AL-KAUNIYAH: Jurnal Biologi, 15(1), 2022, 62-73
Website: http://journal.uinjkt.ac.id/index.php/kauniyah
P-ISSN: 1978-3736, E-ISSN: 2502-6720

THE UTILIZATION OF FALLEN FRUITS AS RAW MATERIALS FOR PRODUCING LIQUID ORGANIC FERTILIZER IN BOGOR BOTANIC GARDENS

PEMANFAATAN LIMBAH BUAH-BUAHAN SEBAGAI BAHAN BAKU PEMBUATAN PUPUK ORGANIK CAIR DI KEBUN RAYA BOGOR

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Naskah Diterima: 9 Agustus 2020; Direvisi: 19 Maret 2021; Disetujui: 19 Desember 2021

Abstract

Bogor Botanic Garden is an area designated to conserve and protect many species of plants from Indonesia and other countries as well. Most plant collections belonged to plants that continuously producing fruits. Many of fallen fruits produced by different plant species still remained optimally unmanaged and unutilized. The objective of this study was to increase the value of fallen fruits by utilizing it as raw materials for producing organic liquid fertilizer (POC). The first step of this study was conducted by collecting data about the species of fruiting plants. Liquid organic fertilizer was produced using a semi-anaerobic fermentation system with adding an effective microorganism 4 (EM 4). The results showed that there were 19 trees from 15 species such as *Parmentiera cereifera*, *Ficus racemosa*, *F. fistulosa*, and *Dillenia indica*. The fertilizers are made with a variety of supporting materials to produce liquid organic fertilizer (type A) and liquid organic fertilizer (type B). The temperature and pH had the similar value pattern during the fermentation process. Liquid organic fertilizer (type B) has a C/N ratio of 37.65, higher than liquid organic fertilizer (type A) which is 27.23. In addition, the C-organic liquid organic fertilizers (type B) was higher than liquid organic fertilizers (type A). The C-organic and N, P, and K contents have not reached the minimum technical standard for organic fertilizers that regulated on Decree of the Minister of Agriculture Number 261/KPTS/SR.310/M/4/2019. Eventually, the optimization attempts to increase the C-organic and N, P, and K contents on liquid organic fertilizer will be subsequently required.

Kata kunci*:* Bogor Botanic Gardens; Fallen fruits; Liquid organic fertilizer; Non-edible

Abstrak

Kebun Raya Bogor merupakan kawasan konservasi tumbuhan yang memiliki koleksi berbagai macam jenis tumbuhan yang berasal dari Indonesia maupun dari luar negeri. Sebagian besar tumbuhan merupakan tumbuhan yang menghasilkan buah setiap tahunnya. Selama ini buah dalam jumlah banyak yang jatuh dari pohonnya belum termanfaatkan secara optimal. Tujuan dari penelitian ini adalah untuk meningkatkan nilai tambah limbah buah tersebut sebagai bahan dasar untuk pembuatan pupuk organik cair (POC). Studi awal dilakukan pendataan jenis tumbuhan yang berpotensi menghasilkan buah non-edible. Pembuatan POC dilakukan dengan sistem fermentasi semi-anaerobik menggunakan aktivator Effective Microorganism 4 (EM4). Hasil penelitian menunjukkan terdapat 19 pohon dari 15 jenis tumbuhan di antaranya Parmentiera cereifera, Ficus racemosa, F. fistulosa, dan Dillenia indica. Pupuk organik cair dibuat dengan variasi bahan pendukung yang berbeda menghasilkan POC A dan POC B. Pola perubahan suhu dan pH pada saat proses fermentasi relatif sama untuk kedua jenis POC. POC B memiliki rasio C/N sebesar 37,65 lebih tinggi dibandingkan dengan POC A yang hanya sebesar 27,23. Selain itu, konsentrasi Corganik POC B yang lebih tinggi daripada POC A. Nilai C-organik dan N, P, K diketahui belum mencapai standar teknis minimal pupuk organik berdasarkan SK Menteri Pertanian Nomor 261/KPTS/SR.310/M/4/2019 sehingga diperlukan optimalisasi fermentasi lebih lanjut.

