

Original Paper

Evaluate of Coffee Husk Compost

Endar Hidayat¹, Asmak Afriliana^{1,3}, Gusmini², Masuda Taizo¹, Hiroyuki Harada^{1*}

1) Department of Environmental Science, Prefectural University of Hiroshima, Shobara, Japan

2) Department of Soil Science, University of Andalas, Padang, Indonesian

3) Department of Agricultural Product Technology, University of Jember, Jember, Indonesian

*) Corresponding Author: ho-harada@pu-hiroshima.ac.jp

Received: 5 September 2019; Accepted: 16 April 2020

DOI: <https://doi.org/10.46676/ij-fanres.v1i1.8>

Abstract Purpose In this study, to evaluate the physico-chemical properties of coffee husk compost. **Methods** The compost process in aerobic condition for 84 days. Physico-chemical parameters were analyzed. In addition, the seed germination, leaf width, stem length, and fresh weigh yield of Compost were investigated on matured Compost using *Brassica rapa*. **Results** The obtained results indicate that the pH value 7.72 and EC value 12.54 ms/cm. The total carbon value of 37.41%. The total nitrogen value of 2.05%. The C/N ratio value 18.2. The seed germination indicates that Compost was matured with a range of 80-100%. On compost yields the optimum doses of the *Brassica rapa* 3% with leaf width 1.3 cm, stem length 5.1 cm, and fresh weight 2.18 gram. **Conclusion** Generally, the final Compost can be served as organic matter for improving soil and plant.

Keywords Coffee husk, Quality Compost, Composting

I. INTRODUCTION

In 2018, the value of coffee production in Indonesian amounted to 612 thousand tons per year [1]. The coffee tree produces a waste of 48%, consisting of 42% of coffee cherry and 6% of the coffee husk [2]. If compared with coffee production in Indonesian that it was equal to 257 thousand tons of coffee cherry and 36.72 tons of coffee husk.

Coffee husks contain compounds such as caffeine, tannins, and polyphenols, which restricts its larger extent uses in agriculture and imposing problem on the environment [4]. On the other hand, coffee husk has Nitrogen contains as much as 0.41%, phosphorus contains as much as 0.29%, and potassium contains as much as 1.47% [8]. If compare with the characteristics of Compost according to Indonesia National Standard (SNI 19-7030-2004) [5], that coffee husk have more nutrients are good for agricultural purposes.

Huge amounts of coffee husk are generated and disposed without proper utilization. It is important to consider that this waste can contribute to environmental problems if not disposed properly. The treatment of coffee waste by composting reduces the severe damage that the application of immature Compost to the soil would cause and allows complete conservation of the residual energy stored in the organic material, as mentioned by [6]. Composting process is one of the most suitable ways of

disposing of unpleasant waste and increasing the amount of organic matter that it can be used to restore and preserve the environment [7]. The objective of this study was to evaluate the physico-chemical properties of coffee husk compost.

II. MATERIAL AND METHODS

A. Preparation of *Bacillus* Activator

The bacillus activator that we used is a commercial activator. The activator is patented by the Bio-Food Industry Research Center and the Industrial Technology Center, Fukuoka Prefectural, and produced by the non-profit organization Ecoycle Kyushu/Okinawa, Japan. The function of the activator is to activate the solvent bacteria, rapidly degraded organic materials, and added to enhance the composting process [8].

B. Preparation of Compost Vessel

The type of vessel that used in this research was a plastic box that contains holes along it up to allow the aeration process to occur. The dimension of the composting vessel was shown in Fig 1. The length of the vessel is 21 cm, width 19.5 cm, height 12 cm.

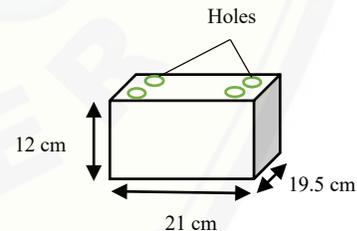


Fig 1. The dimension of box used as compost vessel

C. Treatments and Composting Procedure

The study was conducted at the Prefectural University of Hiroshima, Shobara campus. The structural materials were used coffee husk (200 g) mixed with cow dung (100 g), chicken manure (100 g), and rice grain (50 g), and bacillus activator commercial (EBB) with dose 1ml/100 ml water. The moisture of water content was maintained in the range of 45-60%. All these materials were put into the composting vessel (Fig 1). The

process of composting during 84 days. Coffee husk from Solok Radjo Cooperative, West Sumatera province, Indonesian. Cow dung and chicken manure from Yasaki. Co. Ltd. Japan.

