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Quality of an ecoenzyme and potential of its residues as composting bioactivator

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Abstract. *Ecoenzyme is a complex organic solution that can be used as an alternative for environmental management. In this study, six ecoenzym were made by fermenting water spinach, chinese cabbage, mango, and papaya at different mixture composition, designated as ECO1 to ECO6, with the addition of palm sugar or granulated sugar and water in plastic bottles of 1,500 mL for 3 months. The ecoenzyme solution was analyzed for aroma quality, color, pH, volume, and alcohol content. The ecoenzyme residues (BRE), effective microorganisms (BEM), and without bioactivator (TBP) were tested for the ability to decompose organic waste aerobically in plastic buckets. All treatments produced an ecoenzyme solution with a strong acid aroma, light brown to reddish brown, pH ranging from 3.1 to 3.4, volume ranging from 740 to 780 mL, and alcohol ranging from 4.1 to 4.8%. The residual ecoenzymes (BRE), effective microorganisms (BEM), and without bioactivator (TBP) can decompose organic waste with the results of pH, temperature, humidity, total N, P_2O_5, and K_2O that meet the Indonesian national standard (SNI) for composting. The composting pH value ranges from 6.4 to 7.5, temperature ranges from 27 to 36 °C, humidity ranges from 66 to 81%, total N ranging from 0.68 to 0.80%, P_2O_5 ranges from 0.49 to 0.54%, and K_2O ranging from 0.75 to 0.90%. This study concludes that using mango, papaya waste, and palm sugar produces an ecoenzyme solution with the highest alcohol content and potential of ecoenzyme residues as composting bioactivator.*

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INTRODUCTION

During the Covid-19 pandemic, all activities were carried out from home and caused the volume of household waste to increase. Then the community is advised to increase the consumption of fruits and vegetables to improve the body's immunity which ultimately increases the waste of fruit and vegetables (Sharma et al. 2020). Increased community activities have the potential to cause an increasing volume of waste. Human activities will not be separated from the presence of organic and inorganic waste (Megah et al. 2018). According to Juniartini (2020), Indonesia is the second largest waste contributor in Asia with a volume of 187.2 million tons/year, after, China with 262.9 million tons/year, followed by the Philippines, Vietnam, and Sri Lanka. Mahyudin (2017) stated that, waste management in Indonesia is an actual problem along with the increasing population growth, which impacts the increasing amount of waste produced.

According to Prabekti (2020) and Septiani et al. (2021), waste management in Indonesia still uses the end-of-pipe approach, in which waste is collected, transported, and disposed of in a landfill. The paradigm of waste management that uses such a final approach must be replaced. The new paradigm views waste as a resource that has economic value and can be used as a source of energy, ecoenzyme, compost, fertilizer, or industrial raw materials.

One way to treat organic waste is to convert it into ecoenzymes. Ecoenzyme is a solution of complex organic substances produced from vegetable and fruit waste fermentation, plus sugar and water. This ecoenzyme solution is brown and has a strong acidic aroma (Hemalatha and Visantini 2020). The principle of the process of making ecoenzyme is similar to composting. Still, water is added as a growth medium, so the final product obtained is a preferred solution because it is easier to use. Making ecoenzyme does not require a large area and a composter tub; only plastic bottles are needed. Bottles of mineral water or other products can be used for fermentation. Ecoenzyme has many benefits, such as being used as a plant growth activator, a mixture of floor cleaning detergents, and for cleaning pesticide residues, descaling, and reducing car radiator temperatures (Bernadin et al. 2017; Rohyani et al. 2020).

The process of organic waste fermentation does not only produce an ecoenzyme solution but solid residues. Ecoenzyme residues can be used as organic fertilizers and composting bioactivators because they contain nutrients and microbes. According to Utama et al. (2013), various kinds of decomposer microbes in nature can be used as composting bioactivators. This microbe type is often called a local microorganism (MOL), which can be cultured using various sources of organic matter. Vegetable waste can be a good medium for the proliferation of decomposing microbes and can be used as a bioactivator in composting. Almost all vegetables will undergo lactic acid fermentation, usually carried out by various types of bacteria *Streptococcus, Leuconostoc, Lactobacillus*, and *Pediococcus* (Utama et al. 2013). Since the problem of organic waste is increasing and polluting the environment, this study was carried out to utilize organic waste to produce ecoenzyme and analyze the quality of the ecoenzyme solution and the potential use of its residue as a composting bioactivator.

