

PAPER • OPEN ACCESS

The effect of additional vegetables and fruits waste on the quality of compost of cassava chip industry solid waste on takakura composter

To cite this article: Yommi Dewilda *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **602** 012060

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

The effect of additional vegetables and fruits waste on the quality of compost of cassava chip industry solid waste on takakura composter

Yommi Dewilda¹, Rizki Aziz², Restu Ayu Handayani³

Department of Environmental Engineering, Faculty of Engineering, Andalas University, Padang, 25163, Indonesia

Email: yommidewilda@gmail.com

Abstract. This study aims to determine the optimum raw material composition on an aerobic composting method using takakura composter. Each variation was tested for maturity and quality of compost then compared with SNI 19-7030-2004 on macro element parameters. This research mixes raw materials, namely solid cassava chips industrial waste in the form of cassava peel and domestic organic waste in the form of vegetable and fruit waste from the homes of residents around the cassava factory and the addition of EM4 bio-activator. The raw materials used are Cassava Peel (CP) and Vegetables Fruits Waste (VFW) and additional EM4 as bio-activator. The composter used has a capacity of 5 kg as many as 7 units with 7 variations, namely variation 1 (100% CP), variation 2 (100% CP; EM4), variation 3 (90% CP; 10% VFW; EM4); variation 4 (80% CP; 20% VFW; EM4), variation 5 (70% CP; 30% VFW; EM4), variation 6 (60% CP; 40% VFW; EM4), and variation 7 (50% CP; 50% VFW; EM4). The results showed that all composters had met the standards following the compost standards used in Indonesia, namely the SNI 19-7030-2004 standard on compost specifications from domestic organic waste. The quantity of compost produced in this study was 1.0-1.5 kg where variation 6 produced the most compost quantity as 1.5 kg. The optimum dosage for composting was assessed from the highest scoring system was variation 6 with a mixture of 60% CP; 40% VFW; EM4 with a score of 24 and composting time for seven days.

1. Introduction

West Sumatra Province is famous for processed cassava chips [1]. Abundant cassava commodities encourage the establishment of various cassava chips processing industries in various cities in West Sumatra Province, especially in Padang City. Based on data from the Central Statistics Agency in 2016, Padang City has 87 small to medium industrial units that process cassava into one of the typical foods of West Sumatra, namely Balado Chips. A large number of cassava processing industries in Padang City has the potential to contribute the increasing waste generation in Padang City.

One way to reduce waste generation is by processing cassava peel into compost. Compost is an organic fertilizer made from the decomposition process of plant or animal wastes [2]. Composting is one of the oldest and simplest methods of organic waste stabilization. It is a self-heating biological conversion, which generates suitable end products such as fertilizers, substrates for mushroom cultivation and bio-gas (methane) [24]. Cassava peels contain high levels of C-organic by 59.31%, and N-total content of 2.06% is useful as a source of nutrition for plants so that cassava peel waste can be



used as compost raw material [3]. Takakura composter is one of the composting methods which is economic and easy to apply.

Based on previous research using household organic waste, cassava peel, and cow rumen bio-activator, with plastic containers, showed that the initial C/N value of cassava peel waste and the household organic waste respectively were 71.42 and 31.08, and the final C/N ratio of the waste mixture was 21.13 [5]. Besides, cassava peels aerobic composting method using cow rumen, wastewater deposits and manure as supplements resulted in C/N value of 16.32 [6]. The main factors controlling food waste in composting processes include temperature, moisture content, pH level, aeration rate, C/N ratio, particle size and nutrient content [23].

Therefore, in this study, a combination of raw material composition in the form of cassava peel, vegetable, and fruit waste was carried out by takakura composting method to obtain compost results that meet the requirements according to SNI 19-7030-2004 [7].

2. Material and Method

This study utilizes cassava chips waste in the form of cassava peel with the addition of domestic organic waste consisting of vegetable and fruit waste. EM4 was used as bio-activator. This research was conducted to determine the appropriate quantity comparison of cassava peel waste, domestic organic waste and the addition of EM4 as bio-activator.

Cassava peel waste was taken from Cahaya Balado cassava chips industry located in Jati Street, Padang City, West Sumatra, while the domestic organic waste was taken from residents' houses around the industry. A sample was carried out at the Laboratory of Solid Waste Department of Environmental Engineering of Universitas Andalas and enumeration of cassava peel, and domestic organic waste was carried out at the Integrated Waste Management Center, Universitas Andalas.

The composter used is a takakura composter using a basket measuring 36 cm x 26 cm x 47 cm. The amount of garbage put in this basket was 3 kg. Components of takakura composter are cardboard, paddy rice pad, black cloth and basket cover. Composter design in this study shown in figure 1. Each composter has a difference in composition and weight of the raw material used. Comparison of this variation was chosen by considering the raw material of more cassava peels. Detail of variation can be seen in table 1 below.