Keywords*: Kebun Raya Bogor; Limbah buah; Non-edible; POC*

Permalink/DOI: http://dx.doi.org/10.15408/kauniyah.v15i1.16871

INTRODUCTION

Bogor Botanical Garden is a Plant Conservation Study Center located in the center of Bogor City with an area of more than 87 ha. The Bogor Botanical Garden (KRB) has a collection of more than 15 thousand species of living plants from all over Indonesia (Ariati et al., 2019). More than 100 types of plants that live in the garden can produce fruit, both edible and non-edible. There are many types of plants from the KRB collection that bear fruit every year. These fruits become waste in the garden and smell bad when they rot. Fruit waste that is rotten and mixed with other waste can produce large amounts of leachate (Marjenah et al., 2017). Fruit waste that has not been used optimally in the Bogor Botanical Garden has the potential to be processed as liquid organic fertilizer or eco-enzyme. The fruits that become waste a lot in the Bogor Botanical Garden are nonedible fruits from a collection of rare plants whose potential study and utilization are not yet known.

Liquid organic fertilizer (POC) is known to be rich in nutrients needed by plants. Liquid organic fertilizer is easier to use, the manufacturing process is relatively simple, and the cost is not too large (Hadisuwito, 2012). POC production can be carried out under aerobic or anaerobic conditions (Jamilah, 2014). In general, the processes and stages that occur in the manufacture of POCs are the conversion of organic materials into simpler materials through chopping, the use of microbial activity, as well as the help of decomposers and activators (Bouallagui et al., 2005; Peng et al., 2019; Suwardiyono et al., 2019). Liquid organic fertilizer has many benefits for plant growth because it contains plant hormones and enzymes that are useful as catalysts for plant growth metabolism. Liquid organic fertilizer also plays a role in providing nutrients needed by plants, reducing organic waste that can pollute the environment, reducing dependence on the use of chemical fertilizers. The activity of converting organic waste, especially fruits into liquid organic fertilizer, greatly affects the nutrient cycle in the soil. Organic fertilizers have three advantages, among others, can improve the physical, chemical, and biological properties of the soil, contain most of the essential nutrients needed by plants, and reduce dependence on synthetic fertilizers. The use of organic fertilizers can increase the availability of nutrients for plants. The manufacture of POC from fruit waste is similar to the manufacture of eco enzymes which can also be produced from the conversion of organic wastes such as vegetables and fruits that are fermented with sugar and water (Rochyani et al., 2020). Eco enzymes can be used as plant fertilizers, biopesticides, allpurpose cleaners, and are able to overcome environmental pollution (Megah et al., 2018). Eco enzymes can be produced from the fermentation of fruit waste such as pineapple and papaya (Rochyani et al., 2020). Several studies have revealed that the nutrient content produced in POC is more and more easily absorbed by plants because the manufacturing process is added by decomposer microbes and also enrichment of raw materials rich in nutrients (Tanti et al., 2019; Jumirah et al., 2018).

Liquid organic fertilizer can be used as a solution in the maintenance of collection plants in the Bogor Botanical Garden. The manufacture of POC is environmentally friendly because it does not use chemicals and has a good residual effect for plant growth. Organic materials that can be used as raw materials for making liquid organic fertilizer are fruit waste, whether edible or not, and other organic materials rich in nutrients as a source of carbohydrates, protein, and nitrogen such as coconut water, potatoes, bananas, nuts, gingers, and coconut fibers (Tanti et al., 2019; Jumirah et al., 2018; Lestari & Murkalina, 2017). Each of these organic wastes has different nutritional characteristics.

Fruit waste is known to have important nutrients for plants so that it can be developed as liquid organic fertilizer. Sources of POC that have been circulating in the market or made by the community today mostly come from organic materials that are widely known and whose presence is found in many around the environment, for example vegetable waste (spinach, kale), forage waste (gamal leaves, pandan leaves, grass), and fruit waste (watermelon, orange peel, papaya, banana peel) (Meriatna et al., 2018; Kasmawan et al., 2018). In this study, POC was made using plant fruit waste that was not widely known and had not even been cultivated by the community, but the plant was able to produce very dense and inedible fruit (non-edible). This is due to the carrying capacity of the Bogor Botanical Garden, which has a collection of plants from nature throughout Indonesia and has not yet been explored for its usefulness. Therefore, it is important to conduct this study to reveal the potential and new value of Indonesia's natural flora to be processed and developed into POC with high use and economic value.