METHODS

Location, Time, Material, and Equipment of Study

The study was conducted at the Baraya village and the Soil Chemistry and Fertility Laboratory, Hasanuddin University, Makassar, Indonesia, In 2022. The materials and equipment used are papaya and mango waste, water spinach and Chinese cabbage waste, palm sugar, granulated sugar, water, used mineral bottled-1,500 mL, analytical balance, measuring cup, erlen meyers, plastic bucket, pH meter, and UV-VIS spectrophotometer.

Procedure of Study

Ecoenzyme Preparation

Ecoenzyme is prepared by material treatment, given in Table 1. The procedure for preparing the ecoenzyme was by putting 600 mL water into a bottle-1,500 mL, adding with 100 g granulated or palm sugar, homogenizing, and adding 300 g mango and papaya waste and or water spinach and Chinese cabbage waste. Subsequently, the mixtures were fermented for three months in a place with no direct sunlight. The bottle cap was opened every 24 h during fermentation to release gases.

Quality Analysis of Ecoenzyme Solution

The ecoenzyme solution obtained was observed and analyzed for aroma quality, color, pH, volume, and alcohol content. The aroma and color were observed and assessed organoleptically by 20 respondents. While the volume is measured using a measuring cup. The pH and alcohol content were respectively analyzed using pH meter and UV-VIS spectrophotometer.

Testing the Potential of Ecoenzyme Residues as Composting Bioactivator

The raw materials to be composted, namely vegetable, fruit, and leaf waste, were collected, cut into 2–3 cm^2 sizes, and dried in the sun for three days. Then, these dried organic wastes were composted aerobically in plastic buckets with the addition of 10% bioactivator, namely ecoenzyme residue (BRE), commercial effective microorganism (BEM), and control or without bioactivator (TBP). Composting was done in a place with no direct sunlight for five weeks. During the process, the composting pH, temperature, and humidity were measured weekly using a thermometer, hygrometer, and pH meter. The composts produced were then observed for color and texture, and the content of N, P, and K were analyzed in the Soil Chemistry and Fertility Laboratory.

Table 1 Raw materials used for preparing ecoenzyme

Ecoenzyme	**Mixture of materials**				
	Vegetable and fruit waste	**Weight (g)**	**Sugar type**	**Weigh (g)**	**Water (mL)**
ECO1	Papaya, mango, water spinach, and Chinese cabbage	300	Granulated sugar	100	600
ECO2	Papaya and mango	300	Granulated sugar	100	600
ECO3	Water spinach and Chinese cabbage	300	Granulated sugar	100	600
ECO4	Papaya, mango, water spinach, and Chinese cabbage	300	Palm sugar	100	600
ECO5	Papaya and mango	300	Palm sugar	100	600
ECO6	Water spinach and chinese cabbage	300	Palm sugar	100	600

Data Analysis

The data obtained on the quality of ecoenzymes and the potential of their residues as composting bioactivators as compared to the BEM and control treatments were analyzed statistically using Anaysis of Variance. If there is a significant different effect between treatments, it is continued with the least significant difference (LSD) test at 95% significance level.

RESULTS AND DISCUSSION

Quality of Ecoenzym Solution

Ecoenzyme solutions obtained in the first week had a distinctive aroma of fresh vegetables and fruits, clear in color when using granulated sugar and light brown when using palm sugar. After 3 months of fermentation, the solutions had a strong acid aroma, light brown in ECO1 and ECO3, yellowish brown in ECO4 and ECO5, and reddish brown in ECO2 and ECO6 ecoenzyme with pH values ranging from 3.1 to 3.4. Meanwhile, the lowest volume of ecoenzyme solution of 740 mL was obtained in ECO2, and the highest of 780 mL was in ECO6 (Table 2). The characteristics of these ecoenzyme solutions follow the results of several studies, namely acid aroma, brown color, and low pH. The making of ecoenzymes is successful if a brownish solution is formed, has a strong or fresh fruit acidicaroma, and a pH < 4 (Dewi et al. 2021; Safitri et al. 2021). The acid aroma comes from the acetic acid contained in the ecoenzyme solution.