Figure 1. Takakura composter

Table 1. Raw Material Mixture Variation

Variation	CP		VFW		EM4
	(kg)	(%)	(kg)	(%)	(mL)
V1	3	100	0	0	0
V2	3	100	0	0	0
V3	2.7	90	0.3	10	3
V4	2.4	80	0.6	20	3
V5	2.1	70	0.9	30	3
V6	1.8	60	1.2	40	3
V7	1.5	50	1.5	50	3

Variation 1 (V1) is a variation of control using raw materials in the form of 100% cassava peel without a mixture of other raw materials and bio-activators. Variation 2 (V2) uses 100% cassava peel with the addition of bio-activator. Variation 3 (V3) uses raw material in the form of 90% cassava peel plus 10% vegetable and fruit waste with the addition of bio-activator. Variation 4 (V4) uses raw material in the form of 80% cassava peel plus 20% vegetable and fruit waste with the addition of bio-activator. Variation 5 (V5) uses raw material in the form of 70% cassava peel plus 30% vegetable and fruit waste with the addition of bio-activator. Variation 6 (V6) uses raw material in the form of 60% cassava peel plus 40% vegetable and fruit waste with the addition of bio-activator. Variation 7 (V7) uses raw materials in the form of 50% cassava peel plus 50% vegetable and fruit waste with the addition of bio-activator. Addition of 3 mL of bio-activator to variations of 2, 3, 4, 5, 6 and seven was done to see whether the bio-activator affected the speed of compost maturity. The use of 3 mL EM4 bio-activator liquid by general instructions that have been listed in the packaging of the bio-activators.

3. Result and Discussion

3.1. Preliminary test

From the experiments that have been carried out, it was found that the water content of fruit and vegetable samples was 46.42% and the moisture content for cassava peel samples was 38.75%. C/N levels of fruit and vegetable samples were 25.5 while the C/N ratio for cassava peel was 28.8. Test results of water content and the C/N ratio of both samples meet the quality standards. Of concludes that these two raw materials can be used for composting.

Table 2. Raw material Moisture Content and C/N ratio

Parameter	Raw Material		Standard
	CP	VFW	
Moisture Content	46,42%	38,75%	< 50%
C/N	28,8	25,5	20:1sd 40:1

3.2. Moisture Content analysis

In monitoring humidity during the composting process, each composter produces a considerable amount of moisture which causes the compost to become wet. The amount of reduced material shows the high activity of microorganisms, resulting in considerable moisture. The water vapor that is formed cannot be released into the air because the composter is closed. This is why water vapor is formed again to the compost pile so that the compost becomes wet and the humidity is high [8]. If the compost is too wet, the pores will fill up with water and cause reduced oxygen availability [9]. Therefore composting is carried out so that the conditions in a pile become normal again. Composting moisture content for each variation can be seen in figure 2.

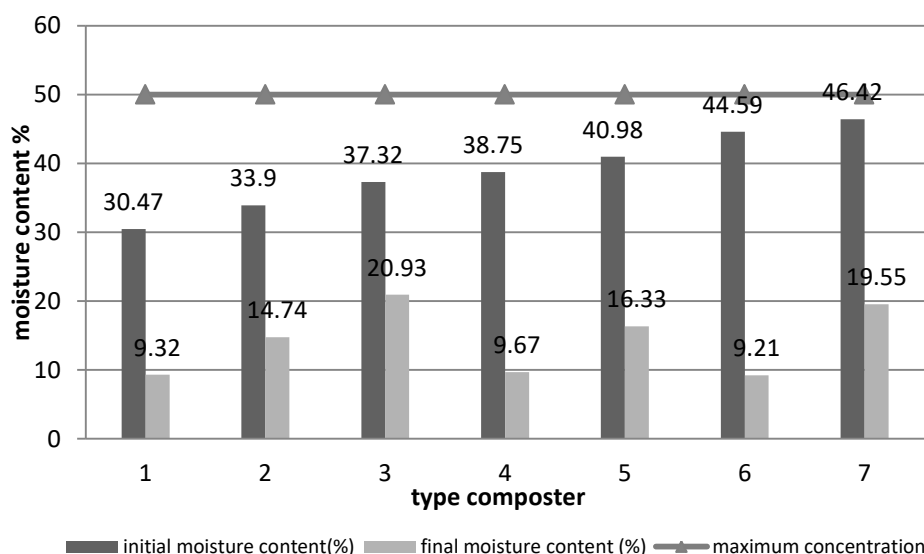


Figure 2. Moisture content value of composting

The initial moisture content of the composting process for each variation of material varies, for V1 that is 100% cassava peel without a mixture of other raw materials has the lowest percentage of other variations that is equal to 30.47%, while V 7 is mixing 50 % of cassava peel and 50% of domestic organic waste has a high enough moisture content of 46.42%. Based on these data it can be seen that the composter which only consists of cassava peel without a mixture of other raw materials has a lower moisture content compared to the composter which mixes the raw material more varied. The initial moisture content of each compost variation meets the composting standard. The moisture content in the compost should not be too little or far below the allowable range of <50%. Too little water content, it is feared will disrupt the growth and metabolism of microorganisms thus affecting the decomposition process. The decomposition process runs slowly, meaning the length of composting will also be longer. The water content is too high or exceeds the range of > 50%, and it will have a negative impact on compost. Compost that is too wet will make the pores fill with water, causing reduced oxygen availability [9]. Therefore, composting can be done so that the conditions in the embankment become normal again.

