DOI :https://doi.org/10.36378/juatika.v4i1.1833
JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL.4 NO. 1 January 2022
eissn 2656-1727
pissn 2684-785X
Hal : 206 – 214

Analysis of the Nutrient Content of Liquid Organic Fertilizer (POC) Household Organic Waste in Rimba Jaya Village, Merauke Regency Using the Stacked Bucket Method

*Yosefina Mangera, Nurhening Yuni Ekowati
Fakultas Pertanian Universitas Musamus
Jl. Kamizaun Mopah Lama, Rimba Jaya, Kec. Merauke,
Kabupaten Merauke, Papua 99611
e-mail : mangera@unmus.ac.id

ABSTRACT

The purpose of this study was to analyze the nutrient content of POC produced from household waste using the stacked bucket method. This research was conducted for 3 months from September to November 2020. This research is a descriptive study. The first process is the process of making organic fertilizer from household waste which is fermented in a stacked bucket for 2 months. Leachate from organic waste is dried in the sun for one month or until the leachate is blackish in color and has no more subtle aroma. The finished POC is sampled and tested in the laboratory to determine the content of micro and macro nutrients as well as organic C. To measure the content of macro and micro nutrients, the test material used was Kjeldahl for nitrogen content while P, K, Fe, Mn, Cu, Zn, S, Ca, Mg, Na used spectrometric wet oxidation method and the content of C-organic by spectrophotometric method. The test results showed that the POC of household waste contained 0.08% total N, 0.07% total P, 0.28% total K, 5 ppm total Fe, 0.4 ppm total Mn, 0.0 ppm total Cu, Zn total 0.6 ppm, total S 0.5%, total Ca 165.0 ppm, total Mg 106.9 ppm, total Na 172.7 ppm, organic C 1.06%, and C/N ratio 13.27.

Keywords : nutrients, POC, organic waste, stacked buckets

1. INTRODUCTION

Success in agriculture is largely determined by land resources. Various efforts have been made to increase the productivity of agricultural land. Fertilization, which is one way to increase soil fertility, actually causes a decrease in soil quality. This is caused by an imbalance of nutrients in the soil due to the absence of return of soil organic matter.

Copyright © 2022. The authors. This is an open access article under the CC BY license (https://creativecommons.org/licenses/by/4.0/)

Fertilization should pay attention to the concept of efficient and effective in its application as well as the benefits obtained. The application of organic waste that contains high nutrients can increase metabolic processes in plants and the activity of soil microorganisms(Gusti & Hamzah, 2021). Liquid organic fertilizer (POC) is a form of organic fertilizer that can be used to increase plant fertility and is easy to apply. Provision of POC on marginal land can increase nutrient absorption and the availability of macronutrients and micronutrients in the soil(Tuhuteru et al., 2021). In addition, POC can also be made by yourself in an easy and simple way, one of which is by using a stacked bucket bioreactor.

The high price of fertilizer due to the removal of subsidies from the government and the lack of raw materials for fertilizer that must be imported encourage the use of waste or organic waste as an alternative to using fertilizers.(Susi et al., 2018). Household organic waste is waste that has great potential to be used as the basic material for making organic fertilizers. The use of black soldier fly (BSF) larvae with the scientific name Hermetia illucens as an agency for the decomposition of kitchen waste which is classified as organic waste into liquid organic fertilizer (POC) is still not popular among the Indonesian people, even though the use of these fly larvae can be an innovative strategy in minimizing the amount of waste. organic(Junaidi, Mariyono, 2021). BSF larvae which are popularly called “magot” are very active in eating organic waste such as leftover vegetables or fruits. The decomposition product of these larvae is in the form of leachate which will then become POC.

