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Acceleration Process of Food Waste Treatment and Higher Quality Product with Innovative Rotary Kiln Composter

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ABSTRACT

The objective of this research is to utilize a rotary kiln composter to rapidly process food waste into mature and stable compost without the production of leachate. This research also ensures that the compost generated fulfil to the quality standards established by SNI 19-7030-2004. Furthermore, the operation of the rotary kiln composter can be assisted by using a smartphone, which simplifies the operation. Food waste was chopped and placed into a rotary kiln composter equipped with an aeration system (6 L/min), stirring mechanism, and remote-control functionality via mobile phone for automated operation. Further, a bulking agent was added with a ratio of food waste vs bulking agent of 70:30. The addition of microorganism mass was varied to speed up the composting process for 14 days. The results showed that the compost derived from food waste was stable within 3 days. The temperature of the food waste matrix reached 46 °C, and the pH value of the compost was close to neutral since day 4. In this study, no leachate was produced, either R1, R2, R3, or R4. The final total organic carbon (TOC) content was 12.12–15.22%, Total-N was 0.83–1.04%, phosphorus was 0.18%, and potassium was 1.05%. On the basis of the C / N value and the germination index (GI), the R2, R3, and R4 reactors produced mature and stable compost on the third day with C/N values < 20 and GI > 100%. This result is a good breakthrough because the rotary kiln composter can accelerate the composting process of food waste within 3 days.

Keywords: bulking agent, food waste, food loss, rotary kiln composter, rapid composter.

INTRODUCTION

Indonesia is ranked the second country with the world's highest food loss and waste, 300 kg/person/year (FirlyYassindra, 2019). Heterogeneous differences in socio-economic, geographic, cultural, sanitary conditions and infrastructure and management characteristics between regions cause the composition of food waste to be different (Fernández-González et al., 2017). The facts show that the community rarely does food waste management by reducing, recycling, reusing and collecting waste. Almost all regions rely on final disposal sites. However, the availability of landfills is already critical, and finding alternatives to new landfills will be difficult and expensive, especially in large and populated cities (Garsoni, 2011). Developing countries like Indonesia have a tremendous opportunity to apply onsite food waste processing techniques (Sukholthaman and Sharp, 2016). Food waste processing technology should be technically easy to implement, economical, socially acceptable, affordable, environmentally friendly, and exhibit physical compatibility (Adani et al., 2002). People want food waste to be processed immediately after disposing of waste in the kitchen.

Food waste composting is a sustainable solution to manage biological waste, contribute to the circular economy and reduce environmental pollution (Baptista et al., 2024). Various composting techniques, such as dynamic high-temperature aerobic composting and biogas residue composting, have been studied for their effectiveness in producing quality compost and reducing carbon emissions (Ahn et al., 2024; Wafula et al., 2024; Wu et al., 2024). The addition of bulking agent such as olive wood chips and calcium peroxide in the composting process has been shown to improve compost quality, stability, and maturity, making the final product suitable for agronomic and soil improvement applications (Baptista et al., 2024; Wafula et al., 2024). Composting not only aids in waste reduction but also improves soil quality by increasing organic matter content, promoting the formation of large soil aggregates, and improving aggregation stability, thereby contributing to sustainable waste management practices and environmental conservation (Wu et al., 2024).

The solid waste processing stations are referred to by several designations provided by the Indonesian government. Thermal treatment units, composting, biodigesters, landfills, and recycling centers are some of the waste processing facilities used in the processing of food waste (Farahdiba et al., 2023). Various technologies are available to treat and recycle organic waste, including food waste (Purwono et al., 2016), such as composting, incineration, anaerobic digestion (for the production of electricity, heat energy and fuel) (Guidoni et al., 2018). Montejo emphasized the importance of implementing residential scale composting as an alternative to solid waste management in urban areas (Montejo et al., 2015). The composting technique involves the biotransformation of organic waste by aerobic microorganisms under controlled conditions and produces compost as a byproduct (Montejo et al., 2015). Separation and processing organic (biodegradable) waste in situ can eliminate waste collection and disposal in landfills (Martínez-Blanco et al., 2010). Creation of composting units as well as treating and transporting waste or compost products requires minimal resources (Bernal et al., 2009). Onsite composting reduces methane (CH_4) and nitrogen oxide (N_2O) emissions during waste decomposition and biotransformation (Paredes et al., 1996).

It is necessary to ensure that the degradation process of organic matter takes place effectively and efficiently to maximize onsite composting. This activity requires defining clear parameters during composting, such as ripening time, bulking agent and waste ratio, aeration, system humidity and CH_4, N_2O emissions, leachate generation, and strong odours (Bertoldi et al., 1983). In addition, the development of microbes and the emergence of high temperatures can indicate the speed of the composting process (He et al., 2005). When the composting process parameters are well controlled, the composting becomes more efficient, has low gas emissions, and produces quality compost. According to Massoud, bulking agents can reduce gas emission, moisture content, and stabilization of materials (Massoud et al., 2009). Bulking agents can change physical properties, chemical characteristics, microbial activity, composting time, and leachate formation (Mathur et al., 1993). The choice of bulking agent depends on such factors as material availability, regional conditions, water absorption capacity, and porosity.

An effective composting process can be done using a cylindrical rotary kiln composter (Bezama et al., 2007). The addition of microorganism additives is necessary to speed up the composting process. This addition uses a semi-automatic sprayer inside the rotary kiln. Various microorganisms collectively decompose food waste (Choi et al., 2001). The mixture needs stirring to make it homogeneous. This stirring process can be done manually or automatically using a motor (Bezama et al., 2007). While current technologies and methods for composting food waste are relatively successful, they face significant challenges, such as the generation of leachate and unpleasant odors, and require a long time to achieve fully mature and stable compost. The objective of this research is to utilize a rotary kiln composter to rapidly process food waste into mature and stable compost without the production of leachate. This study utilizes a rotary kiln composter to convert food waste into mature and stable compost.

