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Quality of Physical and Chemical Properties of Liquid Organic Fertilizer from Tofu Liquid Waste with Banana Hump Mol Decomposer

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Abstract: Liquid organic fertilizer is a fertilizer that is available in liquid form. This liquid organic fertilizer can be made naturally through a fermentation process to produce a solution of decay from plant residues. Liquid organic fertilizer is better to use because it is free from chemicals and has a good impact on health. The purpose of this research is to study the manufacturing technique and to determine the physical and chemical properties of liquid organic fertilizer from tofu liquid waste with banana hump mole decomposer. The research method is experimental. The results obtained are the quality of the physical properties of liquid organic fertilizer from tofu liquid waste with banana hump Mol with an average temperature from 26 to 29^{o}C, yellow (8/8) 10YR color or reddish yellow, characteristic sour smell, and TSS 5132 – 5879 mg L^{-1}. The quality of the chemical properties of liquid organic fertilizers are the average pH 3.62 – 3.72: Nitrogen 7.98 – 8.22%, Phosphor 0.002%, and Potassium 0.03%. The liquid organic fertilizer is under the standard of liquid organic fertilizer but the pH value is slightly lower than the standard.
Keywords: liquid organic fertilizer, tofu liquid waste, banana hump, Mol

1. Introduction

Tofu is a food product made from processed soybeans and proteins was thickened by adding a coagulant**.** Indonesia is one of the countries that make tofu as a side dish that contains high protein. In the process of making tofu in Indonesia, it is still done simply. In the processing process, the tofu industry can produce waste, whether it is a solid waste in the form of soybean dregs or liquid waste. According to [1], the liquid waste produced from the tofu processing process contains various organic substances that result in the rapid growth of microbes in the water. The liquid waste generated from the home-based tofu industry contains various organic compounds such as 40-60% protein, 25-50% carbohydrates, and 10% fat, therefore if this liquid waste is discharged directly into waters such as rivers or lakes, the water contained in it become polluted [2] matter will affect the high nitrogen, phosphorus, and sulfur in water [3]. Therefore, the liquid waste produced from this tofu has the potential to be developed into liquid fertilizer. Tofu liquid waste has various nutrients and can be used as a new alternative fertilizer that can be applied for plant growth.

Liquid organic fertilizers have several benefits including being able to encourage and increase the formation of leaf chlorophyll and the formation of root nodules in leguminous plants to increase the photosynthetic ability of plants and the absorption of nitrogen from the air, can increase plant vigor so that plants become sturdy and strong, increase plant resistance to drought, weather stress and disease-causing pathogens, stimulate the growth of production branches, and increase the formation of flowers and ovules, and reduce the fall of leaves, flowers, and ovules [4]. Liquid organic fertilizer contains various substances needed for plant growth. Liquid organic fertilizer contains nutrients, phosphorus, nitrogen, and potassium needed by plants and can improve nutrients in the soil. Liquid organic fertilizer is a fertilizer whose basic ingredients come from animals or plants that have undergone fermentation and the product form is in the form of a liquid. The chemical content in it is a maximum of 5% [5].

2. Material and Methods

2.1. Materials

The material used in this study was 2 kg of the banana hump, 2 kg of brown sugar, 2 liter of rice washing water, and 40 liters of tofu liquid waste.

2.2. Methods

2.2.1. Sample collection and preparation

2.2.1.1 Preparation of banana hump mol

Banana hump and brown sugar smoothed by using a blender, filtered, put in a jar, and closed it. Next, the banana hump mol was stored in a place protected from sunlight at room temperature.

2.2.1.2. Observation of the banana hump mole

The fermented hump mol stirred and smell the aroma. During the fermentation process, this odor observation was carried out every day with organoleptic tests using the sense of smell carried out by 5 to 8 people. The banana hump was ready to use indicated by the smell of tapai.

2.2.1.3. Liquid organic fertilizer

Liquid organic fertilizer was obtained from 600 ml of banana hump mixed with 60 liters of tofu liquid waste in jerry cans. Then incubated by storing in the shade and installing an aerator therefore oxygen enters to accelerate of incubation process.

2.3. Experimental variable and analytical procedures

Physical properties of liquid organic fertilizer were observed consisting of temperature, color, smell (aroma), and Total Suspended Solid (TSS). Chemical properties consist of pH, Nitrogen (N), Phosphor (P), and Potassium (K). All of the variable were analyzed descriptively.