Various methods have been carried out to process household organic waste into organic fertilizer, both liquid (POC) and solid organic fertilizer. Research conducted by(Widyabudiningsih et al., 2021) and (Nur et al., 2018)using EM4 bioactivator to accelerate the decomposition process of organic matter. Other studies also mention that the manufacture of organic fertilizers, both solid and liquid, can also be done using local microorganism starter (MOL) derived from rice(Lailiyah et al., 2019), as well as the MOL of fruit waste, banana weevil, cow rumen, cow urine, and golden snails(Manullang et al., 2017). Bucket stack is a tool for making fertilizer which is made by uniting 2 buckets that are arranged in tiers. Stacked buckets are used to treat organic waste in the form of fruit and vegetable waste or other household organic waste with the help of BSF larvae. BSF larvae play a role in helping the aerobic composting process and accelerating the decomposition of organic waste in the stacked bucket reactor. The stacked bucket reactor also allows the leachate flow to be separated from the solid material to produce liquid fertilizer.

Knowledge of POC content is very important to know to ensure efficiency in fertilization. Based on this, the authors are interested in conducting research in order to examine the nutrient content of POCs produced from household waste with the help of BSF larvae through the stacked bucket method.

2. RESEARCH METHODS

Materials and tools

This research is a descriptive research. The material used is household waste in the Rimba Jaya sub-district, Merauke district. The waste fermentation process is

carried out in an open space under direct sunlight with temperatures ranging from 30-32oC. The materials used in this study were household organic waste consisting of fruit waste such as banana peels, papaya, and watermelon, as well as vegetable waste in the form of vegetable residues such as mustard greens, spinach, cassava leaves, and kale. While the tools used are 2 buckets (17 liters), a cutting grinder faucet, a drilling machine, and used plastic bottles (1500 ml volume).

Research implementation

This research was conducted according to the research flow chart in Figure 1. The stacked bucket bioreactor used in this study was designed according to Yuwono (2019). The stacked bucket bioreactor design is presented in Figure 2.

How to make a stacked bucket bioreactor

1) Bottom bucket: install the faucet on the bottom side, only take the edge of the cover to support the top bucket. Its function is as a leachate reservoir.
2) Top bucket: make small holes in the bottom for drainage, make small holes (4) on the top side under the lid. Garbage function. The four small holes serve as entrances for BSF flies.

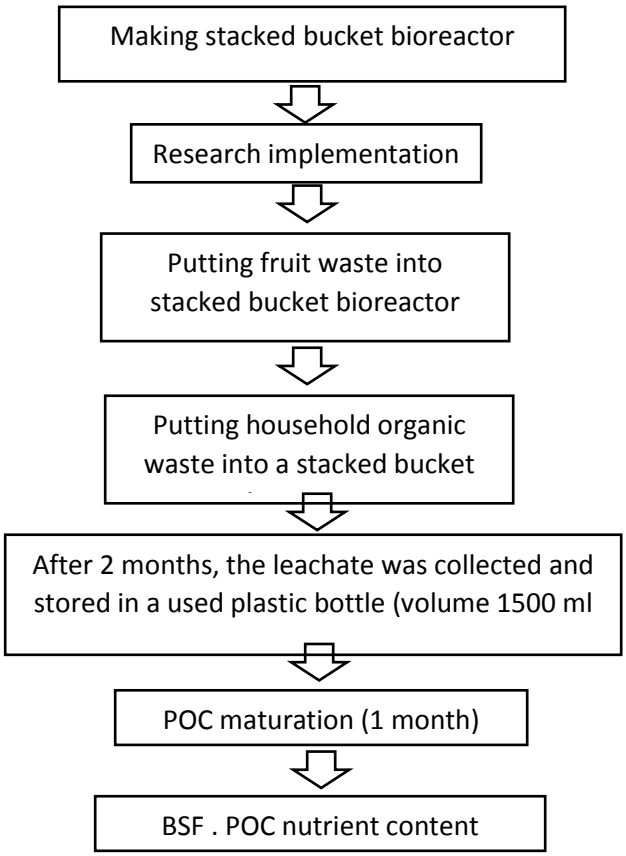

Figure 1. Research flow chart

Figure 2. Stacked bucket bioreactor (Yuwono, 2019)

How to make POC:

1) Put the fruit waste in the top bucket, in a hot and humid atmosphere, microbes grow quickly, the aroma of the volatile compounds produced will invite Hi flies to lay eggs. This will last for the first 2 weeks.
2) Wait until the Hi larvae are seen a lot and are actively working, add household organic waste such as vegetable and fruit waste continuously according to the capacity of the bucket.
3) Leachate is left in the bottom bucket, after 2 months it is continued with the maturation process into liquid organic fertilizer (POC). The trick is to put the leachate into a clear bottle, half a bottle, loosen the bottle cap, dry in the sun until it turns black and brown and has a soft aroma on the nose (± 1 month).