MATERIALS AND METHODS

The research was conducted over a 14 days period at the greenhouse of the environmental engineering department, Faculty of Engineering, Diponegoro University. To shield the rotary kiln composter from the elements, it had been protected from both sunlight and rain. The cylindrical rotary kiln was 45 cm in diameter and 75 cm in length. It is made of galvalume, and its design leaves plenty

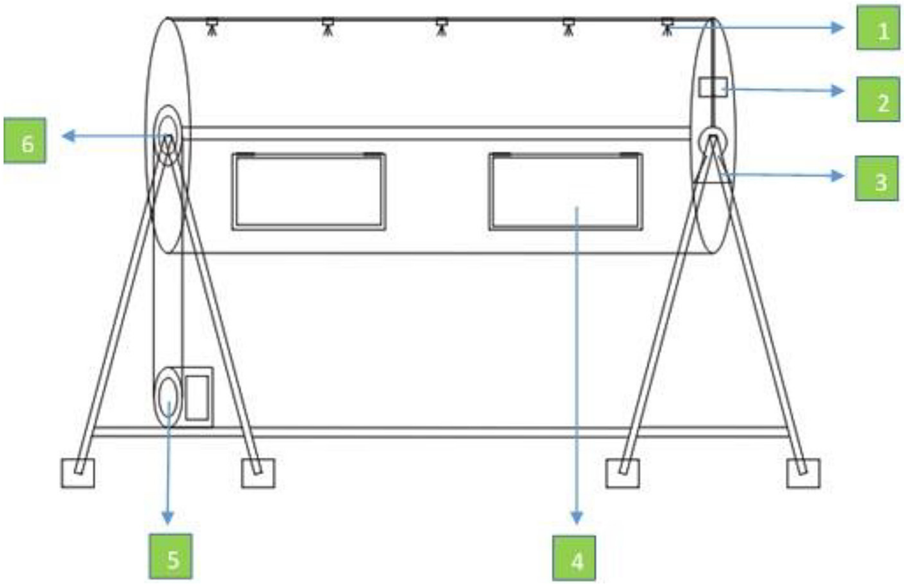

Figure 1. Rotary kiln composter consisting of: (1) sprayer; (2) composter with galvalume material; (3) supporting stick; (4) product exit; (5) motor propulsion and water supplier; (6) rotary kiln composter shaft

of room for mixing by rotation because the maximum working volume is kept to half of the total capacity. A mixer that was attached to the composter wall allows for thorough mixing inside the reactor. Venting holes of 5 mm in diameter were placed at the top and bottom of the composter to control leachate and through the top entrance, more bacteria were added to the composter. The blower that supplies the composter with air had a 6 L/min discharge rate and the support was provided by metal plates positioned at the reactor bottom. A 1 HP electric motor made in Germany by Tjap Mata powers the rotating kiln and an android smartphone was used to remotely control motor operation through the use of a smart Wi-Fi switch manufactured by Sonoff, China (Figure 1).

The raw materials were collected from the community of P4A Kalipepe Housing, Banyumanik, Semarang City within a maximum of 5 days after disposal. Food waste material consists of leftover fruit and vegetable peelings from carrots, bananas, cabbage, lettuce, and apples, etc. The percentage of each component was calculated by dividing its weight by the overall weight of food waste, then the result was multiplied by 100%. Food waste was chopped using a chopper up to ± 10 mm in size before being added to the composter in the rotary kiln. Afterwards, a bulking agent was added to the composter at a ratio of 70% food waste to 30% bulking agent (v/v). This bulking agent was made up of mature and stable compost that is around 10 mm in size. Due to its affordability and accessibility throughout the community, this mature compost was used as the bulking agent. Through the top aperture of the composter, microorganisms – especially the Stardec activator – were sprayed into the mixture, according to the study conducted by Raharjo et al. (2016). Throughout the composting process, this activator helps to achieve thermophilic temperatures.

The rotary kiln composter rotates at a pace of 70 revolutions per minute for one minute after the 1 HP electric motor is turned on using a cell phone. The goal of this rotation procedure was to fully include the bulking agent, microbes, and food waste (Table 1). In the last phase, the air was added from outside with a discharge of 6 liters $min^{-1}kg^{-1}$. Several star bio bacteria were used in the experiments, which last 14 days for each variation, in accordance with the study variations listed in Table 2. In addition to visual checks for flies, leachate, and the germination index (GI), test parameters evaluated during composting include temperature, pH, moisture content, total organic carbon (TOC), total N, total P, total K and C/N ratio.