2.4. Data Analysis

The variables observed in this study were as follows: 1. The temperature is observed every day using a thermometer, 2. Observation of color with Munsell soil color book, 3. The smell is observed by smelling the aroma every day. 4. Analysis of the content of TSS in liquid organic fertilizer to determine the dissolved solids in the water in the form of organic matter filtered using 0.45 m millipore paper, 5. Analysis of the content of N (Kjeldahl), P (P Bray 1), K (Flame photometry) C (Walkey and Black), and pH (pH meter) in liquid organic fertilizer [6]

3. Results and Discussion

The results of the analysis of the physical and chemical properties of liquid organic fertilizer can be seen in the following Table 1.

Table 1. Average Physical and Chemical Properties of Liquid Organic Fertilizer

Sample	Physical Properties			Chemical Properties				
	Temperature (°C)	Color	Smell	TSS mg L^{-1}	pH	N (%)	P (%)	K (%)
1	27	Y (8/8) 10YR (reddish yellow)	Original Ingredients-Sour	5879	3.62	7.98	0.002	0.03
2	26	Y (8/8) 10YR (reddish yellow)	Original Ingredients-Sour	5643	3.67	8.13	0.002	0.03
3	27	Y (8/8) 10YR (reddish yellow)	Original Ingredients-Sour	5875	3.65	8.21	0.002	0.03
4	29	Y (8/8) 10YR (reddish yellow)	Original Ingredients-Sour	5132	3.72	8.22	0.002	0.03

Source: Results of Laboratory Observations and Analysis

3.1. Physical Properties of Liquid Organic Fertilizer from Tofu Liquid Waste

3.1.1. Liquid Organic Fertilizer Temperature

The supporting parameter in the process of making liquid organic fertilizer is temperature. Temperature is influenced by external factors and when decomposition occurs. The temperature of liquid organic fertilizer has increased from the beginning of making liquid organic fertilizer. The results of temperature measurements during the fermentation process varied, ranging from 26^0C to 29^0C. The temperature of liquid organic fertilizer in this study is still in a good range for fermentation therefore that microorganisms can degrade the substrate in liquid organic fertilizer. Temperature is a factor that can affect the occurrence of anaerobic fermentation. The optimal temperature for fermentation is 35-55°C [7].

From 28 days of observations made, the temperature decreased on the first 6th day and for the next day increased to a maximum of 29°C. Microbes decompose organic matter into CO_2, water vapor, and heat. After most of the material has decomposed, the temperature will gradually decrease [8]. This temperature observation is carried out every day using a thermometer and the stirring of liquid organic fertilizer raw materials is also carried out every day, this stirring function aims to obtain sufficient oxygen so that bacteria do not float on top and can be mixed with raw materials.

3.1.2. Liquid Organic Fertilizer Color

Observation of the color of liquid organic fertilizer was carried out using the Munshel Soil Color Chart (MSCC) soil color book (Fig.1). The results of the observation of the color of the liquid organic fertilizer showed that the liquid organic fertilizer produced was of good quality, seen from the color of the liquid organic fertilizer.

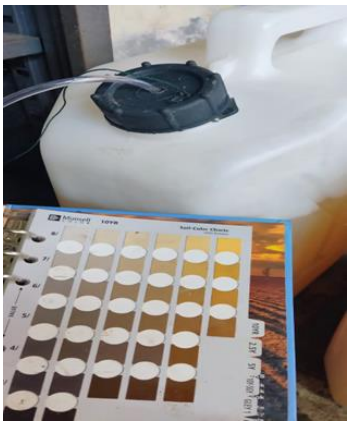

Figure 1. Color observation

The color of the liquid produced from liquid organic fertilizer in the first curing process is yellow to reddish yellow. According to [9], the indicator of the success of a liquid organic fertilizer is liquid organic fertilizer that is yellow and does not have a strong odor. During the fermentation process takes place there is no color change in liquid organic fertilizer until harvest. Color observations were carried out once every 3 days starting on the first day until the harvest was finished. On the first day after the liquid fertilizer was mixed with other ingredients the color had become Yellow (8/8) 10 YR (reddish yellow) until the end of the fermentation, the color remained the same**.**

3.1.3. Smell of Liquid Organic Fertilizer

The aroma of organic fertilizer is a parameter that affects the maturity of organic fertilizer from the fermentation process. The decomposition process can remove the organic compound that causes strong odors, which is ammonia [10]. Observation of the smell of organic fertilizer was carried out by organoleptic test using the sense of smell, the results of observing the smell of liquid organic fertilizer showed that liquid organic fertilizer smelled like tape, which means that the organic fertilizer produced was of good quality. After 28 days of the fermentation process of making liquid fertilizer with the basic ingredients of liquid waste tofu with MOL banana hump, all samples experienced a change in odor from the beginning of the fermentation process to the end of the fermentation process. The odor produced by all treatments on the first day until the sixth day still smells of the original material, because it has not been decomposed by microbes. On the seventh day, the fermentation process has undergone a pungent odor change, while on the tenth day, the odor has changed to sour until the end of the fermentation. The aroma of liquid organic fertilizer between smell not pungent and strong smell [11].