Analysis of BSF POC nutrient content (leachate))

Samples of finished POCs were taken and tested in the laboratory to determine the content of macro and micro nutrients as well as organic C. To measure the content of macro and micro nutrients, the test material used was Kjeldahl for nitrogen content while P, K, Fe, Mn, Cu, Zn, S, Ca, Mg, Na were used wet oxidation method spectrometry and C-organic content with the wet oxidation method. spectrophotometry.

3. RESULTS AND DISCUSSION

This research was conducted to process organic waste generated from household waste in the form of fruit and vegetable residues into liquid organic fertilizer (POC). One of the most innovative technologies in waste management is the bioconversion of waste using insects(Čičková et al., 2015). The waste treatment process is carried out using stacked buckets as a waste processing bioreactor according to the Yuwono (2019) method. This stacked bucket bioreactor method uses Black Soldier Fly in the waste degradation process. The black army fly has the Latin name Hermetia illuscens, this fly is widely known as the BSF or HI fly, which is an insect from the Stratiomyidae family.(Deshmukh, 2019). BSF flies are widely used in organic waste processing, several previous studies have stated that BSF flies have the potential to convert organic waste into biomass that is more economically valuable. This insect is known to grow well on various types of organic matter and manure. The results of the activity of BSF flies in addition to

producing liquid and solid organic fertilizers, can also be used as biogas producers, even BSF larvae can be used as animal feed.(Boccazzi et al., 2017).

The results of the laboratory analysis of the nutrient content of POC BSF produced in this study are presented in Table 1.

Table 1. Results of analysis of POC nutrient content from household waste treated with a stacked bucket bioreactor

Kind of Hara	Parameter	POC nutrient content	Quality Standard*	Unit
	C-organic	1.06	minimum 6	%
	C/N ratio	13.27	max 2	
Heavy metal				
	Pb Total	0.00	maximum 2.5	ppm
	Total CD	0.00	max 0.5	ppm
pH H2O		4.9	4 - 9	
Hara Macro				
	N Total	0.08	3 - 6	%
	P2O5 Total	0.07	3 - 6	%
	K2O Total	0.28	3 - 6	%
Micro Nutrients				
	Total Fe	5	90 - 900	ppm
	Mn Total	0.4	250 - 5000	ppm
	Cu Total	0.0	250 - 5000	ppm
	Zn Total	0.6	250 - 5000	ppm
	S Total	0.5	not required	%
Other elements				
	Total Ca	165.0	not required	ppm
	Mg Total	106.9	not required	ppm
	Na Total	172.7	not required	ppm

Figure 3. The leachate from the stacked bucket bioreactor is brown (A); The leachate that has been dried in the sun is dark blackish in color and has a fresh smell and can be used as POC (B)

The leachate obtained from the stacked bucket bioreactor is brown in color, after drying it is dark black in color with a fresh aroma and can be used as POC (Figure 3). The nutrient content analyzed in this study included organic C content, C/N ratio, heavy metals (Pb, Cd), macro nutrients (N, P, K), micro nutrients (Fe, Mn, Cu, Zn, S), others (Ca, Mg, Na) and pH analysis. The results of the analysis of the nutrient content of the POC BSF presented in Table 1 show that the nutrient content in the POC BSF has not met the minimum technical requirements required in the Regulation of the Minister of Agriculture Number 70/Permentan/SR.140/10/2011. According to Hardjowigeno (2003) in (Pramushinta & Yulian, 2020), the standard criteria for soil nutrient quality are N> 0.10, P> 0.035, K> 0.06, so based on this criterion the P and K macronutrient content of POC

This BSF has met the minimum nutrient standard for soil nutrient quality. The production of POC produced in this study gave POC results with lower N content, but higher P and K content than the NPK content of POC processed using EM4 bioactivator in previous studies.(Nur et al., 2018).