Utilization of fruit waste as an alternative fertilizer for chemical fertilizers is very suitable to be developed in the Bogor Botanical Garden because of its abundant availability. In addition to abundant raw materials, its economic value is also relatively high because it does not require large costs. Proper handling to utilize fruit waste to become more valuable is urgently needed. This is of course a homework for the entire community at the Bogor Botanical Garden at this time. Therefore, the purpose of this study is an initial study to initiate the utilization of fruit waste by producing liquid organic fertilizer and to determine the feasibility of producing liquid organic fertilizer. The study activity was carried out by collecting data on plants that were bearing fruit in the garden and making liquid organic fertilizer from selected fruit waste and testing for nutrient content. The feasibility standard of liquid organic fertilizer is compared with the minimum technical requirements of organic fertilizer, biological fertilizer, and soil repairer from the Decree of the Minister of Agriculture Number 261/KPTS/SR.310/M/4/2019 as a derivative of the Regulation of the Minister of Agriculture Number 1 of 2019 which was recently ratified.

MATERIALS AND METHODS

Stages of Study Implementation

The study was divided into three stages, namely collecting data on plants that produce fruit, the process of making liquid organic fertilizer, and testing the character of liquid organic fertilizer.

Collecting Data of Plants that Produce Fruit

The initial stage in this study is collecting data on raw fruit materials from plant collections in the Bogor Botanical Garden. Determination of the sample of fruit-producing plants was carried out using a direct survey method in the entire collection of the Bogor Botanical Garden with a collection registration catalog book guide. The survey activity was carried out during October 2018 to determine the type and number of plants that are bearing fruit. When encountering plants that are bearing heavy fruit, data collection is carried out on the names of plant species, families, location coordinates, fruit potential, maturity level, and fruit weighing.

The selection of samples was determined by the following criteria: trees were bearing heavy fruit, non-edible, and had fallen to the ground. Dropped fruit is an indicator of maximally ripe fruit and technically makes it easier to collect samples. Checks and observations were carried out by surveying all locations of the Bogor Botanical Garden which have a collection of fruiting plants. Furthermore, complete data collection of the above criteria is carried out. All samples of fruit were put into sacks and weighed to determine the potential for production of these plants in producing fruit in the Bogor Botanical Garden. Based on the direct survey results, as many as 9 types of plants that are bearing fruit and are used as raw materials for the manufacture of this liquid organic fertilizer, namely *Corynocarpus cribbianus*, *Dillenia indica*, *Ficus racemosa*, *Flacourtia jangomas*, *Garcinia celebica*, *Garcinia latissima*, *Gmelina arborea*, *Parmentiera cereifera*, and *Swinglea glutinosa*. This initial stage is the basis for the selection of materials in the manufacture of POC based on the availability of fruit in the Bogor Botanical Garden.

The Process of Making Liquid Organic Fertilizer

The manufacture of liquid organic fertilizer from fruit waste includes several stages, including 1) chopping and crushing mixed fruit so that all waste materials become homogeneous; 2) separation of waste liquid with its dregs so as to produce brown water which is known to contain nutrients, enzymes and plant hormones; and 3) fermentation of fruit waste liquid. Enumeration and destruction of all 44 kg of fruit samples was carried out using an organic waste chopper machine so that everything was evenly mixed. The crushed fruit waste is put into the prepared drum.

The fruit waste is squeezed and the liquid is separated with the pulp. Treatment variations were made by adding other supporting materials with the same volume. POC A contains fruit waste liquid plus 1 L of coconut water, 1 kg of potatoes, 1 kg of eggs, 1 kg of vegetables, 1 kg of ginger, and 1 kg of sugar. POC B contains fruit waste liquid plus 1 L of coconut water, 1 kg of coconut fiber, 1 kg of banana hump, 1 kg of peanuts, 1 kg of bananas, and 1 kg of sugar. All ingredients are mixed in a drum and diluted with water to a volume of 50 L. The determination of the variation in the composition of the ingredients in each fermentation substrate refers to the three essential nutrients needed by plants, namely nitrogen (coconut water, vegetables, and sugar), phosphorus (banana hump, banana, egg), and potassium (ginger, potato, peanut, and coconut fiber) (Jumirah et al., 2018; Lestari & Murkalina, 2017; Jamilah, 2014; Kusriyanto et al., 2019). In addition, this combination of raw materials is used to help speed up the decomposition process of organic waste. These organic materials are the preferred medium for microorganisms to grow, live, and develop (Marlinda, 2015; Komala et al., 2012). The enrichment of these raw materials can be a source of energy for microbes in the process of overhauling organic waste into stable products through the fermentation stage.

The manufacture of POC is enriched with microbial starter so that the source of nutrients for the growth of decomposer microorganisms must be available properly (Jalaluddin et al., 2016; Meriatna et al., 2018). The fermentation process is carried out with a semi-anaerobic process for 24 days with the help of 10% effective microorganism 4 (EM4) activator per drum (Ramadhan et al., 2019). At the beginning before fermentation, measurements of pH, temperature, and observations of the color of the substrate were carried out. The initial measured pH was 3.9 for both types of POC. Measured starting temperature is 25 °C (POC A) and 24 °C (POC B). Color change was observed at the beginning and end of fermentation.