According to SNI 19-7030-2004, the maximum moisture content of mature compost is 50%. At the end of composting, the moisture content decreased. This indicates that there is no more bacterial activity in the decomposing organic material. V3 has the highest water content of 20.93%, while V6 has a low moisture content of 9.21%. The water content decreases in each of these variations because the water produced during the composting process is absorbed by the bearing containing the rice husks in the composter so that the moisture conditions in the composter can be maintained.

3.3. Temperature Analysis

Temperature is one of the composting parameters to see the maturity of compost. Temperature is measured every day from the start of composting until the compost is matured. Increased microbial activity will produce energy in the form of heat so that the resulting temperature will also be higher. Composting temperature can be seen in Figure 3 below.

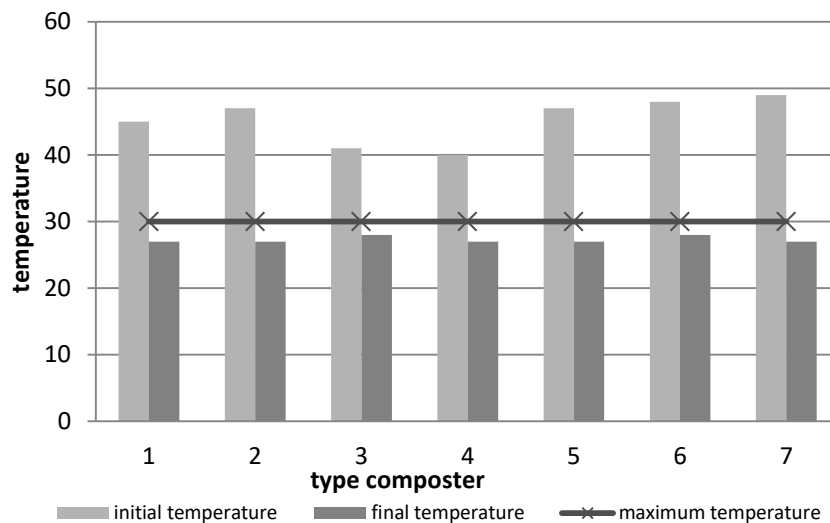


Figure 3. Temperature of compost

At the initial conditions, the composting temperature is quite high. The increase in temperature that occurs at the beginning of composting is caused by heat generated from the process of organic matter reform by microorganisms [10]. This temperature will continue to increase due to bacterial activity. At the beginning of decomposition, microorganisms involved in the composting process are mesophyll (the composting temperature is still below 40 °C). In this study, the highest temperature that can be achieved is only 40 °C in V4 on the 3rd day of composting. Mesophyll microorganisms work at temperatures (25-40) °C. The best temperature is (50-55) °C and will reach (55-60) °C in the active period. Low temperature causes composting to take a long time. Low temperatures can be caused because there is no process of bacterial activity in the decomposing organic material in compost so that the absence of heat is generated in the composting process which results in low compost temperature. High temperatures (60-70) °C cause rupture of the insect eggs, and the death of pathogenic bacteria that usually live at mesophilic temperatures [11]. Then over time, the temperature will decrease by itself because there is no process of decomposition of organic matter by bacteria.

Based on figure 3 it can be seen that the final composting temperature has begun to decrease at the end of composting. In this study, each compost temperature variation has reached an average of 27 °C. Based on SNI 19-7030-2004 regarding the quality standard of compost, the maximum value of temperature is 30 °C. So in this study, the composting temperature has met the standard values that exist in each composter.

3.4. Compost quality test analysis

1. Carbon rate analysis

Carbon functions as a microbial energy source to decompose organic material. In this study, C-organic values were in the range of 16.83-29.00%, where the lowest percentage of C-organic was in V1, namely composter which has a composition of 100% cassava peel without any mixture and the highest value in V7 composters with a composition of 50% cassava peel and 50% vegetable and fruit waste added with bio-activator. Based on SNI 19-7030-2004 regarding compost quality standards, the minimum C-organic value is at a value of 9.8, and the maximum is at the value of 32. The variety of C-organic values in each composter is also influenced by the length of composting time. This is because organic carbon compounds are utilized by bacteria as an energy source in metabolic processes and cell multiplication which is converted to CO₂, NH₃, and H₂O aerobically as well as anaerobically,

carbon compounds are converted into organic acids first and then converted to CO_2 , CH_4 , NH_3 and H_2O [12].