The composting process in aerobic conditions. The decomposition of organic material in aerobic composting proceeds more rapidly as compared to the anaerobic process. In anaerobic decomposition the composted material must be held for periods of six months to a year to ensure the proper decomposition of organic material while in aerobic composting the complete decomposition time (or composting time) is about 3 to 6 months [9]. Aerobic composting is the most efficient form of decomposition, and produces finished Compost in the shortest time. There are several advantages of an aerobic condition like a) rapid decomposition of raw material, b) the number and intensity of objectionable emissions are sharply reduced and, c) can be generated in a short of time [10]

D. Physical and Chemical Analysis

The physical and chemical analysis include: the temperature was measured by using a digital thermometer, the pH was measured used IAQUA twin-pH-22B, electrical conductivity (EC) was measured used IAQUA twin-EC-33B were determined by [11]. Ammonium (NH₄-N), nitrate (NO₃-N), and phosphate (PO₄) were extracted by shaking 1 gram of sample with 10 ml NaCL, and concentration was determined in the filtered extract by molecular absorption spectrophotometry [12]. Total organic carbon and total organic Nitrogen were determined in the dry sample by Macro Corder-MT 6.

E. Germination and vegetable productivity test of the matured compost samples

Before sowing the seed of *Brassica rapa* on the composted samples, equal proportions of compost samples (50 g and 10 seeds with two replication) were filled in a pot and put in a greenhouse with a temperature of 30°C. The LED model (PF15-S5WT8-D with power 5W) was used as a light source and placed in the greenhouse. The free space between lamps and a pot about 37 cm. The treatment of this study is A0; only soil, A1; 1%, A2; 3% and A3; 5%. Compost is used to assess whether the leaf width, stem length, and fresh weight of the *Brassica rapa* is increased or not using by Compost after 1 month growth. Soil and plant it was separated from the pot first, so that easy to measure leaf width, stem length, and fresh weight. *Brassica rapa* was chosen for the study because it is a common vegetable and economical, which is easily grown. The germination study was conducted for check the mature Compost. Germination is defined as the emergence and development from the seeding, its ability to produce a normal plant under favorable conditions. Each seedling was monitored carefully, and the final leaf width, stem length, and fresh weight were noted.

Calculate of germination index :

$$\text{Germination index (\%)} = \frac{\text{Number of Emerged Plants}}{\text{Number of Seeds Sown}} \times 100$$

III. RESULTS AND DISCUSSION

Chemical composition of the major organic material used for composting is presented in Table 1. The analysis data revealed

that the pH of the coffee husk was low in reaction 5.98 when compared to cow dung (pH 6.43), chicken manure (pH 6.48), and rice grain (pH 6.27). The low pH of coffee husk may be due to the presence of acids in these materials. The EC of coffee husk was 0.9 ms/cm, indicating the presence of lower soluble salt content in these wastes. The coffee husk contained a high amount of carbon 46.26% and lower nitrogen 0.43% when compared to cow dung, chicken manure, and rice grain. If the higher of the level Nitrogen materials, it will be easier for decomposition and also will be increasing the level of Nitrogen [13].

Table 1. Physico-Chemical Properties of Compost Materials Before Composting.

Nutrient Data	Rice Grain	Chicken Manure	Cow Dung	Coffee Husk
pH	6.27	6.48	6.43	5.98
EC (ms/cm)	15.67	13.47	1081	0.9
NH ₄ (mg/g)	0.76	2.15	2.66	0.17
NO ₃ (mg/g)	0.28	0.4	0.69	0.2
PO ₄ (mg/g)	0.38	0.19	0.34	0.063
Total Carbon (%)	43.42	19.36	29.55	46.26
Total Nitrogen (%)	2.23	2.15	2.39	0.43
C/N ratio	19.4	9	12	105.21

EC: electrical conductivity

Table 2. Physico-Chemical Properties Initial and After Composting

Nutrient Data	Initial	After
pH	7.57	7.72
EC (ms/cm)	8.26	12.54
NH ₄ (mg/g)	0.26	0.12
NO ₃ (mg/g)	0.49	0.48
PO ₄ (mg/g)	0.16	0.1
Total Carbon (%)	42.06	37.41
Total Nitrogen (%)	1.17	2.05
C/N ratio	35.09	18.2

EC: electrical conductivity

Physico-chemical properties initial and after composting in Table 2. The composition of coffee husk is dependent on cultivation conditions, particularly, the amount of fertilizers, soil, and kind of coffee. The results also showed that the content of C/N ratio is so high for plants. Therefore, to improve the quality of Compost and reduce the time of incubation, we proposed a supplement of chicken manure, cow dung, and rice grain.