Product Result Testing (Laboratory Test)

At this stage the organic liquid fertilizer produced is tested for its nutrient content. The chemical analysis of the POC tested consisted of pH, C-organic (Walkey & Black), nitrogen (Kjehdahl), C/N ratio of bases, namely P_2O_5, K_2O, Fe and micro namely Cu, Zn, Mn, Na by using wet ashing method HNO_3:$HClO_4$ and analysis of the number of phosphate solubilizing bacteria and *Azotobacter* bacteria using the Total Plate Count (TPC) method. The results of the measurement of the concentration parameters of the C/N, C-organic, N, P, K ratios on the 24th day were compared with the standard liquid organic fertilizer which has been regulated in the Decree of the Minister of Agriculture Number 261/KPTS/SR.310/M/4/2019 on Minimum Technical Requirements for Organic Fertilizer, Biological Fertilizer, and Soil Improvement.

RESULTS

The results of the plant data collection showed that as many as 19 individual trees from 15 types of plants were bearing fruit at the time of data collection (Figure 1). As for the 19 trees, 10 of them are garden collections and 9 are non-collection. Garden collections are plants whose origins are clear while non-collections are plants that spontaneously grow in the garden. The potential for fruit production of all fruiting trees is shown in Table 1.

Table 1. Types of plants and volume of fruit produced

Plant type	Location	Collection/ non collection	Fruit weight (Kg)
Artocarpus heterophyllus	Kawasan pintu 3	Non collection	12
Averrhoa carambola	Vak. XV.J.B	Collection	40
	Kawasan kantor wilayah	Non collection	30
Baccaurea macrocarpa	VIII. F. 84	Collection	1
Dillenia indica	Taman akuatik II.Q	Collection	200
Diospyros discolor	Kawasan kantor herbarium	Non collection	5
Ficus fistulosa	Vak V.F	Collection	110
F. racemosa	Dekat gedung 9	Non collection	55
	Kawasan meksiko	Non collection	120
*Garcinia latissim*a	VI.C.338	Collection	23

Plant type	Location	Collection/ non collection	Fruit weight (Kg)
Morinda citrifolia,	Taman akuatik II. Q	Collection	18
Parmentiera cereifera	Taman Meksiko	Collection	100
	Vak. VVI. B X.6	Collection	10
	Kawasan taman *Araceae*	Non collection	30
Psidium friedrichsthalianum	V.A. 184A	Collection	10
Sapotaceae	IV.D.170	Collection	5
Swinglea glutinosa	Vak. XXIV. B. X. 6	Collection	30
Syzygium	Kawasan taman meksiko	Non collection	22
Syzygium cumini	Kawasan koleksi *Myrtaceae*	Non collection	5

The fruit waste that has been collected is then chopped and crushed. The chopped results are then squeezed to produce 20 L of fruit juice. The addition of different supporting materials adds to the variety of liquid organic fertilizer products produced.

Figure 1. Examples of types of fruit that become waste in the Bogor Botanical Garden, *Parmentiera cereifera* (a) and *Ficus racemosa* (b)

In this study, the leachate at the beginning of the fermentation was gray to beige in POC B. It is suspected that there was a supporting material in POC B which was decomposed by EM4 microorganisms resulting in a lighter color (Figure 2).

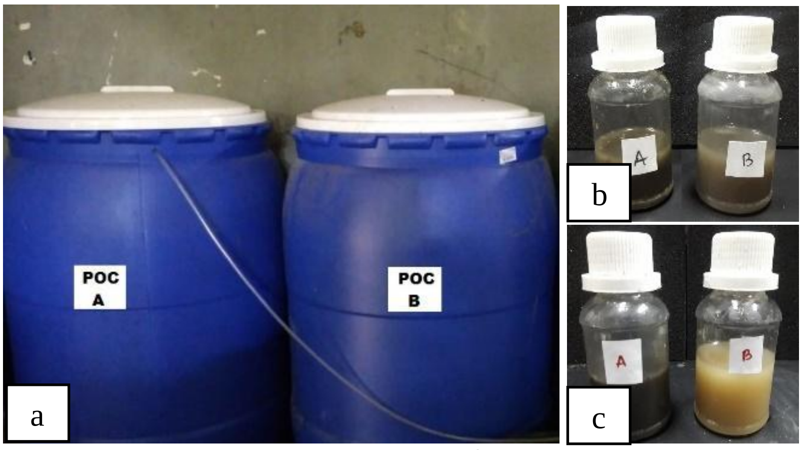

Figure 2. The leachate during the study, namely the fermentation process with a semi-anaerobic system (a), sample liquid before fermentation (b), and after fermentation (c)