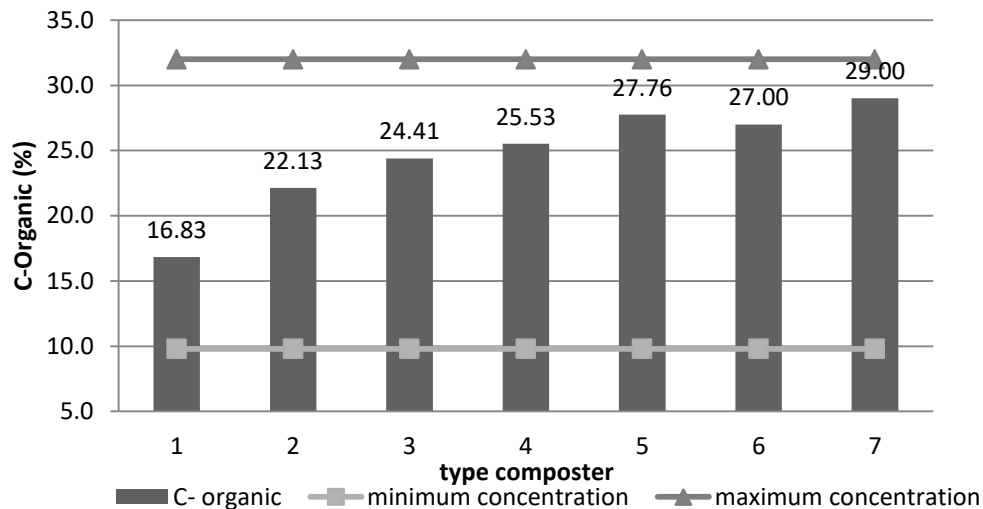


Figure 4. Carbon analysis value

The final content of C-Organic for each variation of compost meets SNI 19-7030-2004. When compared with carbon levels at the start of composting, the carbon content of each composter has decreased. In the composting process changes in organic matter take place into $\text{CO}_2 + \text{H}_2\text{O} + \text{nutrients} + \text{humus} + \text{energy}$. During the composting process, CO_2 evaporates and causes a decrease in carbon content (C) [13]. According to Simamora and Salundik [14] in the breeding process, microbes eat organic carbon as food ingredients and according to Damanhuri [11] in the composting process, 2/3 of carbon is used as an energy source for the growth of microorganisms and another 1/3 is used for bacterial cell formation.

2. Nitrogen rate analysis

Nitrogen (N) is the main component derived from protein, for example in animal waste and is needed in the formation of bacterial cells [11]. Decomposition is a chemical process that produces nitrogen in the form of ammonium and is oxidized again to nitrate [12]. This decomposition process is carried out by microorganisms that are sensitive to environmental conditions, such as temperature, pH, and others. If organic matter which is relatively containing more carbon than nitrogen, there will be a high C/N ratio [12].

Nitrogen is the main nutrient for plants, which is generally needed for the formation or growth of vegetative parts of plants, such as stems and roots. However, if too much can inhibit flower growth and fertilization in plants [15]. While for microorganisms, nitrogen acts as an energy source [12]. Nitrogen content for each variation can be seen in Figure 5.

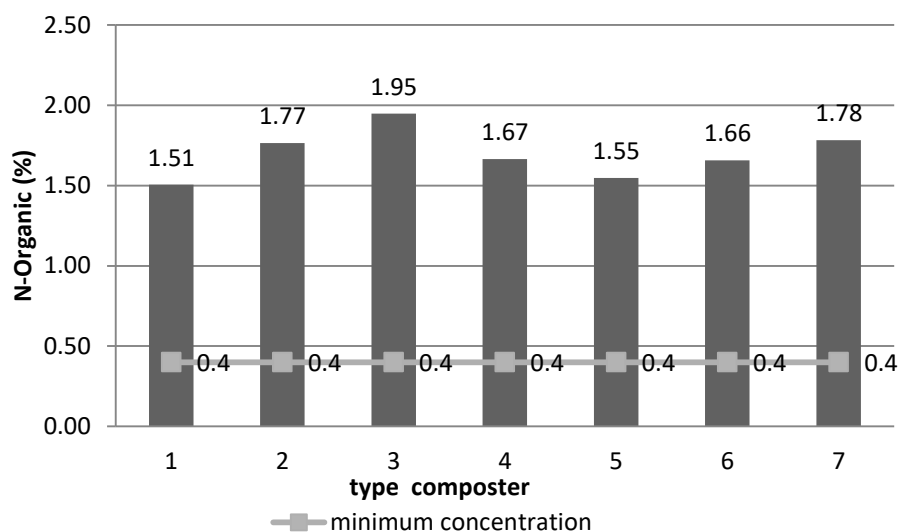


Figure 5. Nitrogen analysis value

The maximum nitrogen content in compost based on SNI 19-7030-2004 regarding the standard of compost quality is 0.40%. Based on the figure above, all variations of compost meet the minimum value of compost standard, where the nitrogen content is in the range of 1.51-1.95%. The highest nitrogen is found in V3 composters with the nitrogen content of 1.95%. Nitrogen content has increased and decreased during the composting process; this is due to fluctuating nitrogen (N). Overall the nitrogen content of each composter has increased. Nitrogen content is needed by microorganisms to maintain and form body cells. The more nitrogen content, the faster the organic matter decomposes, because microorganisms that break down compost material require nitrogen for its development [16].

According to Sutedjo, et al. in [15] that the ability and activity of microorganisms to decompose organic matter is very dependent on the state of the element N in the organic material. According to Pangestuti [17], high nitrogen values are influenced by the availability of sufficient potassium ions so that the amount of K content in compost material can cause nitrogen content to be high. The high value of nitrogen is also influenced by pH values which tend to be alkaline. According to Waluyo in [18], when the temperature rises, mesophilic bacteria activity is stopped and then replaced by a group of thermophilic bacteria. This change produces ammonia and nitrogen.