Ecoenzymes made from vegetable waste and palm sugar produced higher volume of solution than fruit waste and granulated sugar (Table 2). Vegetable waste used were the leaves, stems, and roots of water spinach and Chinese cabbage. These plant organs function in water distribution metabolism. Therefore, when these organs are harvested, their water content is still high. According to Lakitan (2011), the water content of the plant roots, stems, and leaves is higher than in the fruits. Water content of plant tissues ranges from 80 to 90%. Using palm sugar in ECO4, ECO5, and ECO6 resulted in a higher volume of ecoenzyme solution than granulated sugar in ECO1, ECO2, and ECO3.

Table 2 Quality of ecoenzym solution

Ecoenzyme	**Materials**	**Aroma**	**Color**	**Volume (mL)**	**pH**
ECO1	Fruit and vegetable waste	Strong acid	Light brown	750	3.3
ECO2	Fruit waste	Strong acid	Reddish brown	740	3.3
ECO3	Vegetable waste	Strong acid	Light brown	760	3.4
ECO4	Fruit and vegetable waste	Strong acid	Yellowish brown	770	3.2
ECO5	Fruit waste	Strong acid	Yellowish brown	770	3.1
ECO6	Vegetable waste	Strong acid	Reddish brown	780	3.2

Ecoenzyme is an event of overhaul of organic compounds by microbes so that the final product is influenced by their performance. Microbes need sugar as a source of energy. The higher the sugar content of the substrate, the higher the capacity of the microbes to fulfill their energy source. According to Lempang (2012), palm sugar contains 84% sucrose, and it is only 20% in granulated sugar. Supriyani et al. (2020) stated that the type of sugar affects the volume of ecoenzyme solution obtained. The higher the availability of sugar (sucrose), the higher the yield of ecoenzyme solution.

Ecoenzyme solution contains alcohol, so that it can function as a growth inhibitor and kill unwanted microbes. Therefore, ecoenzyme solution can be used as a floor cleaner, disinfectant, and insecticide. The percentage of alcohol content of ecoenzyme solution is a determining factor for its effectiveness as an antiseptic. This study revealed that the solution of ecoenzyme-prepared papaya, mango waste, and palm sugar contains more alcohol than water spinach and Chinese cabbage waste and granulated sugar, in which the alcohol content ranged from 4.1 to 4.8% (Figure 1).

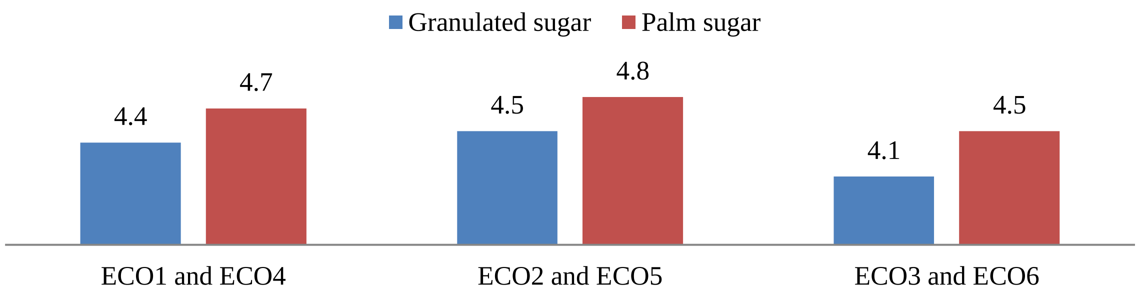

Figure 1 Alcohol content of the ecoenzym solution

According to Lakitan (2011), the glucose contained in fruits is higher than in plant leaves, stems, and roots. Glucose is used as a source of nutrients in the fermentation process, which will then be converted into alcohol (Mimi 2018). Microbes attempt fermentation to obtain energy from carbohydrates (glucose) with alcohol or acetic acid as the product, depending on the microbes involved. Fungi and some bacteria produce alcohol, whereas most bacteria produce acetic acid. In their fermentation study, Munir et al. (2020) reported that adding three different types of sugar, namely coconut sugar, palm sugar, and granulated sugar, resulted in different alcohol levels. The highest alcohol content was obtained from adding palm sugar (4.56%), and the lowest was granulated sugar (3.40%).