3.1.3. Total Suspended Solid (TSS) of liquid organic fertilizer

The TSS of liquid organic fertilizer from the sample was between 5132-5879 mg L^{-1}. There is no standard for TSS in liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement [12]. The Total suspended from the organic liquid fertilizer manufacturing process from palm oil mill effluent (POME) is approximately 2,000 mg L^{-1} [13].

Figura 2. Obervation of TSS

3.2. Chemical Properties of Liquid Organic Fertilizer

3.2.1. The pH of liquid organic fertilizer

The pH value indicates the concentration of H^+ ions in the solution, an increase in the concentration of H^+ increases the potential of the solution which is measured by the instrument and is converted into a pH scale. The glass electrode is a special H^+ selective electrode, making it possible to measure only the potential caused by the increase in H^+ concentration. Based on Table 1, the pH value can be seen that there are four replications showing a very acidic value, namely 3.62 - 3.72. The pH value is slightly lower than the requirements for liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement which states that the pH value of Liquid Organic Fertilizers between 4-9 [12] This acidity is due to the microorganisms involved in the fermentation process converting organic matter into organic acids resulting in an acid release process that affects the pH to become acidic [7].

3.2.2. Nitrogen in Liquid Organic Fertilizer

Nitrogen plays an important role in the growth of leaves, stems and the preparation of chlorophyll which makes plants green [14]. Nitrogen is an essential element in the plant growth process with the highest molecular weight and consists of amino acids bound by peptide bonds. Nitrogen is absorbed by plants in the form of nitrate and ammonium, but this nitrate is immediately reduced to ammonium through enzymes containing molybdenum [15]. More protein can be produced if there is more nitrogen available. The more nitrogen is given, the faster the carbohydrate synthesis is carried out by plants. Based on Table 1, the determination of the N-total value of liquid organic fertilizer in the four repetitions carried out by fermentation for 28 days showed that the N content of liquid organic fertilizer was very high, namely 7.98 - 8.22%. Some previous studies showed low Nitrogen content in liquid organic fertilizer. Nitrogen content in liquid organic fertilizer from *Gracilaria* sp. and the mixture of two types of seaweed, namely 0.56% and 0.67% [10]. Meanwhile, the Nitrogen content in liquid organic fertilizer from kersen leaves and eggshells with the addition of 50 ml spoiled rive local microorganism bioactivator was 0.01296% [11].

The N-organic value is under the requirements for liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement which states that the N-organic value of Liquid Organic Fertilizers minimum 0.5% (w/v) [12]. The fermentation process causes nitrogen-degrading microorganisms to change when these microorganisms grow and divide at the maximum speed so that the activity of microorganisms in decomposing organic compounds increases and affects the increase in total N levels which results in higher total nitrogen levels in fermented liquid organic fertilizers for 28 days [16].

3.2.3. Phosphorus in liquid organic fertilizer

Phosphorus is one of the most important nutrients needed by plants. Plants need phosphorus as a growth promoter. However, the available phosphate can be absorbed by the soil in low amounts. Most of the phosphorus in the soil is in the form of adsorption. Phosphorus is strongly influenced by the length of fermentation and the volume of the tofu liquid waste which varies. The greater the nitrogen contained, the more microorganisms that remodel phosphorus will also be greater so that the phosphorus content in fertilizers will also increase [17]. The phosphorus content obtained is influenced by the length of fermentation time and the volume of tofu liquid waste which is varied. Plant phosphorus is useful in the formation of fruit, seeds, and flowers and also plays a role in energy transfer in plants that cannot be replaced by other elements [18].

Based on Table 1, the P value of liquid organic fertilizer in four repetitions was fermented for 28 days, the results obtained from the analysis showed the same value of 0.002%. According to [19], this number has a fairly low phosphorus value, phosphorus content is an element that is not easy to move because it has dynamic properties**.** Analysis of phosphorus content in liquid organic fertilizers from *Gracillaria* sp. 0.045% and *Sargassum* sp. 0.0078% [10]. Meanwhile the Phosphor (P_2O_5) content in liquid organic fertilizer from kersen leaves and eggshells with the addition of 50 ml spoiled rive local microorganism bioactivator was 0.8928 % [11].