The lowest nitrogen content is 1.51% in variation 1 with the composition of 100% cassava peel without a mixture of other ingredients. In this variation, there is no addition of bio-activator so that the compost degradation process is less optimal. This is in line with the opinion of Suswardani, et al. [19] which states that the content of N in compost comes from compost organic matter which is degraded by microorganisms so that the ongoing process of degradation (composting) greatly affects the content of N in compost. According to Tarigan [12], nitrogen levels decreased because some NH_3 evaporated and microorganisms in anaerobic conditions could reduce nitrates and nitrite. The process of composting organic nitrogen is converted first to volatile ammonia (NH_3) through an amination process. The amination process is carried out by microorganisms that have many types through enzymatic digestion then ammonia is converted to ammonium (the ammonification process) after which it is converted to nitrite (NO_2^-) and nitrate (NO_3^-) nitrification processes which are more stable forms of nitrogen.

3. C/N rate analysis

One of the most important aspects of total nutrient balance is the ratio of organic carbon to nitrogen (C/N). In living metabolism, microorganisms utilize about 30 parts of carbon for each part of nitrogen.

About 20 parts of carbon are oxidized to CO_2 , and ten parts are used to synthesize protoplasm. The C/N ratio is the ratio between the levels of carbon and nitrogen contained in compost useful for microorganisms for the decomposition of organic compounds. Carbon and nitrogen are needed by microorganisms as a source of energy in the decomposition process of organic compounds. Carbon is a source of energy for microorganisms, while nitrogen is the most important component as a protein constituent. Bacteria need nitrogen to accelerate their growth. If the amount of nitrogen is too little, then the bacterial population will not be optimal, and the process of decomposition of the compost will become slower.

Conversely, if the amount of N is too much, it will cause microbial growth very quickly. In these circumstances, some of the nitrogen will turn into ammonia gas which causes odor. This situation will be detrimental in the composting process because it causes the nitrogen we need to be lost [9]. The results of the C/N ratio for each variation can be seen in the following figure 6.

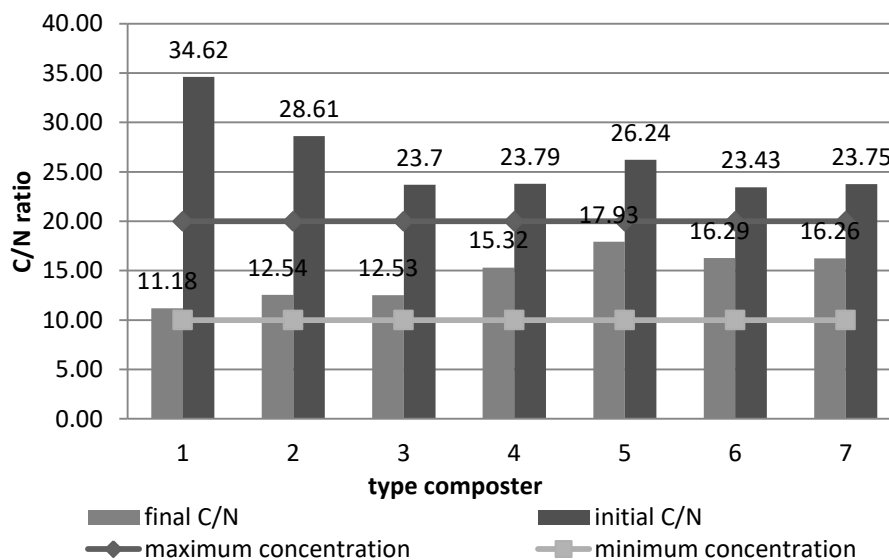


Figure 6. C/N ratio value on initial composting

Based on the results of the initial C/N ratio analysis, the compost raw material was in the range of 23.43 - 34.62. This value meets the initial C/N ratio, which must be in the range 20-40. Therefore, all variations of compost raw materials in this study can be continued for maturity testing and compost quality.

One factor that influences the composting process is the C/N ratio. The C/N ratio is the sum of the ratio of carbon elements to the nitrogen contained. Microorganisms break down carbon compounds (C) as energy sources and use nitrogen (N) for protein synthesis. In certain C/N ratios, microorganisms will get the right carbon element for the right energy and nitrogen elements for protein synthesis. If the organic matter has a C/N ratio close to the C/N ratio of the soil, then the material can be absorbed or used by plants.

The ratio of C/N organic matter is an indicator of nutrient availability. If organic matter which has a high C/N ratio is not composted first (directly given to the soil), then the decomposition process will occur on the ground. In the process of digestion by microorganisms, a combustion reaction occurs between elements of carbon and oxygen to heat and carbon dioxide. This carbon dioxide is then released in the form of gases, while the decomposed elements of nitrogen are then captured by microorganisms. When microorganisms die, the nitrogen element will stay in compost (with dead bodies), so the C/N ratio decreases [20]. If the value of the C/N ratio is too low, then the compounds

used as sources of energy by microorganisms are not enough to bind free nitrogen. However, if it is too high, it can be a limiting factor for the growth of microorganisms [12].