The potential of Ecoenzyme Residues as Composting Bioactivator

Composting wastes of vegetables, fruit, and leaves using a bioactivator of the ecoenzyme residues (BRE), effective microorganisms (BEM), and without bioactivator (TBP) resulted in pH < 7 at the first week. Longer composting time increased the pH. At the end of composting time, the highest pH of 7.5 was measured at BRE and BEM treatments, while at TBP treatment, it was 7.2. After five weeks of composting, the composting pH range was from 6.4 to 7.5 (Figure 2). According to Whitman and John (2000), the ideal pH range during the composting process is 6 to 8. The maturity phase of the compost in all treatments was reached on day 28 with a pH value of around 7.5. This pH value indicated that the compost has matured and is safe for soil conditioners. According to Supadma and Arthagama (2008), the pattern of pH changes in compost begins with a slightly acidic pH due to the formation of simple organic acids. Then the pH increases with incubation time due to protein breakdown and ammonia release. The increase and decrease of pH is also a marker of the activity of microbes in decomposing organic matter (Firdaus 2011; Ismayana et al. 2012).

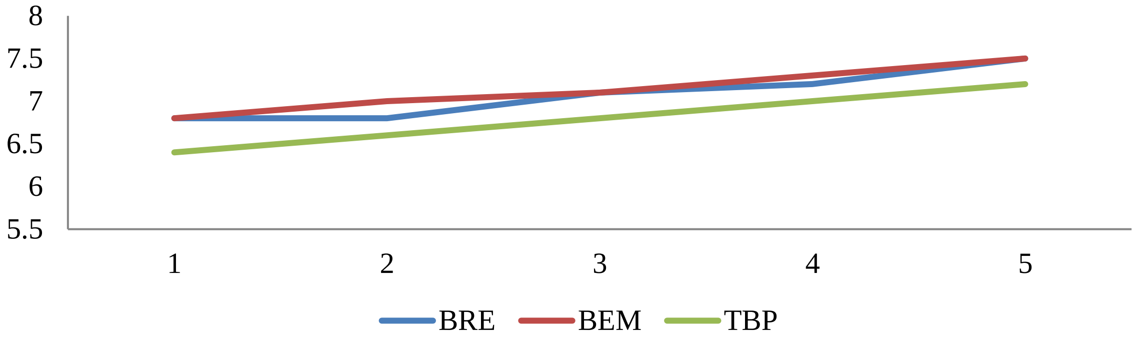

Figure 2 Value of pH in the composting process of organic waste

Composting temperatures ranged from 27 to 36 ºC after five weeks, categorized as medium temperature. The treatments of BRE and BEM resulted in the same composting temperature of 36 ºC, while TBP was only 32 ºC in the first week. The composting temperature in the following weeks decreased until it stabilized in the fifth week (Figure 3). Composting temperature occurs due to the activity of microbes. The use of different sources of bioactivation gave rise to the diversity and number of microbes. According to Widarti et al. (2015), the low composting temperature is thought to be due to insufficient composting waste in the process to provide heat insulation.