Table 1. Composition of food waste in reactors

Reactor food	Waste (%)	Bulking agent (%)
R1	70	30
R2	70	30
R3	70	30
R4	70	30

Table 2. Variations in the dosage of Star Bio microorganisms added to the rotary kiln composter

Reactor	Star bio microorganism (g)	Air flow rate (L/min)	Stirring time (min/d)
R1	0	6	1
R2	35	6	1
R3	45	6	1
R4	55	6	1

Table 3. Temperature (°C) in different reactors from 1–14 days

Days	R1	R2	R3	R4
1	29	30	30	30
2	39	46	45	45
3	37	44	40	42
4	36	39	37	35
5	34	35	35	34
6	32.5	33	33	33
7	31.5	30	32	33
8	31	30	30	32
9	31	30	30	30
10	31	29	30	30
11	30	29	29	30
12	30	29	29	29
13	30	28	29	29
14	29	28	28	28

RESULTS AND DISCUSSION

Temperature

Using a rotary kiln composter, daily temperature readings were taken during the composting process to evaluate how the microorganisms in each reactor responded to different aeration rates. The temperature measurement results are shown in Figure 2. The results show that by using a rotating kiln composter, the maximum temperature may be raised to 46 °C with an airflow rate of 6 L/min (R2). At the beginning, the temperature of each reactor matrix varied from 29 to 30 °C. However, on the first day of the investigation, the matrix temperature increased to 46 °C, leading to the designation of R2 reactor. The thermophilic phase, which is characterized by this temperature range, is favorable to thermophilic microbe growth. These microorganisms operate optimally at temperatures between 45–60 °C bacteria and are responsible for the breakdown of proteins and carbohydrates, which speeds up the decomposition of food waste (Table 3). (Rezagama and Samudro, 2015; Mulyani, 2014).

Wulandari et al. observed that a low aeration rate limits the amount of water that evaporates, which causes the waste matrix to overheat since there is not enough airflow. The highest temperature of the control reactor (R1) peaked at about 43 °C, falling short of thermophilic conditions. In comparison to aerobic processes, the breakdown of organic matter was slowed considerably in R1 due to the prevalence of anaerobic degradation. According to Herlina (Herlina, 2010), when there is no oxygen present, temperatures drop and anaerobic processes begin, which are frequently accompanied by disagreeable smells. The temperature in R1 stabilizes between the third and the fourteenth day, ranging between 28–31 °C. Symptom of the compost ripening phase corresponds to a slow temperature drop toward stability (Faruq et al., 2021). The temperature was dropping, which means that there is less organic matter available for microbial decomposition and

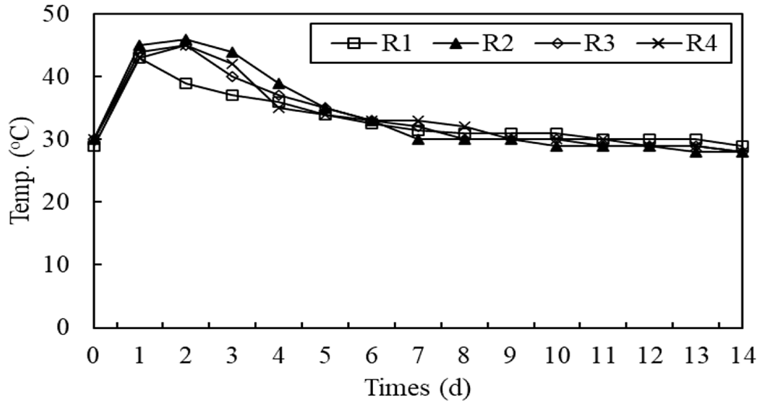

Figure 2. The results of temperature measurements for 14 days

that compost ripening has begun. (Figure 3) After three days, the waste matrix was ripened according to temperature standards.

pH

The pH is one of the critical factors influencing composting success, with daily measurements were conducted to measure acidity levels throughout the composting process utilizing a rotary kiln composter. At the beginning, the food waste was an acidic pH, ranging from 5.4 to 5.5. Ratna et al. (Ratna et al., 2017) indicated that on day 1, the pH fell to 4.9 to 5.0 due to the release of organic acids caused by the breakdown of simple organic molecules. The pH began to rise on day 2 due to the presence of ammonia produced from the nitrogen decomposition process by bacteria. Some ammonia was converted to nitrate and denitrified by bacteria until the compost pH became neutral. This condition happened to R2, since the pH value was close to neutral. The pH reached 6.9 on the fourth day (Table 4). On the same day, the pH values were 6.4, 6.7, and 6.6 for the R1, R3, and R4 reactors (Figure 4). Budiarta and Setiyo (2017) stated that microorganisms grow best in a pH range of 5.5 to 8, which is neutral to slightly acidic. According to Indonesian Standard of mature compost (SNI 19-7030-2004), the minimum and maximum pH value ranges from 6.8 to 7.9 (Figure 5). As of day four, the food waste compost that has been treated in the rotary kiln composter satisfies the compost standards according to these criteria. This result shows that the compost is in a stationary phase, so the degradation activity will be stable.

Water content

Moisture content is one of the factors that influence the composting process. Too much moisture from food waste causes pores to fill with water. As a result, the piles are trapped under anaerobic conditions, which triggers an unpleasant odor. The results of measuring moisture content in the composting process using a rotary kiln composter are shown in Figure 6.

Every reactor's water content on day 1 varied between 62.8% and 64.1%. The water content consistently decreased on days 3, 7, and 14. The R2 reactor experienced the most significant