In this research is added rice grain that has a total carbon level above 30%, which served to add nutrient content in the mixture of Compost. The presence of high carbon content can decrease C/N ratio of materials. The more sources of energy carbon used in the composting process can decrease the C/N ratio because the carbon is used as a source of energy in the metabolic process and accelerate the decomposing process.

Adding poultry manure (cow dung and chicken manure) to the process of composting is beneficial as a source of nutrient to build new cells of microorganisms, so that accelerate the maturation process [14]. More nitrogen content can rapidly of the organic material decomposes process, and it will decrease the value of C/N ratio materials because microorganisms are describing the compost material to its development [15].

Physical properties

During the composting process, there was a physical change in the Compost, as shown (Fig 2). Physical of Compost also provides information about whether the Compost is mature or not yet before analysis chemical. The final physical condition of Compost on this research is shaped crumbs, crushed, and the color was brown. As mentioned by [16] that the physical of Compost has been crushed, and it does not resemble the original.



Fig 2. Physical properties of coffee husk and coffee husk compost.

The size of the compost material is one the factor in accelerating the composting process. Size of the material about 5–10 cm is suitable for composting from the aspect of air circulation that may be occurring [17]. The wider surface area will increase the contact between the microbes with the materials, and the decomposition of the process will run faster be caused the microbial activity occurs between the surface area and the air.

When reaching the composting, the size of the material changes to become smaller, and there were small grain shapes. It is a result of the decomposition process by microorganisms during composting.

Temperature

Temperature is one of the factors in composting be caused by the presence of the microorganisms. The temperature measurement of compost was 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77 and 84 days. Every three days, the compost was stirring by spoon. The purpose of stirring was to make the process can be equal and homogenized. Stirring was done by changing the position of the top Compost to the bottom in the vessel. Stirring has the purpose of disposing of excessive heat, inserting fresh air into the compost piles, and to destroy the material to small particles [18]. The temperature of Compost during the composting process always changed. Variation in temperature is one of the most important parameters that reflect the microbiological activity in the composting process [19].

The initial temperature of the composting process was 22°C, then decreased and increased during the composting process until finished to 27°C. The increased temperature in the compost piles indicates that microorganisms were doing well in describing organic materials into NH₃⁺, CO₂, moisture content. After most of the materials have decomposed, composting begins to enter the maturation and cooling stage [18].

If compare with other studies, the increase in temperature is still relatively low. Might be caused the process of composting was done at the laboratory and during the spring season with

temperature 4-14°C. Some authors also have reported that aeration can delay the fermentation process through the release of heat from fermentation piles [20].

Physico-chemical properties of coffee husk compost

A. pH

As mentioned by [7], that pH is one of the indicators to know the maturity level of Compost. As shown in Fig. 3, the pH pattern was fluctuating, where the value begins to increase until reaching day 7 with 7.9 value. The increase in pH value indicates that the decomposition of organic matter inside the compost medium has occurred and ammonium was formed be caused the characteristics of the ammonia is alkaline [21]. After day 7, the pH value decreases up until day 14. Decreased in pH value might be caused by the formation of carbon dioxide gas and organic acid during organic matter decomposition [21].

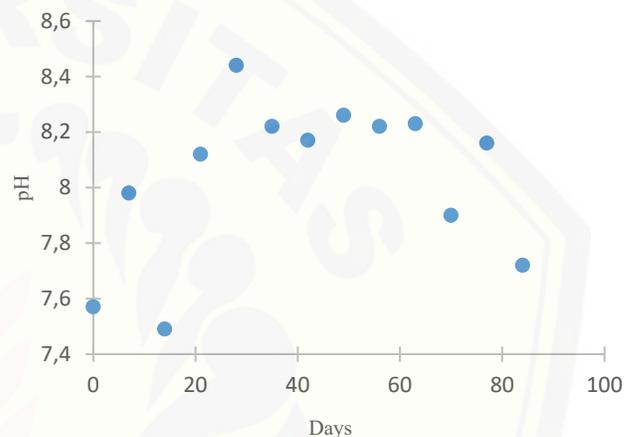


Fig 3. pH during the period

After day 14, the pH value starts to change from neutral to alkaline conditions on day 28 from 7.49 to 8.44. the changes may cause by the released of protein that comes from the mixture of vegetable remains (rice grain) that use along composting process [22]. At the end of the composting process, the value of pH was decreased again due to the enzymatic oxidation of the compound inorganic is the results of the decomposition process [23]. The final compost 7.72 value. The better pH for Compost between 5.5 and 8.5 value [24].