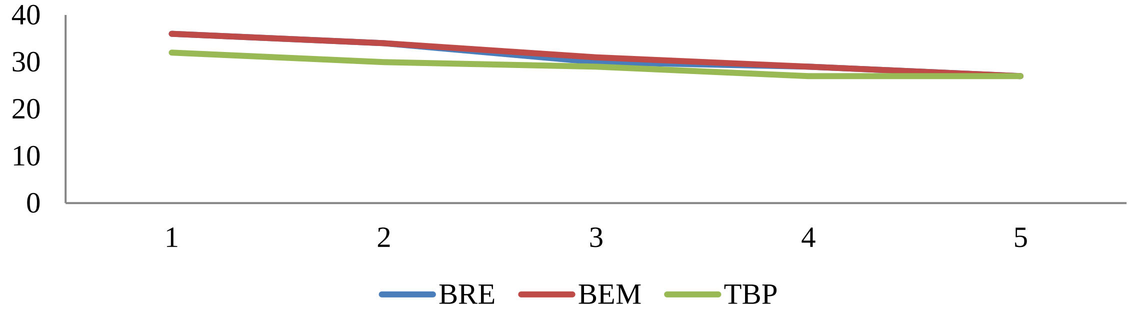

Figure 3 Temperature in the composting process of organic waste

Then, the temperature will decrease due to the reduced amount of organic matter that the microbes can decompose, indicating the compost is starting to ripen. Moreover, the increase in composting temperature is due to bacterial activity in decomposing organic matter (Pandebesie and Rayuanti 2013). Mesophilic conditions are more effective for decomposition because the microbial-activated process is dominated by protobacteria and fungi. According to Ruskandi (2006), the aerobic composting process proceeds in the mesophilic phase at 23 to 45 ºC and the thermophilic phase at 45 to 65 ºC. In this study, the composting temperature fluctuation was not more than 36 ºC, so only mesophilic bacteria could reproduce. According to Indriani (2007), the optimal temperature for composting is 30 to 50 ºC. While according to the criteria of Indonesian National Standard (SNI), the maximum composting process is 50 ºC (BSN 2004).

During the 5 weeks, the composting humidity ranged from 66 to 81%. The highest humidity occurred in the treatments using bioactivator (BRE and BEM) in the first week, then it decreased in the following weeks and stabilized in the fourth week. The humidity in BRE and BEM treatments was not significantly different but differed from TBP treatments in the first and second weeks. The composting at the third, fourth, and fifth weeks showed no significant humidity difference amongst the BRE, BEM, and TBP treatments (Figure 4). Humidity affects the activity of microbes, the higher humidity, however, can cause the microbes to be disturbed and even die because the spaces for aerobic composting are filled with water. Juanda et al. (2011) say the decomposition process will be hampered if the composting humidity is too moist. This is because water will cover the air cavity in the composting materials. Lack of oxygen causes aerobic microbes to die. According to Kusumawati (2011), the optimum humidity for aerobic composting is 50 to 60%. If it is less than 50% then the composting will take place slowly, but if it is more than 60% it will cause the nutrients to be leached out, and the air volume in the compost will decrease.

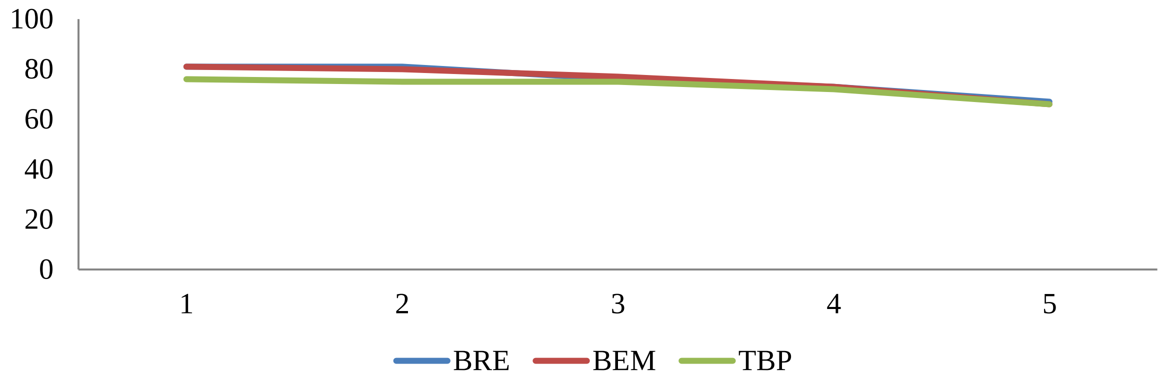

Figure 4 Value of humidity in the composting process of organic waste

The final product of organic waste composting in this study showed the characteristics of color and texture with good quality. The compost is black-brown in color with a smooth texture in all treatments. According to Sulistyawati et al. (2008), the physical quality of the compost produced provides an overview of each decomposer agent's ability to decompose organic matter in the organic waste. According to Ismayana et al. (2012), a good texture of compost is obtained if the final shape does not resemble the original shape of the raw material because it has been destroyed due to natural decomposition by microbes living in the compost. Meanwhile, the results of chemical analysis showed that the compost contained total N, P_2O_5, and that ranged from 0.68 to 0.80%, from 0.49 to 0.60%, and from 0.75 to 0.90%, respectively (Table 3). This compost nutrient content met the Indonesian National Standard (SNI) 19-7030-2004 criteria, namely a minimum total N of 0.4%, P_2O_5 of 0.1%, and K_2O of 0.2%.