The C/N ratio for compost based on SNI 19-7030-2004 regarding minimum compost quality standards is 10, and the maximum is 20. Based on Figure 6 there is a decrease in the C/N ratio at the end of composting. According to Pandebesie [13], the decrease in the value of the C/N ratio in each composter was due to a decrease in the amount of carbon used as a microbial energy source to decompose or decompose organic material. In the composting process changes in organic matter take place into $\text{CO}_2 + \text{H}_2\text{O} + \text{nutrients} + \text{humus} + \text{energy}$. During the composting process, CO_2 evaporates and causes a decrease in carbon content (C) and an increase in nitrogen (N) so that the ratio of C/N compost decreases. C/N ratio that is too high will slow the decay process, on the contrary, if it is too low even though the decay process initially runs quickly, but eventually slows down due to lack of C as a source of energy for microorganisms. Variations that have the lowest C/N ratio are found in V1, which is 11.18. The C/N ratio in this variation is the best, which is close to the C/N ratio of the land. According to Damanhuri [11], the price of C/N soil is 10-12, so materials that have a C/N value close to the C/N value of the soil can be used in plants. Based on Figure 6 it can also be seen that the highest C/N ratio in V5 is 17.93. C/N ratio that is too high is not good for plants because it can cause the decomposition process in the soil. This is not good because the process of fresh decomposing material in the soil usually runs fast because the water and air content are sufficient which will cause CO_2 in the soil to rise so that the plants cannot grow properly [15].

The C/N ratio shows the quality of the compost material used. A high C/N ratio shows the high content of cellulose and lignin in the material, so the decomposition of the material is difficult and vice versa. Therefore, the initial C/N ratio of an organic material to be decomposed will affect the rate of supply of N and other nutrients [18].

4. Phosphor rate analysis

Phosphorus is an element that is difficult to dissolve in water but is needed by microorganisms for the synthesis of nucleic acids so that its existence is very important for the survival of microorganisms [17]. The analysis of phosphorus content can be seen in figure 7.

Based on SNI 19-7030-2004 regarding the quality standards of compost, good compost has a minimum phosphorus content of 0.1%. In figure 7 it can be seen that all variations meet the standards set. The highest phosphorus content is found in variation 3, which is 6.47%. This is in line with the opinion of Suswardani et al. [19] and Stofella and Kahn [21] which stated that content (P_2O_5) in compost was thought to be related to the N content in compost material. The greater the nitrogen contained, the multiplication of microorganisms that break down phosphorus will increase so that the phosphorus content in the compost material also increases. The phosphorus content in the compost material is used by most microorganisms to build cells. The overhaul of organic matter and the process of phosphorus assimilation occur due to the presence of phosphatase enzymes produced by some microorganisms. The lowest phosphorus content is found in variation 1, which is 1.98%. According to Winarso [22], microorganisms have an important role in the creation of phosphorus. Organic P compounds are converted and generalized into organic compounds. According to Tarigan [11], not all phosphorus is released as phosphate, certain amounts are assimilated by microorganisms to synthesize new cell material so that the value becomes high. Phosphate elements are needed by microorganisms in preparing ATP and ADP in supporting their activities so that their development and activities become faster in the decomposing organic matter [17].

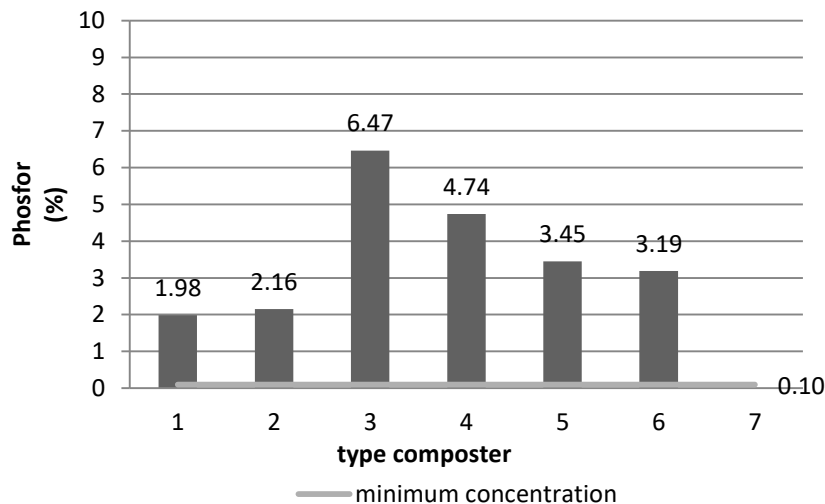
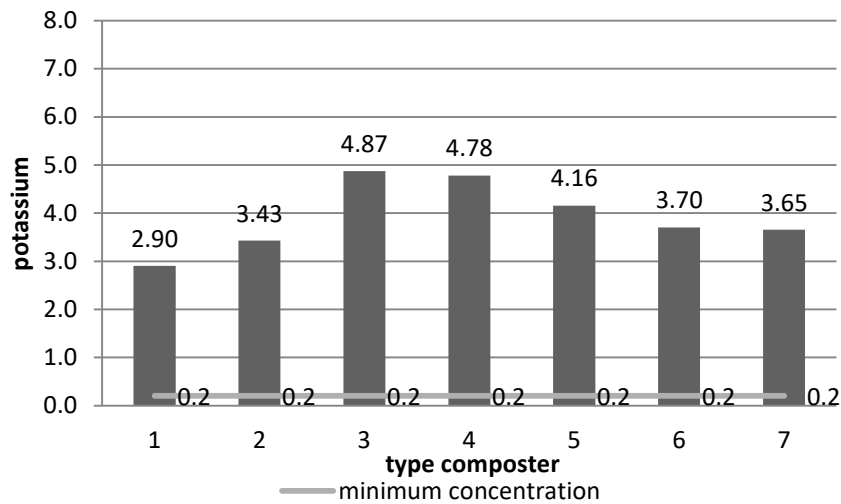