The results of temperature and pH measurements during the fermentation process are shown in Figure 3. The POC temperature began to increase 4 days after fermentation for both types of fertilizers made. The highest temperature for POC A was reached on the 6th day after fermentation, while the highest temperature for POC B was reached on the 4th day. The highest temperature measured during the fermentation process is 29 °C.

pH measurement results showed no difference during the fermentation process. At the beginning of the fermentation the pH value for POC A and POC B was 3.9 while at the end of the fermentation process the pH value for POC A was 3.6 and POC B was 3.7. An interesting thing happened on the second day where the pH decreased when the fermentation temperature increased which was thought to have occurred because microorganisms began to be active to change the substrate of the fruit waste liquid into a more acidic material. The decomposition of organic matter into organic acids occurs during the fermentation process (Jamilah, 2014). When compared with the quality standards of organic fertilizers set by the Ministry of Agriculture No. 1 of 2019 and the minimum technical requirements of the Decree of Minister of Agriculture No. 261/KPTS/SR.310/ M/4/2019, the pH value of the two types of POC is still below the standard quality figure set, namely 4–9.

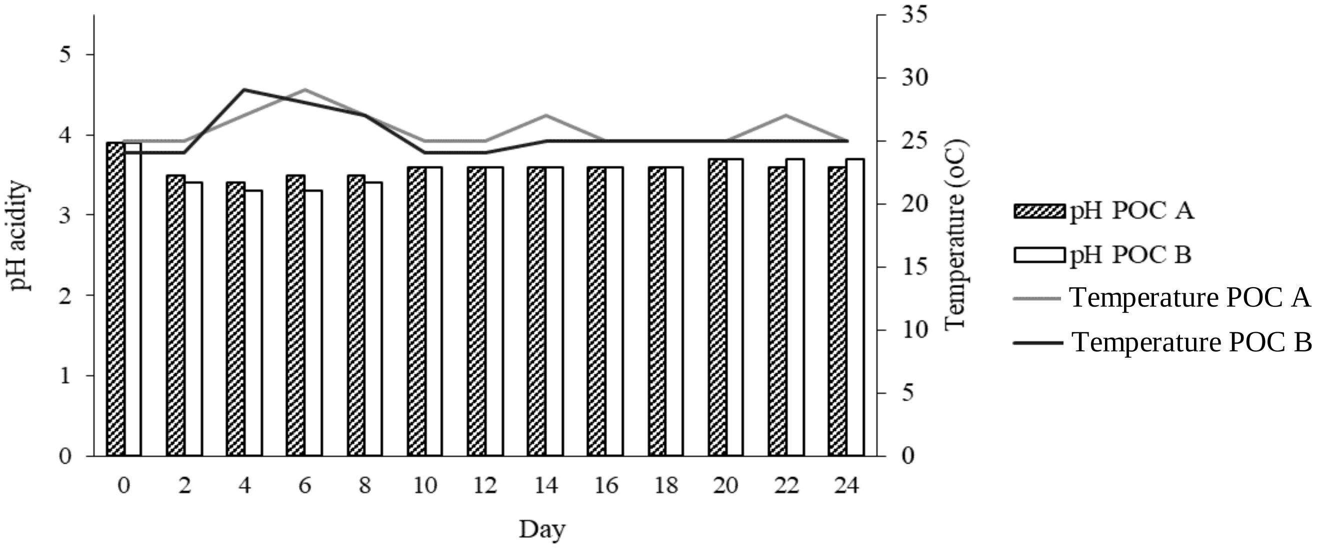

Figure 3. Graph of measuring pH and temperature of liquid organic fertilizer during the fermentation process