B. Electrical Conductivity (EC)

The EC values indicate that the application of these matured compost types for agriculture purposes will not damage the crops or vegetables, as indicated by [24] who reported that the majority of plants could not withstand soluble salt content beyond 4000 ms/cm.

The highest EC values of the piles were obtained at the end of the composting process from 8.26 to 12.54 ms/cm. As mentioned by [16] obtained the same results, and they indicated that the increase in EC might have been due to release of different mineral ions, such as phosphate, ammonium, and potassium.

C. Total Nitrogen %

The content of Nitrogen in Compost is strongly influenced by the composting process, and raw materials were used. In the process of composting, the form of Nitrogen that can be absorbed by plants from the decomposition of organic materials is ammonium (NH_4^+) and nitrate (NO_3^-). The compound is derived from a protein decomposition process [26]. In the process of composting, the nitrogen content is needed for microorganisms for the maintenance and formation of body cells. If you have more nitrogen content, it will be faster for decomposing, because of the microorganisms requiring Nitrogen for development [15].

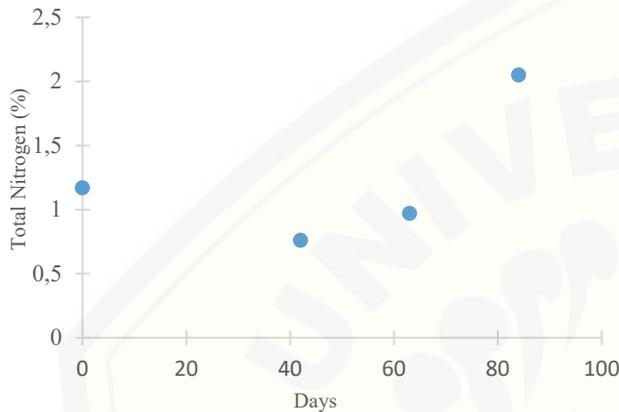


Fig 4. Total Nitrogen during period

As shown in Fig 4, the value of Nitrogen has decreased and increased during composting process. On day 0 to 42, the value of Nitrogen has decreased from 1.17% to 0.76%. Decreased in Total Nitrogen value might caused Nitrogen was reacting with water forming NO_3^- and H^+ . The loss of Nitrogen is solved by the stirring of the compost piles so that water content is reduced, oxygen supply is sufficient for the decomposed microorganisms of protein onto ammonia (NH_4^+), and the aeration process will be better. While after day 42 until the end of the composting process, the value of Nitrogen has increased from 0.76% to 2.05%. On the other hand, if we compare with the C/N ratio after 42 days occurred decrease, as shown in (Fig 5). This is because the process of decomposition of microorganisms for produce ammonia and Nitrogen and the C/N ratio thus decreased during composting [27].

Nitrogen is the primary macronutrient elements that are essential for plant growth. Nitrogen is important for the formation of proteins and plant reproduction [39]. The content of Nitrogen in the Compost is very influenced by the process of composting and raw materials used. In the process of composting, nitrogen forms that can be absorbed by plants from the results of the decomposition of organic material is ammonium (NH_4^+) and nitrate (NO_3^-). The compound comes from the decomposition of proteins [26].

The content value of Nitrogen after the composting process increase from 0.43% to 2.05% due to increase the value of Nitrogen which take place on organic materials relegated greater than NH_3 as well as the occurrence of the decomposition

process organic material by microorganisms that produce ammonia and nitrogen N value, so that the value nitrogen of Compost is increased [28].