Based on the requirements for liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement which states that the total $N+P_2O_5+K_2O$ is 2-6%(w/v) [12].

3.2.4. Potassium in liquid organic fertilizer

Potassium plays a role in the formation of proteins and carbohydrates, hardening of wood from plants, improving seed quality, and increasing resistance to diseases and pests. The lack of K in plants will be seen by the presence of dryness symptoms at the tips of the leaves, especially old leaves. The lack of element K in fruit will affect the taste. Tofu liquid waste contains more nitrogen, phosphorus, potassium, and water than solid tofu waste. According to [17], potassium functions in the substrate material as a catalyst, with the presence of bacteria, and their activities will greatly affect the increase in potassium. Based on Table 1, the average K value of liquid organic fertilizer in four repetitions was fermented for 28 days, the same result was 0.03%.

These results indicate that the N value in liquid organic fertilizer is very high. The high content of potassium is due to the element potassium being a catalyst for microbes or microorganisms to accelerate the fermentation process, besides the addition of bio activators in the manufacture of liquid fertilizers also affects the high potassium in fertilizers. That is, if the fermentation process runs quickly and is accompanied by the right supporting raw materials, the potassium content will also increase [20]. Based on the requirements for liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement which states that the total $N+P_2O_5+K_2O$ is 2-6%(w/v) [12]. Some studies showed the potassium value of some liquid prganic fertilizer range 0.33-0.68% [10], and 0.02-0.04 % [11].

4. Conclusions

The quality of the physical properties of liquid organic fertilizer from tofu liquid waste with banana hump moles with an average temperature of 26 to 29 degrees, a yellow color (8/8) 10YR, a characteristic sour smell, and a TSS of around 5132 – 5879 mg/liter. The quality of the chemical properties of liquid organic fertilizer is the average pH 3.62 – 3.72: N 7.98 – 8.22%, P 0.002%, K 0.03%. This liquid organic fertilizer contains high N, so it is a good nitrogen source. The pH of liquid organic fertilizer tofu liquid waste is slightly low, if it is to be applied to the growing media, the pH of liquid organic fertilizer must be re-treated under the requirements for plant growth**.**

References

[1] A. Aliyenah, A. Napoleon, and B. Yudono, "Utilization of tofu industrial liquid waste as organic liquid fertilizer on the growth and production of land kangkung (*Ipomoea reptans Poir*)," *Science Research Journal*, vol. 17, no. 3, pp. 102–110, 2015.

[2] A. Rasmito, A. Hutomo, and A. Hartono, "Making liquid organic fertilizer by fermenting tofu liquid waste, banana and cabbage peel filtrate starter, and EM4 bioactivator," *Iptek Journal*, vol. 23, no. 2, pp. 55–62, 2019, doi: 10.31284/j.iptek.2019.v23i1.

[3] S. Saenab, M. Henie, I. Al, F. Rohman, and A. N. Arifin, "Utilization of tofu industrial liquid waste as liquid organic fertilizer to support Makassar City Lorong Garden Program," *Pros. Semin. Nas. Megabiodiversitas Indones.*, vol. 4, no. 1, pp. 31–38, 2018.

[4] R. N. Fitri, E. Ambarwati, and N. W. Yuwono, "Effect of dosage and frequency of application of liquid organic fertilizer on growth and yield of Lowland Beans (*Phaseolus vulgaris* L.)," *Journal of Soil and Environmental Science*., vol. 7, no. 2, pp. 163–178, 2011.

[5] E. Kurniawan, Z. Ginting, and P. Nurjannah, "Utilization of goat urine in the making of liquid organic fertilizer on the quality of macro nutrients (NPK)," *Semin. Nas. Sains dan Teknol.*, vol. 1, no. 2407 – 1846, pp. 1–10, 2017, [Online]. Available: jurnal.umj.ac.id/index.php/semnastek

[6] Balai Penelitian Tanah, "Petunjuk Teknis Analisis Kimia Tanah, Tanaman, Air dan Pupuk. Balai Penelitian Tanah, Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian, Bogor, 2005.

[7] F. Arifan, W. Broto, S. Fatimah, S and E. Salsabila, Pengaruh komposisi dan waktu fermentasi terhadap karakteristik pupuk organik limbah cair tahu. P*ENTANA, Jurnal Penelitian Terapan Kimia*, vol. 03 no. 1, pp. 01-09, April, 2022.