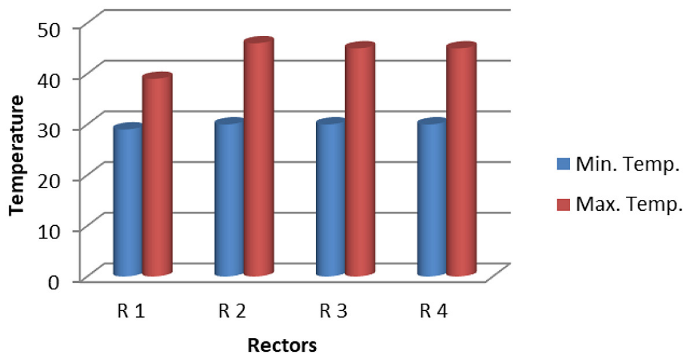

Figure 3. Min. and max. temperature in the reactors

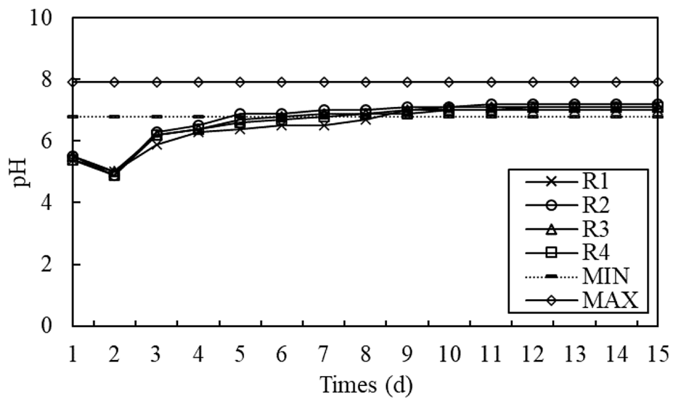

Figure 4. The pH matrix of food waste for 14 days

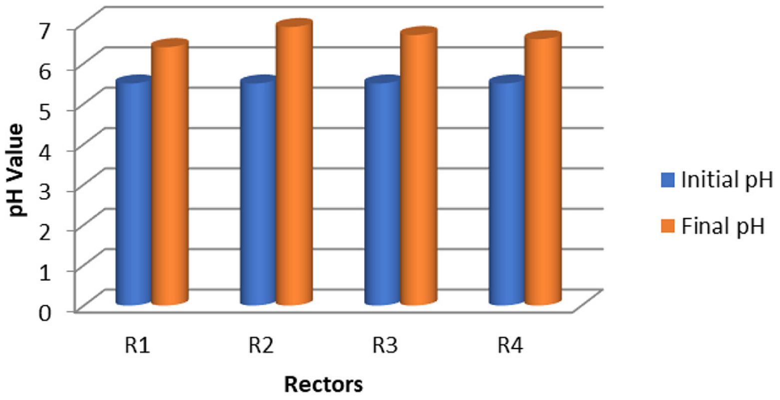

Figure 5. Initial and final pH values of composted material

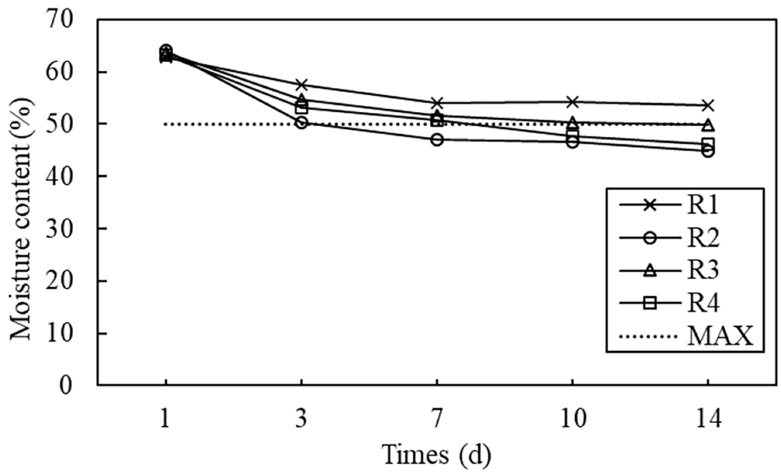

Figure 6. The moisture content of food waste processed using a rotary kiln composter

Table 4. The pH value of different reactors in 14 days

Days	R1	R2	R3	R4
1	5.5	5.5	5.5	5.4
2	6.3	6.5	6.4	6.4
3	6.3	6.9	6.5	6.5
4	6.4	6.9	6.7	6.6
5	7	7	7	7
6	7	7	7	7
7	7	7	7	7
8	7	7	7	7
9	7	7	7	7
10	7	7	7	7
11	7	7	7	7
12	7	7	7	7
13	7	7	7	7
14	7	7	7	7

decline, reaching 44.85% from the initial moisture content of 64.1% on the 14th day (Table 5). In the rotary kiln composter, an aerobic route is used for

Table 5. Water content percentage (%) in 14 days

Days	R1	R2	R3	R4
1	62.8	64.1	63.7	63.2
3	57.5	50.4	54.8	53.1
7	54.04	47.14	51.60	50.82
10	54.18	46.67	50.4	47.72
14	53.63	44.85	49.94	46.20

composting. There are two separate phases to the food waste fall in water content. In the first phase, water molecules evaporate due to biological processes (thermophilic microorganisms) from the surface of the food waste to the surrounding air (Colomer-Mendoza et al., 2013). In the second phase, the evaporated water is transported by the airflow. This result can be explained due to the aeration process and transferred to the outside air. Non-evaporated water and water vapor that is not carried by air will seep through the food waste and collect at the bottom of the reactor to become leachate (Aminah et al., 2017; Velis et al., 2009). The process of decreasing water content in the R1 control reactor is only through a biological process due to the decomposition of food waste by thermophilic microorganisms so that the reduction in water content is slower (Figure 7). Processing of food waste using the pile method releases water from organic material into highly odorous leachate (Nining, 2015). In all of the reactors in this investigation (R1, R2, R3, or R4), no leachate was generated. In order to reduce the possibility of creating a strong stench during the processing of food waste, this lack of leachate is ideal.