D. C/N Ratio

The C/N ratio is an indicator of maturity compost. The initial (day 0) of composting has the C/N ratio values of suitable criteria for the compost materials, which ranges from 30-50 [28], be caused it is considered that the microorganisms require 30 parts of C per unit of N [40]. The highest C/N ratio makes the process very slow as there is an excess of degradable substrate for the microorganisms. The process of the composting was conducted for 84 days due to the C/N value of the initial ratio of high is 35.09, and it was taken a long time for degradation [18].

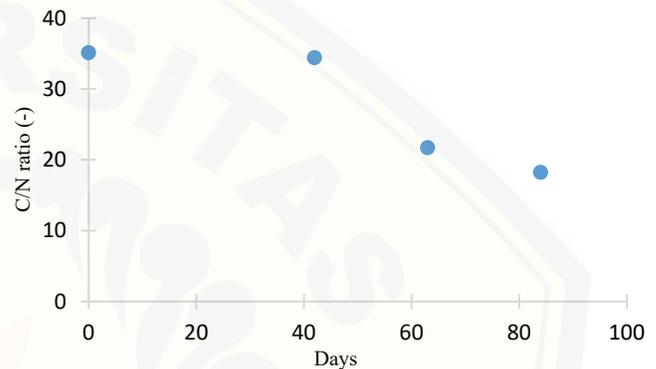


Fig 5. C/N ratio during period

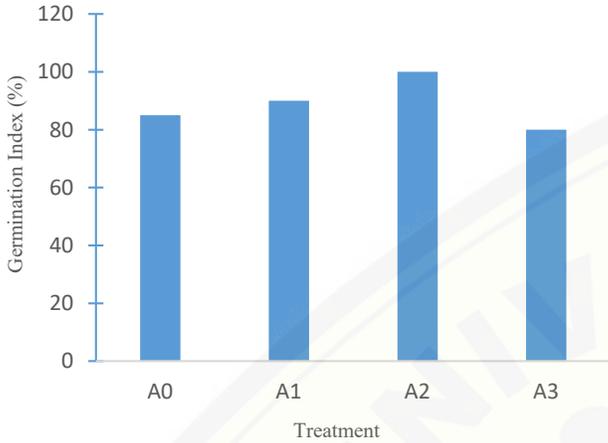
As shown in Fig 5, the C/N ratio decreased until the end of composting process. This is because of carbon as a source of energy for microorganisms and Nitrogen in the formation of microorganisms. During the composting process CO_2 was evaporation, and carbon value will decrease, and nitrogen value will increase. The final of C/N ratio 18.2.

Organic materials have become Compost and can be used for plants if the C/N ratio is < 20 [24]. The high C/N ratio (> 30) on Compost indicated that the Compost was immature and caused slow decomposition and inhibit crop growth due to a shortage of Nitrogen. While the low C/N ratio (< 10) caused Nitrate-N, which can reduce the quality of agricultural crops or percolation into the water supply [17], a decrease in the value of C/N ratio should be equal to C/N ratio of soil might caused easy for the absorption of compost content into the soil [29]. The C/N ratio for the soil with range 10-20 [8].

Germination Test and Yield of Leaf Width, Stem Length, and Fresh Weight

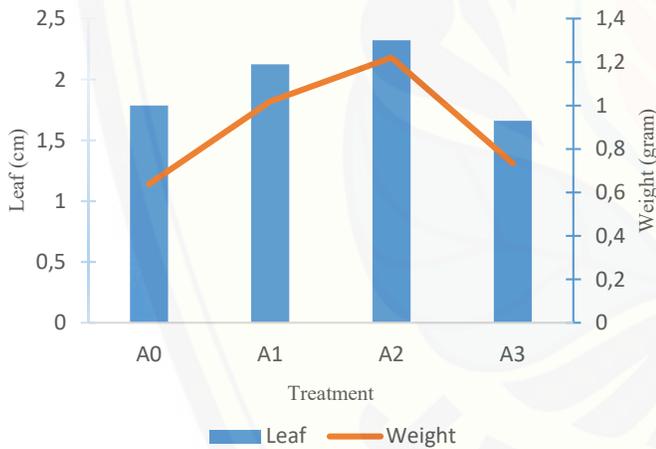
As mentioned by [30], suitable temperature for cultivation of *brassica rapa* with range 15-30°C. As shown in Fig 6, that all the germination index with range 80-100%. As mentioned by [31] a germination index below 50% characterizes an immature compost. This is indicated that all the produced compost samples were rated mature since the sown *Brassica rapa* were germinating and grew. This is implies that the

produced compost samples are free of plant phytotoxicity materials [32].