Concentration of Organic C, N, P, and K in Liquid Organic Fertilizer Products

The concentration values of C-organic, N, P, and K contained in liquid organic fertilizer with variations A and B are shown in Table 2. The results of the calculation of the C/N ratio show that liquid organic fertilizer B (POC B) is higher, which is 37.65 compared to liquid organic fertilizer A (POC A) which was only 27.23. This is comparable to the value of the C-organic content of POC B, which is 8.66% higher than POC A, which is 6.40%. The nitrogen content for the two POCs was relatively the same, namely 0.24% and 0.23%, but the C-organic and N values in the two POCs made had not reached the minimum technical requirements standard from the Decree of the Minister of Agriculture No. 261/KPTS/SR.310/M /4/2019. This is presumably due to the inefficient process of making POC and the raw materials used are fruits whose nutritional content is relatively unknown. However, Nur (2016) stated that unutilized fruit has the potential to be developed as liquid organic fertilizer because the fruit waste itself contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), iron (Fe), sodium (Na), magnesium (Mg), and so on. POC quality from fruit waste to meet quality standards can be done in combination with organic raw materials that are rich in nutrients (Tanti et al., 2019). In contrast to other types of organic materials such as rabbit, goat, and cow urine which are commonly used as a source of raw material for making liquid organic fertilizers because they have a fairly high nitrogen content (Simorangkir et al., 2017; Sitorus et al., 2015; Alvi et al. 2018).

Table 2. Comparison of nutrient content of POC A and B with 2019 quality standards

Sample code	Ratio C/N	C-organic (%)	N (%)	P (%)	K (%)
POC A	26.67	6.40	0.24	0.03	0.13
POC B	37.65	8.66	0.23	0.10	0.15
Minimum technical requirements *	-	Minimum 10	2–6	2–6	2–6

* Referring to the Decree of the Minister of Agriculture Number 261/KPTS/SR.310/M/4/2019

Liquid organic fertilizer that has been successfully made is then packaged in a plastic container. Each pack has a volume of one liter and is labeled and branded to make it more attractive (Figure 4).

Figure 4. Liquid organic fertilizer products produced

DISCUSSION

Bogor Botanical Garden has collection and non-collection plants that have the potential to produce fruit every year. Based on the results of data collection that was carried out in October 2018, more than 10 types of trees were bearing heavy fruit and some of them even produced fruit up to hundreds of kilograms such as *Parmentiera cereifera*, *Ficus racemosa*, *F. fistulosa*, and *Dillenia indica*. The fruit falls on the ground and is mixed with other waste into waste which will gradually cause environmental pollution in the botanical garden if not handled properly. The number of fruits that fall in large enough quantities has not been utilized optimally and has great potential when used as raw material for the manufacture of liquid organic fertilizer. Therefore, it is planned that data collection will continue to be carried out every month to determine the potential for fruit produced for 1 year from fruit trees collected from the Bogor Botanical Garden. This is done to determine the availability of raw material for fruit waste so as to support the production of organic fertilizers, especially liquid organic fertilizers by utilizing the leachate of the fruit waste.

Fruit waste has the potential to be used as fertilizer because it has a total solid content of 8–18%, high water content, and relatively low pH. About 87% of the total solid material contains organic matter including sugar, hemicellulose, cellulose, lignin, N, P, K, and other nutrients (Bouallagui et al., 2005; Peng et al., 2019). In addition, fruit waste also contains 1–15% crude protein and 5–38% crude fiber (Jalaluddin et al., 2016).

Rotten fruit waste can produce large amounts of leachate (Marjenah et al., 2017). Leachate is a liquid that comes out of a pile of garbage and can cause environmental pollution (Sari & Afdal, 2017). Leachate contains nutrients that plants need, while the pulp from fruit waste can be used as a plant growth medium in the form of compost (Hartatik et al., 2015; Marjenah et al., 2017). Previous study revealed that liquid organic fertilizer derived from leachate can accelerate plant height growth and increase the number of celery leaves (Puspita et al., 2016). In this study, 20 L of leachate or fruit juice was produced from 88 kg of fruit waste.

The decomposition process of organic fruit waste is a key success factor in the manufacture of liquid organic fertilizer, so that in its manufacture a decomposer is added which contains important microbes in overhauling organic materials such as cellulose, hemicellulose, and lignin (Suwardiyono et al., 2019; Peng et al., 2019). The manufacture of organic fertilizers with the help of microorganisms will break down complex organic matter from the basic ingredients of fruit into simpler components through the fermentation process. In this study, the source of microbes used came from Effective Microorganisms (EM4). Fermentation was carried out under semi-anaerobic conditions with the addition of an aerator to aerate the closed drum. EM4 is a mixture of beneficial microorganisms. The number of fermenting microorganisms in EM 4 is about 80 genera including the main microorganisms in the manufacture of organic fertilizers such as *Lactobacillus* sp., *Streptomyces* sp., yeast, and *Actinomycetes* (Thoyib et al., 2016). The selected microorganisms work effectively in fermenting organic matter. According to Sundari et al. (2012), the use of EM4 can accelerate the fermentation process for the manufacture of liquid fertilizer. In addition, EM4 will accelerate the fermentation of organic matter so that the nutrients contained will be absorbed and available to plants (Marlinda, 2015). Previous study stated that the more volume of EM4 added, the faster the fermentation process and the reshuffling of raw materials into elements that are easily absorbed by plants in the form of N, P, and K will be completed. The increase in microbial inoculum in EM4 can optimize the availability of nutrients obtained because organic raw materials are completely decomposed due to the greater number of working microbes (Sundari et al., 2012; Jalaluddin et al., 2016; Suwardiyono et al., 2019; Peng et al. 2019).