TOC and total N

Measurement of TOC aims to determine the carbon content in compost. Carbon is a source of energy for microorganisms that will transform carbon into CO_2 and heat so that the amount will continue to decrease. The TOC content at the beginning of the study ranged from 17.54 to 18.14% (Figure 8). Then, the TOC decreased from day 3 to the final TOC level in the 12.12–15.22% range. The total TOC content for 14 days is shown in Table 6. According to Herdiani (Herdiani, 2016), in the composting process, the content of TOC as the primary material is to be reduced, because TOC is converted to simpler compounds, namely CO_2 cell biomass. The activator addition also causes the composting process to run faster, so there is a decrease in the C content in each reactor. According to Indonesia National Standard, the levels of TOC in all reactors met the compost quality standards (Figure 9).

Table 6. TOC content values in 14 days

Days	R1	R2	R3	R4
1	18.145	17.549	17.867	18.129
3	15.227	12.128	14.488	13.189
7	14.205	11.513	13.754	12.868
10	15.605	11.251	12.924	12.474
14	15.835	11.151	12.585	12.161

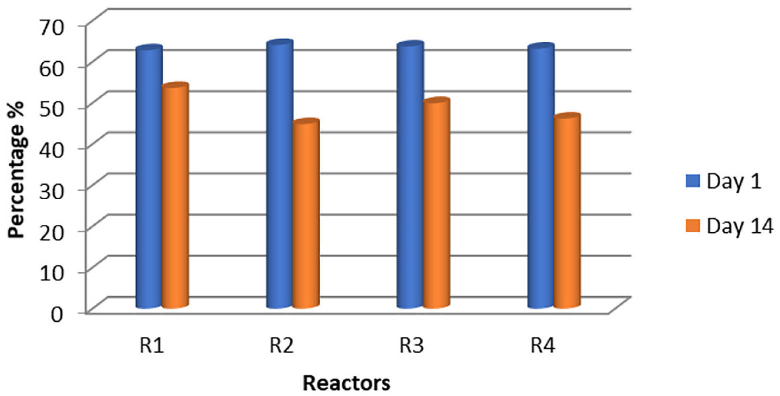

Figure 7. Percentage of water content reduction from 0–14 days

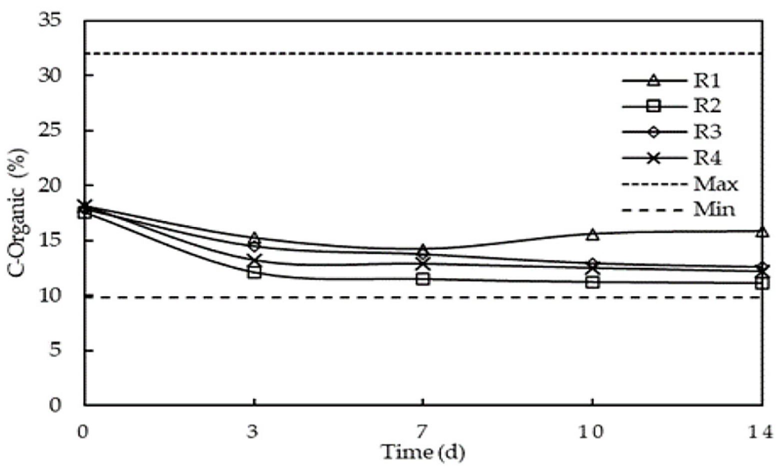

Figure 8. TOC of compost under different treatment conditions

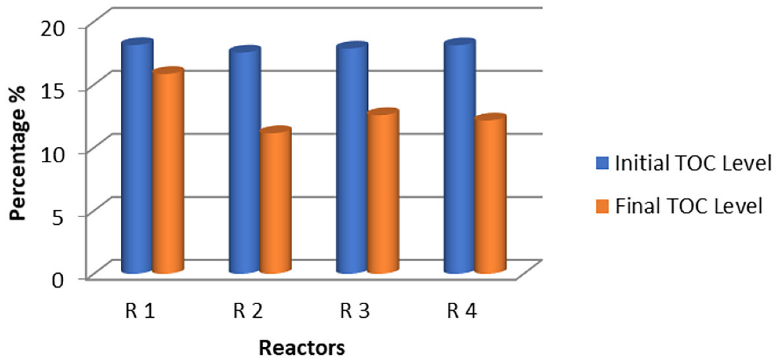

Figure 9. Graphical representation of TOC content from initial level to final level

Ariyanti et al. (Ariyanti et al., 2019) have initial TOC levels starting from the highest to the lowest, namely in mixed waste at 27.64%, leaf waste at 26.43%, and food waste at 23.41%. The level of initial TOC content will affect the final composting result. The final TOC content in mixed waste was 15.83%, leaf waste by 14.75%, and food waste by 12.57%. In turn, Sartika (Sartika, 2017) stated that adding coconut fibers to compost can lower TOC levels but does not meet SNI 19-7030-2004 standards, the high level of organic C in the final fertilizer product might be because the research used new coconut fiber, which has a higher organic carbon content. This would be different if relatively long coconut fibers were employed, as demonstrated in the research by Sudomo (Sudomo, 2012), where using relatively long coconut fibers may improve the germination percentage response to sengon by 83.67%.