A0; Control (only soil), A1; 1%, A2; 3%, A3; 5%.

Fig 6. Germination Index (%)



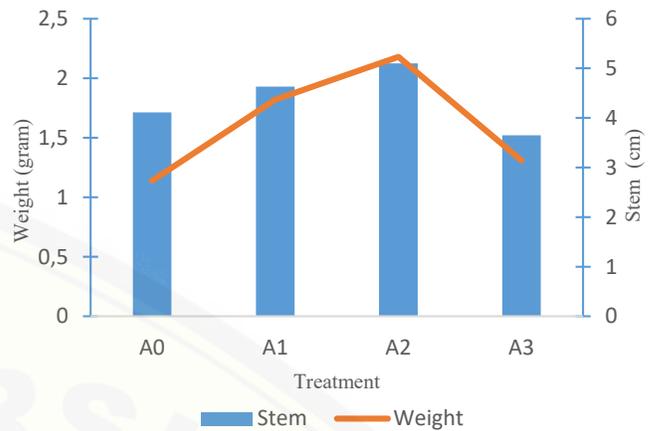
A0; Control (only soil), A1; 1%, A2; 3%, A3; 5%.

Fig 7. Leaf width and fresh weight

The height of plant is shown Fig 7, leaf width, and fresh weight at A2 are 1.3 cm and 2.18 gram, respectively. This indicates that if wide leaf width of the plant it will be increase of fresh weight of the plant because the leaf width is very closely related to the photosynthesis of plants to be stored and it can be generated with the increase of fresh weight [33].

As mentioned by [34], a wider leaf can form and store more nutrients for increase fresh weight. The fresh weight of plants is influenced by nutrient content in plant cells. The rapid growth of the leaves causes the absorption of nutrients, water, and light

for the photosynthesis process is more optimal; the resulting assimilate is used for the development of plants that increase rapidly, so that the fresh weight of plants will increase [35].



A0; Control (only soil), A1; 1%, A2; 3%, A3; 5%.

Fig 8. Stem length and fresh weight

The height of plant is shown Fig 8, stem length and fresh weight at A2 are 5.1 cm and 2.18 gram respectively. This indicates that the highest the *Brassica rapa* can be higher the fresh weight of the plant, because the formation of carbohydrate the results from assimilation plant it will can be increase fresh weight of the plant [36].

As mentioned by [36], organic materials, such as Compost should be adjusted (in a balanced condition) to be implemented to the plant. The yield can be seen from the value of the leaf width, stem length, and fresh weight of the plant. Compost includes a solid organic fertilizer that is slow release (release the nutrients contains by slowly) and when given to the soil that the process of decomposition takes a long time to be absorption by plants [38]. The yield of the plant can be seen in (Fig 9).

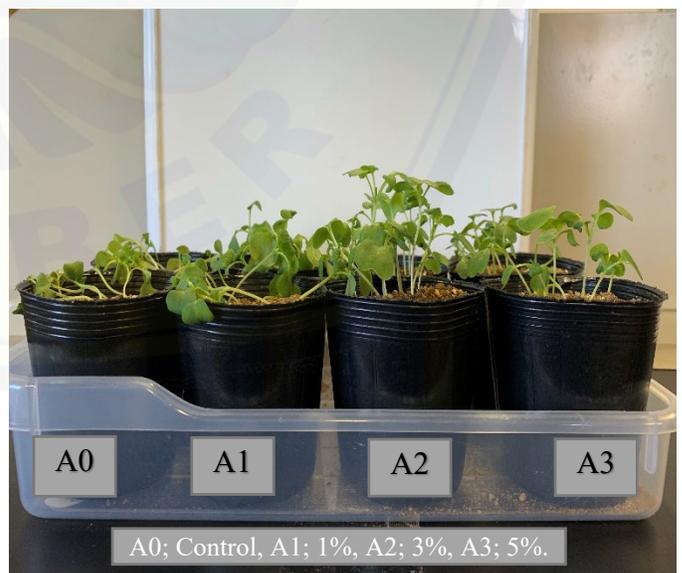


Fig 9. *Brassica rapa* after 1 month growth.