The nutrient content in organic fertilizers is largely determined by the starting materials used in the process of making organic fertilizers. An important criterion in organic fertilizers is the C-organic content and the C/N ratio in the fertilizer. The organic C content and C/N ratio in the BSF POC are not in accordance with the standards set by the Ministry of Agriculture. A high C/N ratio prevents the decomposition of organic matter into nutrients available to plants, a low N content slows down microflora activity that decomposes cellulose into nutrients available to plants, whereas a low C/N ratio minimizes N uptake by microbes so that N uptake by plants is higher Atkins et.al (1989) in (Kinasih et al., 2018).The degradation and decomposition of organic waste by BSF flies caused a decrease in the N content, a significant change in the N content occurred but there was no significant decrease in the carbon content. Nitrogen is an important nutrient for plants that composes amino acids, nucleic acids, proteins, chlorophyll which is a constituent of plant biomass and can stimulate the growth of stems and leaves in plants. In addition to the C/N ratio and total N content, this study also measured P and K content, which were measured in terms of total P2O5 and total K2O. Nutrient P is required in the process of photosynthesis and photosynthesis transport in plants which is absorbed in the form of H2PO4 and HPO42- ions. The P content in BSF POC is still relatively low, but another study stated that POC BSF contained P-solvent microbial groups that could increase soil P availability for plants. Although the results of laboratory analysis still do not meet the standard criteria, the POC BSF produced does not contain harmful heavy metals such as Pb and Cd, so it is safe to be applied to plants. Several previous studies stated that BSF POC had a good effect on plant growth, this was probably due to the presence of microorganisms such as phosphate solubilizing microorganisms, N fixers, and plant growth hormone producers in BSF POCs. so it is safe to apply to plants. Several previous studies stated that BSF POC had a good effect on plant growth,

this was probably due to the presence of microorganisms such as phosphate solubilizing microorganisms, N fixers, and plant growth hormone producers in BSF POCs. so it is safe to apply to plants. Several previous studies stated that BSF POC had a good effect on plant growth, this was probably due to the presence of microorganisms such as phosphate solubilizing microorganisms, N fixers, and plant growth hormone producers in BSF POCs.

Liquid Organic Fertilizer (POC) produced from BSF flies contains a number of phosphate solubilizing microorganisms which are included in four groups of microorganisms including Pseudomonas sp., Bacillus sp., Trichoderma harzianum, and Streptomyces sp. In addition, the POC also contains microorganisms that can fix N from the atmosphere and produce phytohormones(Pakpahan et al., 2020). according to(Phibunwatthanawong & Riddech, 2019)Phytohormones contained in POC BSF are auxins and cytokinins, organic acids-organic acids, as well as other plant growth-promoting substances. BSF flies are also known to produce antimicrobial peptide compounds that can inhibit pathogens (Boccazzi et al., 2017; Vogel et al., 2018 in(Jiang et al., 2019), the application of POC BSF to plants can increase plant resistance to disease.

Organic waste processing involving BSF flies has the potential to be developed in the provision of environmentally friendly organic fertilizers. POC produced and solid waste generated in waste processing with BSF can be used as compost. POC application processed using BSF flies was able to reduce the recommended dose of NPK chemical fertilizer in sugar cane by half. It takes 60 liters of POC BSF for every hectare of sugarcane that is applied to reduce the recommended dose of NPK chemical fertilizer by half(Pakpahan et al., 2020). Another study stated that the application of POC BSF side waste can increase the growth of Pakcoi plants and increase the population of phosphate solubilizing microbes and increase the activity of PME-ase enzymes in the soil around plant roots.(Agustiyani et al., 2021). according to(Martínez-Alcántara et al., 2016), the use of liquid organic fertilizer (POC) can increase the absorption of macronutrients and micronutrients in plants and also increase the content of soil organic matter. The use of organic fertilizers on plants has a positive effect on increasing the carbohydrate content (glucose, fructose, and sucrose) especially on leaves in summer. Research on pokcoi plants showed that the application of solid BSF fertilizer from coffee waste was able to increase pokcoi plant biomass, absorption of N, P and K(Kinasih et al., 2018).