Semi-anaerobic fermentation requires optimal conditions, namely low pH (3–4), high salt and sugar content, moderate water content of 30–40%, and ambient temperature around 40–50 °C (Marlinda, 2015; Nur et al., 2016). Temperature is very influential on the fermentation process because it is related to the types of microorganisms involved. According to Jalaluddin et al. (2016), the optimum temperature for fermentation is 40–60 °C. If the temperature is too high, the microorganism will die, while at the temperature too low, the microorganism cannot work or is in a dormant state.

The application of EM4 in the reform of fruit waste has unique properties, namely it can neutralize organic matter or soil that is acidic or alkaline (Siswati et al., 2009). Acidity can affect the activity of microorganisms that degrade organic matter. A good pH range is around 6.5–7.5 (Jalaluddin et al., 2016). Microorganisms used in EM4 play a role in converting organic matter into other materials that are more acidic so that the pH value will tend to decrease at the beginning of fermentation (Jalaluddin et al., 2016; Meriatna et al., 2018). The content of microorganisms in EM4 consists of photosynthetic bacteria, *Lactobacillus*, *Streptomyces*, and lactic acid bacteria, yeast, *Actinomycetes* and yeast fungi (Widari et al., 2020). According to Saraswati and Praptana (2017), the decomposition process of organic matter in nature is not carried out by one monoculture microorganism but is carried out by a consortium of microorganisms. Microbes capable of breaking down compounds in fruit liquid waste into simpler and more stable forms include *Bacillus cereus*, *B. subtilis*, *Acetobacte*r sp., *Lactobacillus* sp., and *Pseudomonas* sp. (Komala et al., 2012). Microorganisms (fungi, yeast, and *Actinomycetes*) will change the organic acids that have been formed so that the acidity of the fertilizer is close to neutral (Hadisuwito, 2012; Hartatik et al., 2015). In addition, the process of adding natural water resulting from the reshuffle of organic raw materials during the fermentation cooling stage reduces the acidity of the formed fertilizer (Saraswati & Praptana, 2017). At the end of fermentation, the pH stabilization process continues and the formation of humic material is perfected as a stable final product that dominates the content of organic fertilizers. This humic material can increase the ability of the soil to bind and exchange cations in it so that it is easily absorbed by plants (Jindo et al., 2011; Shaila et al., 2019).

One of the supporting materials used in this study is coconut water. Carbohydrates in the composition of coconut water consist of sucrose, glucose, fructose, inositol, sorbitol, and others (Kusriyanto et al., 2019). The application of sugar or materials containing high sugar content such as coconut water can reduce the pH of the substrate to become more acidic during the fermentation process (Jamilah, 2014; Kusriyanto et al., 2019). The pH value from the 10^{th} day to the last day of fermentation experienced a constant phase. It is suspected that the organic matter converted by microorganisms into organic acids has been completely decomposed. This phase is also greatly influenced by the reduced nutrient content and constant environmental conditions both temperature and humidity (Marlinda, 2015; Meriatna et al., 2018).