Table 3 Quality of the final product of organic waste composting

Characteristics	**Quality of compost treated with bioactivator**		
	BRE	**BEM**	**TBP**
Color	Black-brown	Black-brown	Black-brown
Texture	Smooth	Smooth	Smooth
Total N (%)	0.77	0.80	0.68
P_2O_5 (%)	0.54	0.60	0.49
K_2O (%)	0.85	0.90	0.75

CONCLUSION

Fermentation of mango, papaya, water spinach, and chinese cabbage waste with addition of palm sugar or granulated sugar and water-produced ecoenzymes. The ecoenzyme made from papaya and mango waste with palm sugar produced a solution with the highest alcohol content. The ecoenzyme residue can be used as composting bioactivator. The composting process of organic waste in all treatments runs normally, with the final product having color, texture, total N, P_2O_5, and K_2O that complied with the Indonesian National Standard (SNI) 19-7030-2004 requirements.

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REFERENCES

[BSN] Badan Standardisasi Nasional/National Standardization Agency of Indonesia. 2004. *Spesifikasi Kompos dari Sampah Organik Domestik.* SNI 19-7030-2004. Jakarta: BSN.

Bernadin DM, Desmintari, Yuhanijaya. 2017. Pemberdayaan masyarakat desa citeras rangkas bitung melalui pengolahan sampah dengan konsep ecoenzyme dan produk kreatif yang bernilai ekonomi. *Prosiding Seminar Nasional Pengabdian Kepada Masyarakat*. 2(1):110–121.

Dewi SP, Selvia D, Sania A. 2021. Pembuatan dan uji organoleptik ecoenzyme dari kulit buah jeruk. *Hubisintek.* 3(1):649–657.

Firdaus F. 2011. Kualitas pupuk kompos campuran kotoran ayam dan batang pisang menggunakan Bioaktivator MOL Tapai [undergraduate thesis]. Bogor: IPB University.

Hemalatha M, Visantini P. 2020. Potential use of ecoenzyme for the treatment of metal based effluent. *IOP Conf Series: Materials Science and Engineering*. 716:1–6.

Indriani YH. 2007. *Membuat Pupuk Organik Secara Singkat*. Jakarta: Penebar Swadaya.

Ismayana A, Indrasti NS, Suprihatin, Maddu A, Fredy A. 2012. Faktor rasio C/N awal dan laju aerasi pada proses composting bagasse dan blotong. *Jurnal Teknologi Industri Pertanian*. 12(3):173–179.

Juanda, Irfan, Nurdiana. 2011. Pengaruh metode dan lama fermentasi terhadap mutu mikroorganisme lokal. *Jurnal Floratek*. 6:140–143.

Juniartini NLP. 2020. Pengelolaan sampah dari lingkup terkecil dan pemberdayaan masyarakat sebagai bentuk tindakan peduli lingkungan. *Jurnal Bali Membangun Bali*. 1(1):27–40.

Kusumawati N. 2011. Evaluasi perubahan temperatur, pH dan kelembaban media pada pembuatan vermikompos dari campuran jerami padi dan kotoran sapi menggunakan *Lumbricus rebellus*. *Jurnal Inotek*. 15(1):45–56.

Lakitan B. 2011. *Dasar-Dasar Fisiologi Tumbuhan*. Jakarta: Rajawali Press.

Lempang M. 2012. Pohon Aren dan manfaat produksinya. *Info Teknis EBONI*. 9(1):537–544.

Mahyudin R. 2017. Kajian pengelolaan permasalahan sampah dan dampak lingkungan di tpa (tempat pemrosesan akhir). *Jurnal Teknik Lingkungan*. 3(1):66–74.

