Nitrogen (35325 - 78775 mg/L), Phosphorus (195.83 mg/L-471 mg/L) and potassium (422.3 mg/L - 2046 mg/L) [28]. In addition, adding cabbage in the fermentation process increased 75% of the nutrient component content in NPK liquid fertilization. Research on adding banana peels and cabbage to tofu-processing wastewater has been conducted, with variable lengths of fermentation and EM4 ratio [29]. The results showed that the optimum conditions were obtained in the 10-day fermentation process with a ratio of 40 ml of EM4 in 100 ml of a mixture of banana peel and cabbage. The results were obtained for Nitrogen 1.24%, Phosphor 1.01%, and Potassium 3.36%. Another study was conducted to determine the fermentation of tofu-processing wastewater, with the variable addition of EM4 mixed with banana peel juice and molasses and the variable duration of the fermentation process. The most optimum conditions were obtained with the use of EM4 as much as 40 ml and the duration of the fermentation process for ten days, namely Nitrogen 1.3%, Phosphorus as P_2O_5 1.21% and Potassium as K_2O 3.33%. This research was conducted to determine the effect of the ratio of adding cabbage and banana peel to the tofu-processing wastewater fermentation process into liquid fertilization

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II. RESEARCH METHODOLOGY

This research used a set of fermentation equipment, a bottle with the materials containing: Tofu-processing Wastewater, banana peel, cabbage and EM4. The banana peel used in this study was the kapok banana peel. The experiment was started with making a fermentation starter (S1) by finely cutting 500 g of banana peel. Next step, banana peel was mixed with 10 grams of sugar and 100 ml of Tofu-processing Wastewater without adding cabbage. This mixture was used as a control variable at the beginning of the study. The mixture that has been finely crushed was filtered to get 100 ml of the filtrate. The results of the filtration are mixed with 10 ml of EM4, then waited for the mixture to complete its reaction for 1 hour before use. The mixture was divided into a fermentation bottle into 5 variable ratios and coded S1 to S5. The variation of the ratio of S1-S5 is shown in table 1. In each fermentation bottle, 500 mL of tofu-processing wastewater and 100 mL of starter S1-S5 were added. The process the starter addition is shown in Figure 1. The tofu-processing wastewater was tested for its NPK content before being mixed with the fermentation starter. Each variable ratio will be fermented with time duration of 1, 5, 10, and 15 days. The fermentation process is shown in Fig. 2.

Table 1. Variation of Mixed Ratio of Banana peel and Cabbage

Variation	Weight (gram)	
	Banana peel	**Cabbage**
S1	500	0
S2	500	200
S3	500	400
S4	500	600
S5	500	800

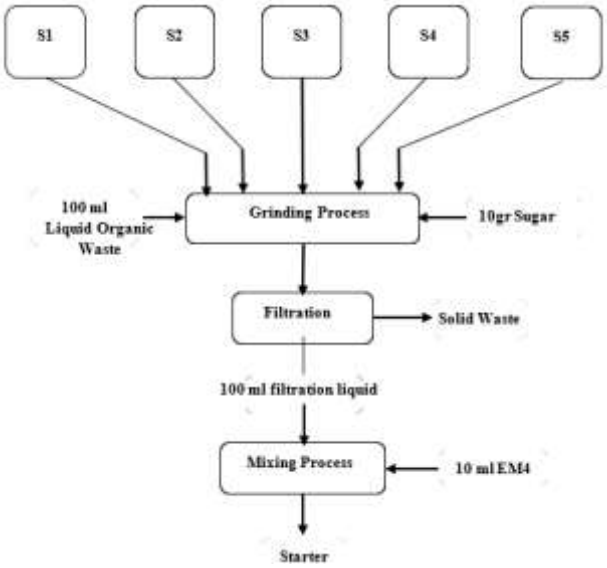

Figure 1. Flowchart of making fermentation starter

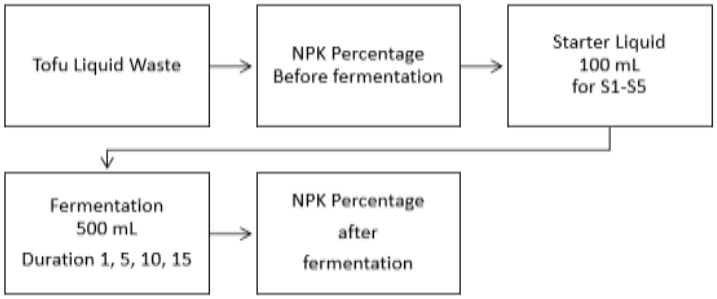

Figure 2. Flowchart fermentation process

III. RESULT

This research was conducted to obtain a liquid organic fertilizer which has a higher nutrient content (N, P, K) than the previous two studies[28], [29]. Processing of Tofu-processing Wastewater into liquid organic fertilizer through a fermentation process by adding EM4 and starter of banana peel and cabbage. Tofu-processing Wastewater has a N content of 0.36%; P content 0.23%; K content of 0.33% before fermentation. The results of the study are shown through a graph of the percentage increase in Nitrogen, Phosphorus and potassium contents. Figure 3 shows a graph that shows the relationship between the weight ratio of banana peels and cabbage to the nitrogen content. The results showed that the longer the fermentation process was carried out, the higher the nitrogen content in the liquid fertilizer. In addition, the addition of the ratio of cabbage to the liquid waste tofu fermentation starter causes an increase in the nitrogen content of liquid fertilizer. The smaller the ratio, the greater the N content is possible because the amount of cabbage added affects the effectiveness of EM4. The longer the fermentation, the more opportunities for EM4 to convert protein into Nitrogen.