The organic waste fermentation process involving Hermetia illuscens flies in addition to producing plant nutrients and phytohormones, also produces biogas which is a by-product of the fermentation process. (Czekała et al., 2020). according toCzekała et al. (2020), the anaerobic fermentation process involving the larvae of the Hermetia illuscens fly takes about 29 days. One of the biogas produced in the fermentation process is methane. The ideal BSF fermentation process is carried out at a temperature of 24-32oC according to the ideal temperature for the growth of BSF larvae. Substrates that contain lots of protein and carbohydrates are good substrates to support the growth of BSF fly larvae. Good growth of BSF larvae requires substrate humidity levels between

60-90%. In addition to fertilizer and biogas, BSF larvae contain high protein so that they can be used as a source of protein for animal feed and aquaculture.

4. CONCLUSION

Liquid organic fertilizer from household organic waste produced with the help of BSF larvae in a stacked bucket reactor contains the nutrients Nitrogen, Phosphate, Potassium, Calcium, Magnesium, Sodium, Iron, Manganese, Copper, Zinc, Sulfur, and Carbon.

ACKNOWLEDGEMENT

We would like to express our gratitude to those of you in Rimba Jaya Village who have participated in this research activity.

REFERENCES

Agustiyani, D., Agandi, R., Arinafril, Nugroho, AA, & Antonius, S. (2021). The effect of application of compost and frass from Black Soldier Fly Larvae (Hermetia illucens L.) on growth of Pakchoi (Brassica rapa L.). IOP Conference Series: Earth and Environmental Science, 762(1). https://doi.org/10.1088/1755-1315/762/1/012036

Boccazzi, IV, Ottoboni, M., Martin, E., Comandatore, F., Vallone, L., Spranghers, T., Eeckhout, M., Mereghetti, V., Pinotti, L., & Epis, S. (2017). A survey of the mycobiota associated with larvae of the black soldier fly (Hermetia illucens) reared for feed production. PLoS ONE, 12(8), 1–15. https://doi.org/10.1371/journal.pone.0182533

ičková, H., Newton, GL, Lacy, RC, & Kozánek, M. (2015). The use of fly larvae for organic waste treatment. Waste Management, 35, 68–80. https://doi.org/10.1016/j.wasman.2014.09.026

Czekała, W., Janczak, D., Cieślik, M., Mazurkiewicz, J., & Pulka, J. (2020). Food Waste Management Using the Hermetia Illucens Insect. Journal of Ecological Engineering (JEE), 21(4), 212–216. https://doi.org/https://doi.org/10.12911/22998993/119977

Deshmukh, S. (2019). Biology of black soldier fly Hermetia illucens (L .) (Diptera : Stratiomyidae) on muskmelon fruit Members Copy Not for Commercial Sale. Indian Journal Of Entomology, 81, 153–155. https://doi.org/10.5958/0974-8172.2019.00012.9

Gusti, RE, & Hamzah, A. (2021). Micro Nutrient Content and Growth of Oil Palm (Elaeis guineensis Jacq) Applied to Oil Palm Liquid Waste Using the Biopori Method. Journal of Tropical Crop Agronomy (JUATIKA), 2(2), 1–11.

Jiang, C., Jin, W., Tao, X., Zhang, Q., Zhu, J., Feng, S., Xu, X., Li, H., Wang, Z., & Zhang, Z. (2019). Black soldier fly larvae (Hermetia illucens) strengthen the metabolic function of food waste biodegradation by gut microbiome. Microbial Biotechnology, 12(41673081), 528–543. https://doi.org/10.1111/1751-7915.13393

Junaidi, Mariyono, SY (2021). Community Empowerment of Tiudan Tulungagung Village. Community Service for Teacher Training and Education, 4(1), 20–28.