Megah SI, Dewi DS, Wilany E. 2018. Pemanfaatan limbah rumah tangga digunakan untuk obat dan kebersihan. *Minda Baharu*. 2(1):50–56.

Mimi BE. 2018. Pengaruh variasi jenis gula merah terhadap kesukaan panelis dan kadar alkohol wine tomat (*Solanum lycopersium* L.) [undergraduate thesis]. Yogyakarta: Universitas Dharma.

Munir NF, Malle S, Huda N. 2020. Karakteristik fisikokimia ecoenzym limbah kulit jeruk *Citrus maxima* (Burm.) Merr. dengan variasi gula. Prosiding Seminar Nasional: Sustainability and Environmentally of Agricultural System for Safety, Healthy and Security Human Life; 2020 Agt 5; Pangkep, Indonesia. Pangkep: Politeknik Pertanian Negeri Pangkajene Kepulauan.

Pandebesie ES, Rayuanti D. 2013. Pengaruh penambahan sekam pada proses pengomposan sampah domestik. *Jurnal Lingkungan Tropis*. 6(1):31–40.

Prabekti YS. 2020. *Ecofermentor: Alternatif Desain Wadah Fermentasi Ecoenzyme*. Bogor: IPB University.

Ruskandi. 2006. Tehnik pembuatan kompos limbah kebun pertanaman kelapa polikultur. *Buletin Tehnik Pertanian*. 11(10):112–115.

Rohyani N, Utpalasari R, Dahliana I. 2020. Analisis hasil konversi ecoenzyme menggunakan nenas (*Ananas Comosus*) dan Pepaya (*Carica Papaya* L.). *Jurnal Kesehatan*. 5(2):135–140.

Safitri I, Yuliono A, Sofiana MSJ, Helena S, Kushadiwijayanto AA, Warsidah W. 2021. Peningkatan kesehatan masyarakat teluk batang secara mandiri melalui pembuatan handsanitizer dan desinfektan berbasis ecoenzyme dari limbah sayuran dan buah. *Journal of Community Engagement in Health*. 4(2):371–377.

Septiani U, Najmi, Rina O. 2021. Ecoenzyme: pengolahan sampah rumah tangga menjadi produk serbaguna di Yayasan Khazanah Kebajikan. Prosiding Seminar Nasional Pengabdian Masyarakat; 2021 Okt 28; Jakarta, Indonesia. Jakarta: Universitas Muhammadiyah.

Sharma HB, Vanapalli KR, Cheela VRS, Ranjan VP, Jaglan AK, Dubey B, Goel S, Bhattacharya J. 2020. Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling*. 16(2):50–58. doi:10.1016/j.resconrec.2020.105052.

Sulistyawati, Endah, Mashita, Nusa, Choesin DN. 2008. Pengaruh agen decomposer terhadap kualitas hasil pengomposan sampah organik rumah tangga. Makalah dipresentasikan pada Seminar Nasional Penelitian Lingkungan di Universitas Trisakti. Jakarta: *Universitas Trisakti.*

Supadma AAN, Arthagama DM. 2008. Uji formulasi kualitas pupuk kompos yang bersumber dari sampah organik dengan penambahan limbah ternak ayam, sapi, babi, dan tanaman pahitan. *Jurnal Bumi Lestari*. 8(2):113–121.

Supriyani, Andari PA, Endang TWM. 2020. Pengaruh variasi gula terhadap produksi coenzyme menggunakan limbah buah dan sayur. Prosiding Seminar Nasional Edusaintek; 2020 Nov 5; Semarang, Indonesia. Semarang: Universitas Muhammadiyah (UNIMUS).

Whitman A, John SD. 2000. *Organic Gardening For Dummies*. New York (NY): Wiley Publishing, Inc.

Widarti BN, Wardhini WK, Sarwono E. 2015. Pengaruh rasio C/N bahan baku pada pembuatan kompos dari kubis dan kulit pisang. *Jurnal Integrasi Proses*. 5(2):75–80.

Utama CS, Sulistiyanto B, Setiani B. 2013. Profil mikrobiologis pollard yang difermentasikan dengan ekstrak limbah pasar sayur pada lama peram yang berbeda. *Jurnal Agripet.* 13(2):26–30.