[8]. N. Lisanty and J. Junaidi, "Production of Liquid organic fertilizer by utilizing local micro organisms in Jegreg Village, Nganjuk Regency," J*ournal of Agriculture and Community Service.*, vol. 1, no. 1, pp. 1–10, 2021, doi: 10.30737/jatimas.v1i1.1668.

[9] Nasrun, Jalaluddin, and Herawati, "Utilization of Barangan banana peel waste as material for making liquid fertilizer," *J. Tech. Kim. Unimal*, vol. 5, no. 2, pp. 19–26, 2016, [Online]. Available: http://ojs.unimal.ac.id/index.php/jtk

[10] A. R. Tsaniya, E. N. Dewi, A. D. Anggo, "Characteristics of liquid organic fertilizer frim different composition types of seaweed between *Gracilaria* sp. and *Sargassum* sp." *J. Phys.: Conf. Ser. 1943 012071*, Boston, MA, 2021, 10p., doi:10.1088/1742-6596/1943/1/012071

[11] M. Yerizam, N. Norfhairna, E. Margaretty, I. Hajar, M. Meilianti, E. Supraptiah, I. Silviyati, and J. Salsabila, "Liquid organic fertilizer production from kersen leaves (*Muntingia calabura L.*) and Eggshells with addition of spoiled rice Local Microorganism (Mol) bioactivator", *5th FIRST T1 T2 2021 International Conference*, *Atlantic Press* vol. 9, pp. 426-430, 2021.

[12] Menteri Pertanian Republik Indonesia, "Keputusan Menteri Pertanian Republik Indonesia no. 261/KPTS/SR.310/M/4/2019 tentang Persyaratan Teknis Minimal Pupuk Organik, Pupuk Hayati dan Pembenah Tanah" Kementrian Pertanian Republik Indonesia, Jakarta, 2019.

[13] F.S. Lubis, Irvan, D. Anwar, B. Amirza Harahap, B. Trisakti, "Kajian awal pembuatan pupuk cair organik dari effluent Pengolahan lanjut LImbah Cair Pabrik Kelapa Sawit (LCPKS) skala pilot", *Jurnal Teknik Kimia USU*, Vol. 3, No. 1, pp. 32-37 Maret 2014

[14] M. Febrianna, S. Prijono, and N. Kusumarini, "Utilization of liquid organic fertilizer to increase nitrogen uptake and growth and production of mustard greens (*Brassica juncea* L.) in Sandy Soil,"*Journal of Soil and Land Resources*, vol. 5, no. 2, pp. 1009–1018, 2018, [Online]. Available: http://jtsl.ub.ac.id

[15] C. Masclaux-Daubresse*, F. Daniel-Vedele, J. Dechorgnat, F. Chardon, L. Gaufichon and A. Suzuki, "Nitrogen uptake, assimilation and remobilization in plants: challenges for sustainable and productive agriculture", *Annals of Botany*, no.105, pp. 1141–1157, 2010, doi:10.1093/aob/mcq028, available online at www.aob.oxfordjournals.org

[16] M. A. Kusumadewi, A. Suyanto, and B. Suwerda, "Content of nitrogen, phosphorus, potassium, and pH of liquid organic fertilizer

from market fruit waste based on time variations," *Journal of Environmental Health.*, vol. 11, no. 2, pp. 92–99, 2019, doi: 10.29238/sanitasi.v11i2.945.

[17] N. K. S. Dharmayanti, A. A. N. Supadma, and I. D. M. Arthagama, "Effect of Biourine and Inorganic Fertilizer Doses (N,P,K) on some chemical properties of pegok soil and spinach (*Amaranthus sp*.)," *J. Agroekoteknologi Trop.*, vol. 2, no. 3, pp. 165–174, 2013, doi: 10.1126/science.345.6196.499.

[18] W. A. Barus, H. Khair, and H. P. Pratama, "The Growth character and yield of radishs on the application of tofu dregs and liquid organic fertilizer of gamal leaves," *Agrium*, vol. 22, no. 3, pp. 183–189, 2020.

[19] R. R. Samsudin, "Bioactive starfruit wuluh (*Averhoa bilimbi (Linn.*)) against formalin levels in tofu," *J. Muhammadiyah Med. Lab. Technol.*, vol. 1, no. 2, pp. 177–186, 2018, doi: 10.30651/jmlt.v1i2.1541.

[20] A. Rahmawati, B. A. Fachri, S. Oktavia, and F. Abrori, "extraction bioactive compound of pegagan (*Centella Asiatica L.*) using solvent-free microwave-assisted extraction," *Mater. Sci. Eng.*, vol. 1053, no. 1, pp. 1–7, 2021, doi: 10.1088/1757-899x/1053/1/012125.