CONCLUSION

An experimental study was carried out successively to determine the physical and chemical properties of coffee husk compost. The obtained results indicate that the pH value 7.72 and EC value 12.54 ms/cm. The total carbon value of 37.41%. The total nitrogen value of 2.05%. The C/N ratio value 18.2. The process of composting in aerobic conditions for 84 days. The germination index value ranged from 80-100%, and this indicates that the coffee husk compost is matured. On compost yields the optimum doses of the *Brassica rapa* 3% with leaf width 1.3 cm, stem length 5.1 cm, and fresh weight 2.18 gram.

ACKNOWLEDGMENT

I would like to thanks to Japanese Government for support financial during master degree program in Japan.

REFERENCES

- [1] Statista, 2019. World's Largest Coffee Producing Countries in 2018 in (1,000 60 kilogram bags). Retrieved from <https://www.statista.com/statistics/277137/world-coffee-production-by-leading-countries/>
- [2] Stentiford, E.L., 1987. Recent developments in composting. In: de Bertoldi, M., Ferranti, M., L'Hermite, P., Zucconi, F. (Eds.), *Compost, Production, Quality and Use*. Elsevier, London, pp. 52-60.
- [3] Zainuddin, D. dan T. Murtisari. 1995. Used of waste coffee cherry in Broiler. Proceeding. Scientific meetings of communication and distribution. Research Center and Development of Animal Husbandry. Bogor. P. 71-78
- [4] Franca As, Oliveira LS (2009) Coffee Processing solid wastes: current uses and future perspectives. In: Ashworth GS, Azevedo P (eds) *Agricultural Wastes*. Nova science publishers Inc, New York, pp 155-189
- [5] The Indonesian Standardization Body. 2004. SNI19-7030-2004 compost specification from domestic organic waste.
- [6] Preethu D, Bhanu Prakash B, Srinivasamurthy C, Vasanthi B (2007) Maturity indices as an index to evaluate the quality of Compost of coffee waste blended with other organic wastes. In: Proceeding of International Conference on sustainable solid waste management, Chennai, India, Citeaser, pp 270-275.
- [7] Wahyono, S., Firman S., dan Feddy S., 2003. *Utilization garbage as Compost*. Edision 1. Jakarta
- [8] Melisa (2018). Study of The Utilization of Waste Leather of Toraja Coffee as Compost Making Materials. *Journal of Hasanuddin University*.
- [9] Gabhane, J., S.P. William, R. Bidyadhar, P. Bhilawe, D. Anand, A.N. Vaidya and S.R. Wate (2012). Additives aided composting of green waste: Effects on organic matter degradation, compost maturity, and quality of the finished Compost. *Bioresour. Technol.*, **114**: 382-388.
- [10] Zeng, J., G.W. Price and P. Arnold (2012). Evaluation of an aerobic composting process for the management of Specified Risk Materials (SRM). *J. Hazard Mater.*, 219:260-266.
- [11] Rice H (1996). Monitoring Compost pH, C/N ratio. Cornell Waste Management Institute Dept. of Crop and Soil Sciences Cornell University. <http://cwmi.css.cornelledu>. Accessed in 20/12/2009. Hawassa research center.
- [12] Houba, V.J.G., I. Novozamsky, and J.J. Van der Lee. (1995). Influence of storage of plant samples on their chemical composition. *The Science of the Total Environment* 176: 73-79.
- [13] Made, I, Dana (2016). The effect add multiple waste livestock on organic waste market against the quality of Compost. Thesis, Faculty of Agriculture, Udayana University. Bali.
- [14] Budi Nining Widartil, Wardah Kusuma Wardhini, Edhi Sarwono. (2015). the effect c/n ratio of raw materials on making Compost from cabbage and banana bark. *Journal of integration process* Vol. 5, No. 2 (Juni 2015) 75 – 80
- [15] Salim, T., Sriharti. 2008. Utilization of Industrial Waste Dodol Pineapple as Compost and Application on Tomato Plants. Proceeding of National Conference Teknoin. Chemical and Tekstil Engineering. Yogyakarta, 22 November 2008. P. 72-77
- [16] Yadav, A., Garg, V.K., 2011. Recycling of organic wastes by employing *Eisenia fetida*. *Bioresour. Technol.* 102 (3), 2874–2880.