Figure 7. Phosphor value analysis

5. Potassium rate analysis

Binder element of potassium comes from the decomposition of organic matter by microorganisms in a pile of compost material. Compost material which is a fresh organic material containing potassium in complex organic forms cannot be used directly by plants for its growth. However, the activity of the microorganisms decomposes the organic compound can be converted into simple organic which ultimately results in the element potassium can be absorbed plant. Potassium has an important role in photosynthesis formation of proteins and cellulose, in addition to strengthening the stem of the plant, which also means to enhance plant resistance [22]. Potassium (K_2O) are not in protein; potassium is not a direct element in the formation of organic matter, just play a role in helping the formation of protein and carbohydrates. Potassium is used by microorganisms in the substrate as a catalyst, with the presence of bacteria and their activity will greatly affect the increase in potassium content [18]. The level of potassium in the compost variation can be seen in Figure 8.

Based on SNI 19-7030-2004 concerning the standard of compost quality, the potassium value that must be in the minimum good compost is 0.2%. At the end of composting all variations of compost meet standard values for potassium parameters. The highest potassium level in variation 3 was 4.87%, and the lowest in variation 1 was 2.9%. Potassium levels can also be influenced by the use of activators and environmental factors. In the composting process, the raw material for compost will be decomposed by microorganisms. This process requires optimal conditions such as adequate nutrient availability, adequate air, and proper moisture [22].

**Figure 8.** Potassium value analysis

6. Compost quality analysis

Recap of compost quality analysis result shows in table 3. By comparing with compost standard SNI 19-7030-2004, all parameters have complied with the standard.

Tabel 3. Recap of compost quality

Item	MC (%)	C-organic (%)	N (%)	C/N	P (%)	K (%)
Standard	< 50	9,8-32	> 0,4	10-20	> 0,1	> 0,2
V1	9,32	16,83	1,51	11,18	1,98	2,90
V2	14,74	22,13	1,77	12,54	2,16	3,43
V 3	20,93	24,41	1,95	12,53	6,47	4,87
V 4	9,67	25,53	1,67	15,32	4,74	4,78
V 5	16,33	27,76	1,55	17,93	3,45	4,16
V 6	9,21	27,00	1,66	16,29	3,19	3,70
V 7	19,55	29,00	1,78	16,26	3,02	3,65

The result of this composting does not produce liquid leachate. Therefore the quantity compost analysis calculated is only the quantity of solid compost volume. Solid compost is a mature compost produced at the end of composting. Recapitulation of the quantity of compost can be seen in table 4.

Table 4. Recap of Compost Quantity

No	Variation	Total weight (kg)	Product (kg)	Reduction (kg)
1	V 1	3	1,5	1,5
2	V 2	3	1,2	1,8
3	V 3	3	1,2	1,8
4	V 4	3	1,2	1,8
5	V 5	3	1,2	1,8
6	V 6	3	1	2
7	V 7	3	1	2

Based on table 4, it can be seen that solid compost of all variations in this study ranged from 1 to 1.5 kg. The most compost is produced by variation 1 with the amount of solid compost as much as 1.5 liters. The quantity of solid compost that is relatively more produced by V1 can be influenced by the composition of the use of raw materials that only use cassava peel. The composition of raw materials that only use cassava peels causes the process of overhauling organic matter not to run well so that the quantity of compost is produced more than other variations — the small amount of solid compost produced in the V6 and V7 as much as 1 kg with a mixture for V 6 that is 60% cassava peel, 40% domestic organic waste (VFW) and bio-activator. V7 uses mixing 50% cassava peel, 40% domestic organic waste (VFW) and bio-activator. C/N levels for V6 and V7 respectively with values of 16.29 and 16.26 help speed up the composting speed and also the amount of material reduced during composting. This is influenced by the presence of bio-activators to remodel organic material in cassava peel waste and domestic waste (VFW). This mixing is considered balanced because the organic material can be decomposed by microorganisms so that the amount of compost produced at the end of composting is little because the decomposition process runs optimally.

4. Conclusion

Based on the results of the study regarding the effect of adding domestic organic waste to the quality of composting of solid waste from cassava chips industry using a takakura composter, it can be concluded that the addition of vegetable and fruit waste influences the composting of the industrial solid waste of cassava chips (cassava peel). Based on the compost maturity test all parameters of compost maturity meet the existing standards, namely SNI 19-7030-2004 regarding compost quality standards. Based on the compost quality test all composters also meet the existing standards, namely SNI 19-7030-2004 about compost quality standards. The quantity of solid compost is produced at most by V6 by mixing 60% cassava peel plus 40% domestic organic waste and bio-activator (EM4). The best raw material composition based on scoring results from selected quality and quantity aspects of V6 with the composition of mixing 60% cassava peel plus 40% domestic organic waste and bio-activator (EM4).