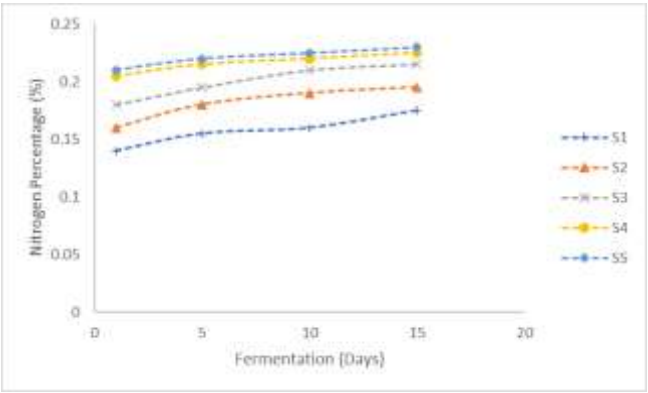

Figure 3. The increase in the percentage of nitrogen in the ratio of cabbage and banana peel in the fermentation of tofu-processing wastewater to Fertilization Liquid

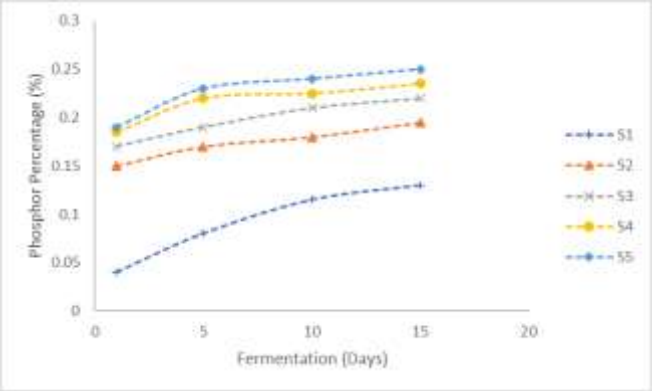

Figure 4. The increase in the percentage of phosphorus in the ratio of cabbage and banana peel in the fermentation of tofu-processing wastewater to Fertilization Liquid

Figure 4 is a graph that shows the relationship between the ratio of the weight ratio of banana peels and cabbage to the levels of Phosphorus in liquid fertilizer. The results showed that the longer the fermentation process was carried out, the higher the phosphorus content in the liquid fertilizer. Fermentation of tofu-processing wastewater without the addition of cabbage produces lower phosphorus content. The highest levels of P were found in 15 days of fermentation with a mixture ratio of banana peels and cabbage 500/800 grams. The smaller ratio of cabbage produces higher phosphorus content in liquid fertilization. This condition caused by the amount of cabbage added affects the effectiveness of EM4. The longer the fermentation, the more opportunities for EM4 to convert protein into Phosphorus.

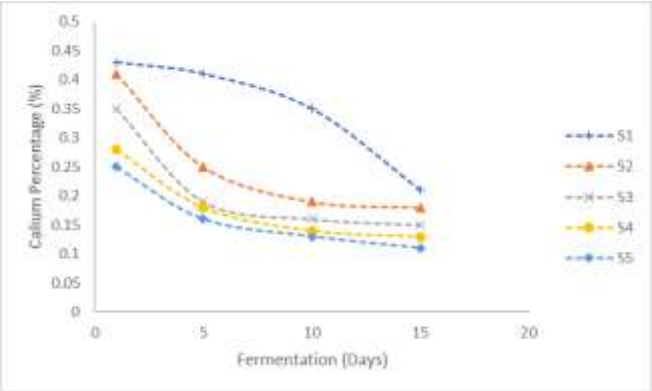

Figure 5. The increase in the percentage of potassium in the ratio of cabbage and banana peel in the fermentation of tofu-processing wastewater to Fertilization Liquid

The addition of cabbage to the starter of tofu-processing wastewater fermentation causes an increase in the levels of N and P in liquid fertilization. However, the addition of the ratio of cabbage to the starter fermentation causes a decrease in K levels. Figure 5 is a graph showing the relationship between the ratio of the weight ratio of banana peels and cabbage to the K content. Tofu-processing wastewater fermentation without the addition of cabbage produces higher potassium content. The smaller the ratio, the smaller the K content is possible because effect of the amount of cabbage added and the length of fermentation affect the effectiveness of EM4.

IV. CONCLUSIONS

The weight ratio of banana peels and cabbage with levels of N and levels of P have in common, namely the smaller the ratio, the greater the levels. The highest levels were obtained at 15 days of fermentation. The weight ratio of banana peels and cabbage with K levels produced the lower calcium levels. The highest levels were obtained on a day of fermentation.

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