Kinasih, I., Putra, RE, Permana, AD, Gusmara, FF, & Nurhadi, MY (2018). Growth Performance of Black Soldier Fly Larvae (Hermetia illucens) Fed on Some Plant Based Organic Wastes. HAYATI Journal of Biosciences, 25(2), 79–84. https://doi.org/10.4308/hjb.25.2.79

Lailiyah, FN, Dewi, TU, & Setiani, V. (2019). Characteristics of Liquid Organic Fertilizer from Household

Waste and Cow Urine. National Conference Proceedings on Waste Treatment Technology, 2623, 161–164.

Manullang, RR, Daryono and Rusmini. (2017). Physical Nature, Chemical and Microorganisms on The Combination of MOL Bioactivator. Journal of Agriment, 2(2), 5–12.

Martínez-Alcántara, B., Martínez-Cuenca, MR, Bermejo, A., Legaz, F., & Quiñones, A. (2016). Liquid organic fertilizers for sustainable agriculture: Nutrient uptake of organic versus mineral fertilizers in citrus trees. PLoS ONE, 11(10), 1–20. https://doi.org/10.1371/journal.pone.0161619

Nur, T., Noor, AR, & Elma, M. (2018). Making Liquid Organic Fertilizer From Household Organic Waste With Bioactivator EM4 (Effective Microorganisms). Convert, 5(2), 5. https://doi.org/10.20527/k.v5i2.4766

Pakpahan, A., Widowati, R., & Suryadinata, A. (2020). Black soldier fly liquid biofertilizer in Bunga mayang sugarcane plantation: From experiment to policy implications. MOJ Ecology & Environmental Sciences, 5(2), 89–98. https://doi.org/10.15406/mojes.2020.05.00180

Phibunwatthanawong, T., & Riddech, N. (2019). Liquid organic fertilizer production for growing vegetables under hydroponic conditions. International Journal of Recycling of Organic Waste in Agriculture, 8, 369–380. https://doi.org/10.1007/s40093-019-0257-7

Pramushinta, IAK, & Yulian, R. (2020). Provision of POC (Liquid Organic Fertilizer) Tempe Wastewater and Papaya Fruit Waste (Carica papaya L.) on the Growth and Productivity of Pakcoy (Brassica rapa L.) Plants The Use of Tempe Wastewater OLF (Organic Liquid Fertilizer) and Papaya Fruits Wa. Journal of Pharmacy and Science, 5(1), 29–32.

Susi, N., Surtinah, S., & Rizal, M. (2018). Testing the Nutrient Content of Liquid Organic Fertilizer (POC) Pineapple Skin Waste. Scientific Journal of Agriculture, 14(2), 46–51. https://doi.org/10.31849/jip.v14i2.261

Tuhuteru, S., Ginting, R., Mahanani, AU, & Pumoku, P. (2021). The effect of Organic Liquid Fertilizer To 5 Varieties Paddy Gogo (Oryza sativa L.) in The Sub-Optimal Land of Wamena. Journal of Tropical Crop Agronomy (JUATIKA), 3(2), 169–179. https://doi.org/https://doi.org/10.36378/juatika.v%.vi%i.1368

Widyabudiningsih, D., Troskialina, L., Fauziah, S., Shalihatunnisa, S., Riniati, R., Siti Djenar, N., Hulupi, M., Indrawati, L., Fauzan, A., & Abdilah, F .(2021). Making and Testing Liquid Organic Fertilizer from Fruit Peel Waste with the Addition of EM4 Bioactivator and Variation of Fermentation Time. IJCA (Indonesian Journal of Chemical Analysis), 4(1), 30–39. https://doi.org/10.20885/ijca.vol4.iss1.art4

Yuwono, NW 2019. Stacked Bucket Innovation for Household Organic Waste Management. In 73 Appropriate Technologies. Andy Publisher. 63-73