References

- [1] Rahman M 2011 *Industri Keripik Balado Christine Hakim di Padang tahun 1990-2007* Tugas Akhir Sarjana Jurusan Sastra Daerah Universitas Andalas [in Indonesian]
- [2] Yuwono D 2005 *Kompos dengan cara aerob maupun anaerob, untuk menghasilkan kompos berkualitas*. Penebar Swadaya. Jakarta [in Indonesian]
- [3] Ankabi 2007 *The Use Of Compost Extract As Foliar Spray Nutrient Source and Botanical Insecticide in Telfairia Occidentalis* World Journal of Agricultural science [in Indonesian]
- [4] Alex S 2012 *Sukses Mengolah Sampah Organik* Pustaka Baru Press Yogyakarta [in Indonesian]
- [5] Hapsoh H, Gusmawartati G, Yusuf M 2015 *Effect various combination of organic waste on compost quality* Journal of Tropical Soils **20 (1)** 50-65 [in Indonesian]
- [6] Sangodoyin A Y and Amori A A 2013 *Aerobic composting of cassava peels using cow dung, sewage sludge and poultry manure as supplements* European International Journal of Science and Technology **2(8)** 22-34 [in Indonesian]
- [7] Badan Standar Nasional 2004 SNI 19-7030-2004 tentang Spesifikasi Kompos dari Sampah Organik Domestik [in Indonesian]
- [8] Afrina Y 2007 *Pengaruh Pemisahan Sampah Organik Sejenis Terhadap Kualitas Kompos Dalam Komposter Rumah Tangga*. Universitas Andalas. Padang Center for Policy and Implementation Studies (CPIS) Buku Panduan Teknik Pembuatan Kompos dari Sampah, Teori dan Aplikasi. Jakarta [in Indonesian]
- [9] Lestari D and Sembiring E 2010 *Komposting dan Fermentasi Tandan Kosong Kelapa Sawit*. Tugas Akhir Sarjana Program Studi Teknik Lingkungan Fakultas Teknik Sipil dan Lingkungan Institut Teknologi Bandung Bandung [in Indonesian]

- [10] Djuarnani N, Kristian and Budi 2005 *Cara Cepat Membuat Kompos* AgroMedia Pustaka Jakarta [in Indonesian]
- [11] Damanhuri, E and Padmi T 2016 *Pengelolaan Sampah Terpadu* Penerbit ITB Bandung Indonesia [in Indonesian]
- [12] Tarigan 2012 *Pembuatan Pupuk Organik Cair Dengan Memanfaatkan Limbah Padat Sayuran Kubis (*Brassica Aleracege. L*) Dan Isi Rumen Sapi* Fakultas Matematika Dan Ilmu Pengetahuan Alam Universitas Sumatera Utara [in Indonesian]
- [13] Pandebesie E S, Rayuanti D 2013 *Pengaruh Penambahan Sekam Pada Proses Pengomposan Sampah Domestik* Jurnal Lingkungan Tropis **6(1)** 31 – 40 [in Indonesian]
- [14] Simamora, Suhut and Salundik 2006 *Meningkatkan Kualitas Kompos* AgroMedia Pustaka Jakarta [in Indonesian]
- [15] Tarigan, D.M, (2008). Pengaruh Pembalikan, Orgadec, dan Nitrogen Terhadap Laju Pengomposan Sampah Organik Serta Kualitas Kompos Yang Terbentuk Dalam Rangka Perbaikan Kebersihan Lingkungan. Program Pasca Sarjana. Fakultas Matematika Dan Ilmu Pengetahuan Alam. Universitas Sumatera Utara [in Indonesian]
- [16] Sriharti, Salim T 2008 *Pemanfaatan Limbah Pisang Untuk Pembuatan Pupuk Kompos Menggunakan Kompos Rotary Drum* Prosiding Seminar Nasional Bidang Teknik Kimia dan Tekstil Yogyakarta [in Indonesian]
- [17] Pangestuti M 2008 *Kajian penambahan isolat bakteri indigenous sampah kota terhadap kualitas kompos dari berbagai imbalanced kacang tanah (*Arachis Hypogaea*) dan jerami padi (*Oryza Sativa. L*)* Program Studi Ilmu Tanah Fakultas Pertanian Universitas Sebelas Maret Surakarta Indonesia [in Indonesian]
- [18] Ely W R 2013 *Rasio C/N, Kandungan Kalium (K), Keasaman (Ph), dan Bau Kompos Hasil Pengomposan Sampah Organik Pasar Dengan Starter Kotoran Sapi (*Bos taurus*) Dalam Berbagai Dosis* [in Indonesian]
- [19] Suswardany D L, Ambarwati and Kusumawati Y 2006 *Peran Efective Microorganism-4 (EM-4) Dalam Meningkatkan Kualitas Kimia Kompos Ampas Tahu* Jurnal Penelitian Sains & Teknologi **7 (2)** 141 – 149 [in Indonesian]
- [20] Center for Policy and Implementation Studis (CPIS) 1992 *Buku Panduan Teknik Pembuatan Kompos dari Sampah, Teori, dan Aplikasi* Jakarta [in Indonesian]
- [21] Stoffella P J and Khan B A 2001 *Compost Utilization in Horticultural Cropping System* Lewis Publisher. London
- [22] Winarso S 2005 *Kesuburan Tanah Dasar Kesehatan dan Kualitas Tanah* Java Media Yogyakarta [in Indonesian]
- [23] Choy S Y, Wang K, Qi W, Wang B, Chen C L, Wang J Y 2015 *Co-composting of horticultural waste with fruit peels, food waste, and soybean residues* Environ. Technol **36** 1448–1456