The potential of fruit waste has been widely studied in the process of making liquid organic fertilizer. Each component of organic matter from fruit waste has different characteristics, especially its nutrient content. Nutrient levels in fruit waste are still relatively low compared to other raw materials such as livestock urine which has a high nutrient content (Kusriyanto et al., 2019). Thus, in the process of making liquid organic fertilizer, it is necessary to enrich other materials (enrichment) to achieve the specified quality standards, these enrichment materials are known for their benefits and high nutrient content so that they can improve the quality of the resulting liquid organic fertilizer (Ratrinia et al., 2014). The enrichment materials in the manufacture of liquid fertilizer were chosen because they have their respective advantages, especially the nutritional content and their effect on the development of beneficial microbes and decomposers in liquid organic fertilizers. Sources of energy for microbial growth are obtained from materials such as sugar, vegetables, potatoes, and eggs (Tanti et al., 2019). In addition, spices such as ginger and legumes such as peanuts or green beans are rich in nitrogen and other nutrients (Jumirah et al., 2018; Lestari & Murkalina, 2017). The combination of these additives needs to be processed in a good way in order to produce a quality liquid organic fertilizer. Based on the tests that have been carried out on POC A and B, the C/N ratio values were 26.67 and 37.65, respectively. The value of the C/N ratio in POC is still quite high, especially in POC B, which is 37.65, this is influenced by the incomplete decomposition process. The composition of POC B ingredients uses coconut fiber as a supporting material, as it is known that the structure of coconut fiber has a high enough lignin content so that it is difficult to decompose in a fast time. Thus, the addition of coconut fiber as raw material for POC B greatly affects the value of the C/N ratio. POC A has a relatively lower C/N ratio, which is 26.67 because it is composed of relatively easily decomposed ingredients such as vegetables, potatoes, and eggs. The value of the C/N ratio in organic fertilizers that can be properly absorbed by plants is below 20. To reduce the value of the C/N ratio, it can be done by increasing the fermentation time and providing additional carbon sources (sugar) to activate the microbial decomposers so that they can decompose properly.

In this study, the results of the analysis of the nutrient content were still below the standard of the regulation of the Minister of Agriculture Number 261 of 2019 concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvements. This is presumably because the stages and processes of making liquid organic fertilizer have not been carried out optimally. In addition, further studies are needed in the selection of the main raw materials and better supports. Although several studies have shown that the C/N ratio content is quite high in fruit waste, the supporting materials with known potential elements of N, P, K are an important factor to increase the nutrients in the final result of liquid organic fertilizer produced (Jalaluddin et al., 2016; Ramadhan et al., 2019).

The use of banana waste in combination with the addition of 50 mL of EM4 can produce organic liquid fertilizer with N, P, and K content that meets quality standards based on Minister of Agriculture Regulation Number 261 of 2019, although the condition of C-organic is still below quality standards (Putra & Ratnawati, 2019). One way that can be done in further study to increase C-organic, N, P, and K elements, is by characterizing fruit waste produced by the Bogor Botanical Garden based on the composition of C-organic, N, P, and K content and combining mixing fruit waste. Seeing the large number of fruits from various types of plants, it is possible to obtain fruit combinations that can produce C, N, P, and K values that meet quality standards. In addition, it is necessary to carry out an optimization process with a combination of adding volume of EM4 or other microorganisms that can assist in the fermentation process, and the length of the fermentation process also needs to be considered because it determines the decomposition process of organic compounds in fruit into important elements in the manufacture of organic liquid fertilizer. The ratio of C/N content is very important in maintaining or improving soil fertility so that it can be used as a parameter in assessing soil fertility. Fertile soil has a C/N content ratio ranging from 1 to 2 (Purnomo et al., 2017). Several studies have shown that lamtoro leaves from the *Fabaceae* family added to the manufacture of POC can increase the levels of N, P and K (Ratrinia et al., 2014). Banana weevil contains relatively high nitrogen, potassium, and phosphorus nutrients so it is suitable for use as an additional material for liquid organic fertilizer (Manullang et al., 2018). Meanwhile, the fermented liquid fertilizer from *jengkol* fruit can produce high phosphorus fertilizer (Reinnoki et al., 2012). Liquid organic fertilizer that has been successfully made must meet the quality standards set. This is because these quality standards represent all the elements in the soil and are needed by plants.

CONCLUSIONS AND SUGGESTIONS

The data collection of plants that have the potential to produce abundant fruit has been successfully carried out. Some plants produce fruit up to hundreds of kilograms and have the potential to be used as raw materials for making sustainable liquid organic fertilizers. Liquid organic fertilizer that has been successfully made still requires further optimization because the results of the analysis of its nutrient content are still below the minimum POC standard based on the Regulation of the Minister of Agriculture Number 261 of 2019. Efforts to utilize and increase the added value of fruit waste have been successfully carried out by making liquid organic fertilizer at the Bogor Botanical Garden.

ACKNOWLEDGEMENT

The author thanks to Mr. Dedi Damhuri and the entire staffs of the Bogor Botanical Garden compost unit and Mr. Saripudin, Mrs. Mimin, and Akbar Nugroho who have helped during this study. This study was funded by *In House Research* Program Number 3790/IPH.3.KP/III/2019 Research Center for Plant Conservation and Botanical Garden, Indonesian Institute of Sciences.

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