Measurement of the Total N value during the composting process was carried out to determine the amount of nitrogen contained in the compost. Microorganisms need nitrogen as a food source for the formation of bacterial cells (Atmaja et al., 2017). According to Figure 10, the highest total nitrogen content was produced from the R2 reactor at 1.04%, and the lowest occurred in the 0.83% reactor R1. In the composting process, organic nitrogen is converted into ammonia (NH_3) which is volatile and then converted to nitrite (NO_2) and nitrate (NO_3^-), which is a more stable form of nitrogen (Tobing, 2009). The level of Total N has increased during the composting process. This result is because of the degraded organic matter which is greater than the volatile NH_3 (Putro et al., 2016). The Total N content in the R1 reactor tends to be lower than in the R3 and R4 reactors (Table 7). According to Colomer-Mendoza et al. (Colomer-Mendoza

Table 7. Total N content in 14 days

Days	R1	R2	R3	R4
1	0.660	0.673	0.678	0.693
3	0.669	0.811	0.830	0.758
7	0.697	1.057	0.914	0.771
10	0.777	1.011	0.933	0.800
14	0.830	1.044	1.003	0.847

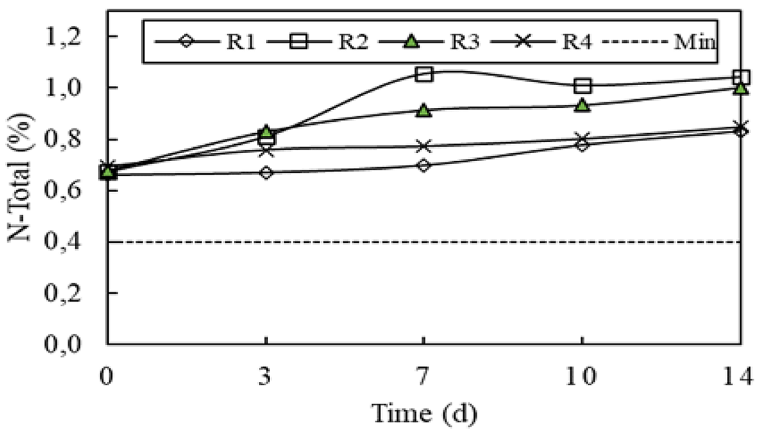

Figure 10. Total N of compost under different treatment condition

et al., 2013) the aeration flowrate with the highest air flow has the lowest total N value in the final process (Figure 11).

The process of decomposition of food waste by microorganisms produces ammonia and nitrogen. Nitrogen reacts with water to form NO_3^- and H^+. The NO_3^- compounds are very mobile, easily dissolved in water, and cannot be bound by soil colloids, and there will be a loss of N in the form of gases, where NO_3^- reacts to N_2 and N_2O. This loss of N is overcome by reversing the manure pile so that the water content is reduced, the oxygen supply is sufficient for microorganisms to break down protein into ammonia (NH_4^+), and a good aeration process (Cesaria et al., 2014). The rotary kiln composter has accommodated the process of reversing (automatic control using a mobile phone) and aeration. The production of organic fertilizers using a combination of the bio activator Star bio and EM4 (P3) produced the best quality of fertilizers compared to making fertilizers with the bio activator EM4 (P1) and the manufacture of fertilizers with the Bioactivator Starbio (P2).

C/N Ratio

The proper C/N ratio can speed up the composting process. In addition, mature and stable compost must have a C/N ratio < 20 so that it is safe to use for fertilizing plants. The results of C/N measurements in the composting process using a rotary kiln are shown in Figure 12. At the beginning of composting, the C/N values of food waste at R1, R2, R3, and R4 were 27.51 each, 26.09, 26.35, and 26.18. The C/N value indicates that the organic material has not completely decomposed (Ismayana et al., 2012). On the third day, the C/N value decreased, where the reactors R2, R3, and R4 had a C/N value < 20, while R1 as a control had C/N > 20, which was 22.75 (Table 8). On the basis of the C/N value, the food waste compost in R2, R3, and R4 has matured starting from day 3. The decrease in C/N value is due to a decrease in the

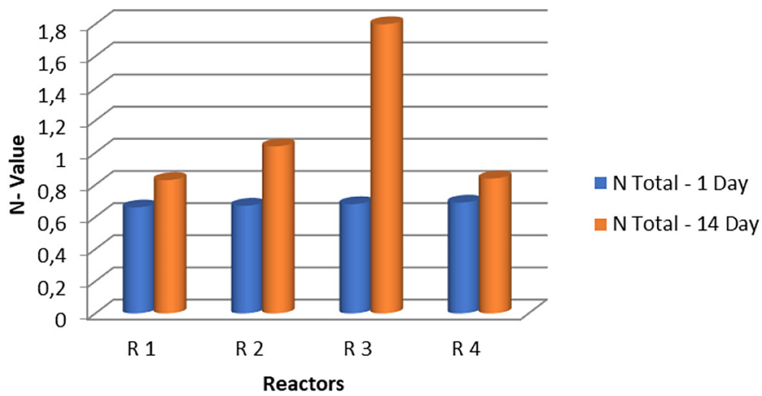

Figure 11. Total N value in 1–14 days

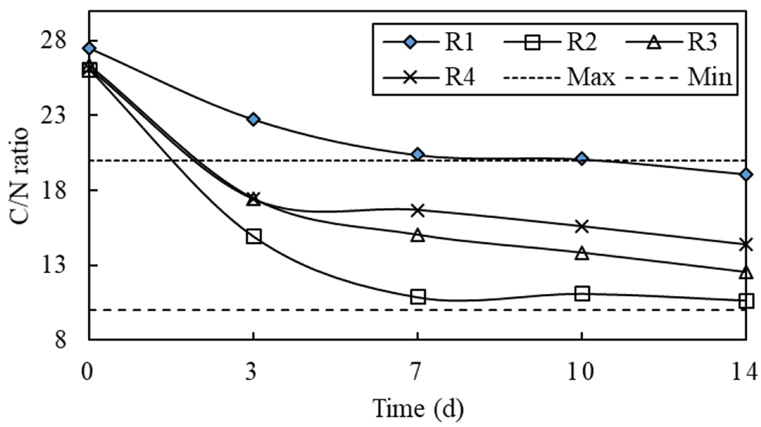

Figure 12. C/N ratio value of food waste processed using a rotary kiln composter for 14 days

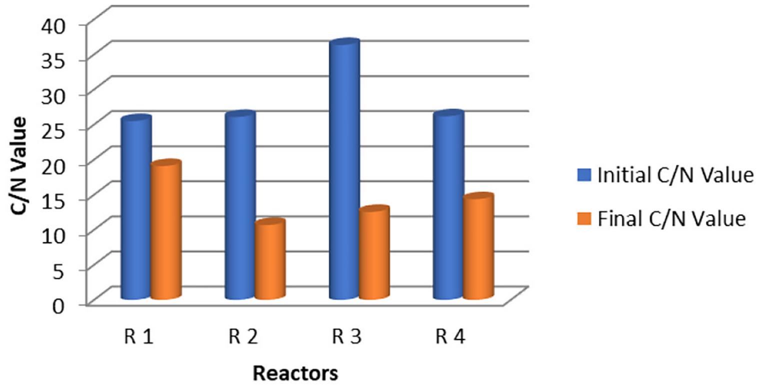

Figure 13. Reduction of C/N value in different reactors

Table 8. C/N ratio in 14 days

Days	R1	R2	R3	R4
1	27.507	26.086	26.352	26.177
3	22.749	14.954	17.455	17.408
7	20.377	10.892	15.045	16.682
10	20.094	11.125	13.851	15.585
14	19.087	10.678	12.551	14.362

amount of carbon used as a microbial energy source to decompose or decompose organic material (Figure 13).

According to Krismawati and Hardini (Prasetiyo and Fidiastuti, 2015), in the process of digestion by microorganisms, there is a combustion reaction between the elements carbon and oxygen to become calories and carbon dioxide. This carbon dioxide is released as a gas. Then, the decomposed nitrogen element is captured by microorganisms to build their bodies. The carbon in these bacteria will remain in the compost and feed the plants after they die. The carbon element is in the form of humus. The composting process was effectively sped up by just three days with the use of the rotary kiln composter. This composting is faster than Ivana and Pradhana (2017) who used PROMI bio activator to decompose goat manure and coconut husk dust with a composting time of more than 20 days.

Phosphorus (P-Total P) and potassium (K-Total)

During the composting process, the content of phosphorus and potassium in the compost is measured as one of the elements needed in carrying out photosynthesis and other plant physiological processes (Widarti et al., 2015). Referring to SNI 19-7030-2004 regarding the specifications for compost from domestic organic waste, the phosphorus and potassium levels in mature compost

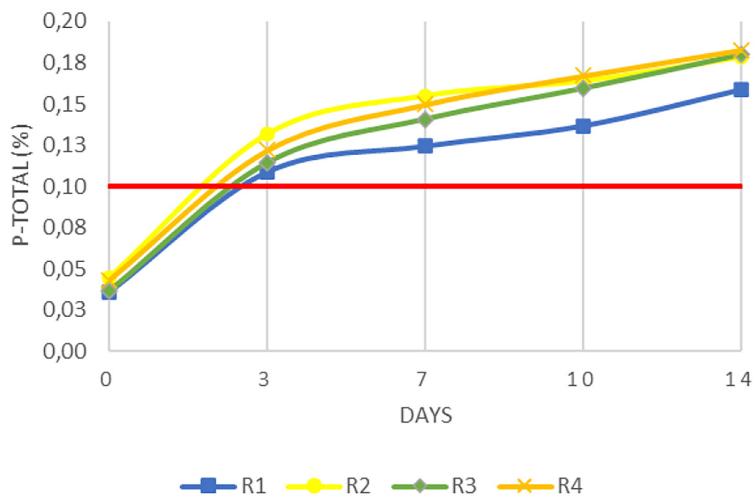

Figure 14. Graphical representation of P-Total percentage in different reactors

Table 9. Phosphorus percentage (P-Total) from 1–14 days

Days	R1	R2	R3	R4
1	0.04	0.04	0.04	0.04
3	0.11	0.13	0.11	0.12
7	0.12	0.15	0.14	0.15
10	0.14	0.16	0.16	0.17
14	0.16	0.18	0.18	0.18

is above 0.1% and 0.2%, respectively. The final results of this study produced a maximum of 0.18% phosphorus from the reactors R2, R3, and R4 (Table 9). At the same time, 1.05% potassium is produced from the R4 reactor (Table 10). The phosphorus and potassium levels in this study met the standards in all reactors. This phosphorus content is higher than Ariyanti's result (Ariyanti et al., 2019), where phosphorus content in food waste by 0.75%. Potassium is essential in photosynthesis, forming protein and cellulose, and strengthening plant stems, which also means increasing plant resistance (Winarso, 2005). The greater the potassium content in the fertilizer, the better for plant growth and development (Figures 14, 15).

Table 10. Percentage of potassium (K-Total) from 1–14 days

Days	R1	R2	R3	R4
1	0.04	0.04	0.04	0.04
3	0.61	0.64	0.68	0.63
7	0.79	0.85	0.88	0.84
10	0.85	0.97	0.95	0.92
14	0.94	1.04	1.03	1.05

Germination index

The germination index (GI) test determines whether the compost sample is ripe and stable. The maturity and stability of the compost should be checked before the compost is applied to the soil because immature and stable compost can inhibit seed germination and plant growth and damage the soil. This result is caused by a decrease in oxygen and nitrogen content due to the activity of microorganisms and phytotoxic compounds (Bernal et al., 2009). Figure 16 shows the change in the germination index matrix of food waste during the composting process using a rotary kiln composter (Figure 17).

At the beginning of composting, the GI value in all reactors is below 80%, which indicates that the compost has not been ripe and is still toxic. According to Selim et al. (Selim et al., 2012), compost is mature if the GI value is above 80% compared to the control. On the third day, the compost in all reactors is above 80%, which indicates that the compost has matured. A GI value of more than 80% indicates the loss of phytotoxin compounds in the compost (Zucconi et al., 1981). According to Cabanas-Vargas et al. (Cabañas-Vargas et al., 2013), GI values > 100% indicate that the compost is stable. According to compost stability, reactors R2, R3, and R4 were mature and stable on the third day. Meanwhile, R1 as a control, produced a GI value of 98%, which indicates that the compost is not stable (Table 11). The highest GI value occurred at reactor R2 on the fourteen day at 154%. According to Cooperband et al. (Cooperband et al., 2003), immature and stable compost can disrupt germination and plant growth. In three days, the rotary kiln composter

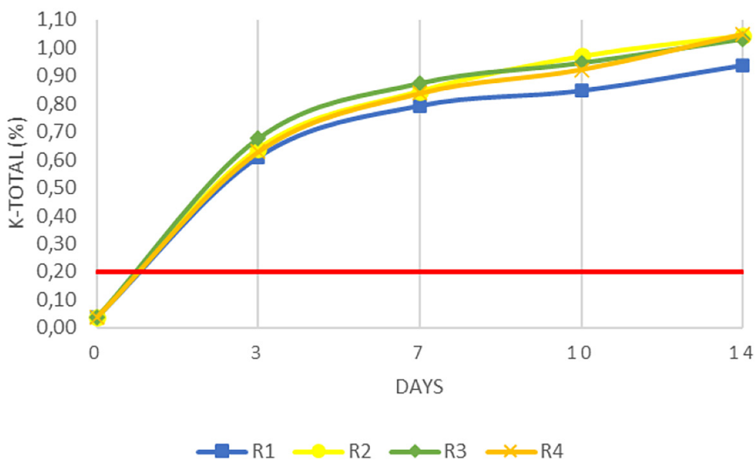

Figure 15. Graphical representation of K-Total percentage in different reactors

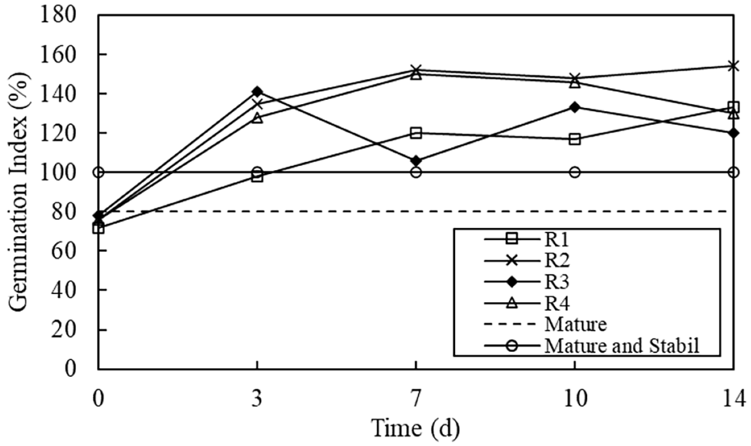

Figure 16. The germination index matrix value of food waste processed using a rotary kiln composter for 14 days

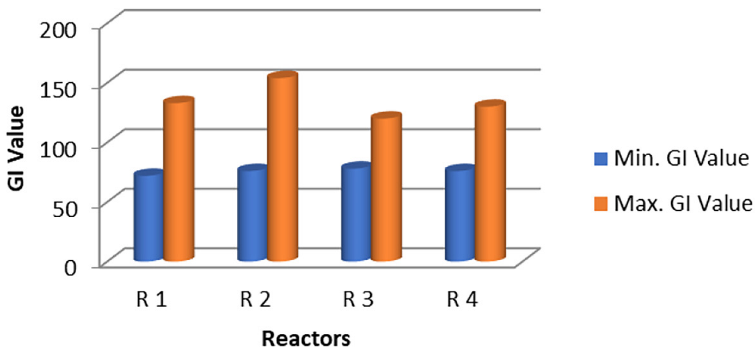

Figure 17. Graphical representation of min. and max. germination index value

Table 11. Germination index in different reactors from 1–14 days

Days	R1	R2	R3	R4
1	72	76	78	76
3	98	135	141	128
7	120	152	106	150
10	117	148	133	146
14	133	154	120	130

can process food waste into mature and stable compost. This result is a promising breakthrough because the rotary kiln composter can accelerate the composting process of food waste.

CONCLUSIONS

The community wants food waste to be processed immediately after disposing of food waste because it causes leachate and an unpleasant odor. The purpose of this study was to process food waste into compost using a rotary kiln composter which was analyzed based on the ripening time and the quality of the compost produced. The temperature of the food waste matrix was reached 46 °C with compost pH value near neutral since day 4. The final TOC content was 12.12–15.22%, Total N was 0.83–1.04%, phosphorus was 0.18%, and potassium was 1.05% on the 14th day. These parameters meet SNI standards. On the basis of the C/N value and the germination index, the reactors R2, R3, and R4 produce mature and stable compost on the third day with C/N values < 20 and GI > 100%. In this study, no leachate was produced, either R1, R2, R3, or R4. This result is promising because the composter can accelerate the composting process of food waste in 3 days and does not produce leachate. Compost quality meets the SNI 19-7030-2004 standards regarding compost specifications from domestic organic waste. In addition, the rotary kiln composter was controlled remotely using a mobile phone, making operation easier.

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