- [17] Setyorini, D., R. Saraswati, dan E.K. Anwar. 2006. *Compost*. Bogor: Agriculture Agency Research and Development of Indonesian.
- [18] Isroi. 2008. *Compost*. Bogor: Research Center. Bioteknologi of Indonesian Plantation
- [19] Epstein E (1997). Trace elements, heavy metals and micronutrients. P. 137-170. In: E.Epstein (ed.). *The science of composting*. Technomic Publ., Lancaster, PA..
- [20] Himanen M., Hänninen M., 2011. Composting of bio-waste, aerobic and anaerobic sludges - Effect of feedstock on the process and quality of Compost. *Bioresour. Technol.* 102, 2842-2852.
- [21] L. Meng, W. Li, S. Zhang, C. Wu, W. Jiang, C. Sha. *Ecol. Eng.* 94, 240, (2016)
- [22] I. Zakarya, S. Khalib, T. Tengku Izhar, S. Yusuf. *Engineering Research and Technology* 4(8), 181-184, (2015).
- [23] Baharuddin, A.S., M. Wakisaka, Y. Shirai, S. Abd-Aziz, N.A.A. Rahman, and M.A. Hassan. 2009. Co-Composting of Empty Fruit Bunches and Partially Treated Palm Oil Mill Effluents in Pilot Scale. *International Journal of Agricultural Research*. 4 (2) : 69 – 78
- [24] Fialho, L.L.; Silva, W.T.L.; Milori, D.M.B.P.; Simoes, M.L; Martin-Neto, L. Characterization of organic matter from composting of different residues by physicochemical and spectroscopic methods. *Bioresource Technology*, Essex, v. 101, n.6, p. 1927-2934, Mar. 2010
- [25] Gessesse, A. and Mamo, G. (1998) Purification and characterization of an alkaline xylanase from alkaliphilic *Micrococcus* sp. AR-135. *Journal of Industrial Microbiology and Biotechnology* 20, 210–214.
- [26] Hardjowigeno, S. 2003. *Soil Science*. Jakarta: Akademika Pressindo.
- [27] Cesaria, R.Y., Wirosedarmo, R., Suharto, B. 2010. The Effect of Using a Starter on The Quality of Fermented Tapioca Liquid Waste as an Alternative to Liquid Fertilizer. *Journal of Natural and Environmental Science*. 12(2):8-14.
- [28] Bernal, M. P. et al., (2009). Composting of Animal Manures and Chemical Criteria of Compost Maturity Assessment. *Science Direct*. Vol 100, Pages 5444-5453
- [29] Djuarnani, N., Kristian dan Setiawan, B.S. (2005). *How to Quickly Make Compost*. Edition 1. Jakarta : Library of AgroMedia
- [30] Sukmawati, S. 2012. Cultivation of *Brassica chinensis*. L by organically with the influence of some types of organic fertilizer. *Scientific works*. Politechnic of Lampung State. 9 pages.
- [31] Zucconi F, Pera A, Forte M. De Bertoldi M (1981) Evaluating toxicity of immature Compost. *BioCycle (USA)* 22(2): 54-57.
- [32] Dadi D, Sulaiman H, Leta S (2012) Evaluating of composting and the quality of Compost from the source separated municipal solid waste. *J Applied Science Environmental Managed* 16:5-10.
- [33] Setiawan, Eko. 2009. Effect four kinds of organic fertilizer on mustard plant (*Brassica jucea* L.) *Journal of Embryo*. 6(1): 27-34
- [34] Ratna DI. 2002. Effect of combination of biological fertilizer concentration with liquid organic fertilizer to the quality and quantity of the results of the tea plant (*Camellia sinensis* (L.) O. Heron) Clone Gamdude 4. *Agriculture Science* 10(2): 17-25.
- [35] Dwijoseputro. 1994. *Introduction of Plant Physiology*. PT. Gramedia Pustaka Utama, Jakarta.
- [36] Endang. 2007. Effect of organic fertilizer and Nitrogen fertilizer for vegetative growing of cucumber (*Cucumis sativus* L.). Faculty of Agriculture. Bogor Institute of Agriculture
- [37] Susanto R. 2002. *Application of organic farming and development*. Kanisius. Yogyakarta.
- [38] Smith J.L, Papendick, D. F. Bezdicke, J. M. Lynch, 1993. Soil Organic Matter Dynamics and Crop Residue Management. pp: 65-94. in : Metting, F. B. (ed.). *Soil Microbial Ecology*. Marcel Dekker, Inc. New york-Barsel Hongkong.

[39] Rynk, R., van de Kamp, M., Willson, G. B., Singley, M. E., Richard, T. L., Kolega, J. J., Gouin, F. R., Laliberty Jr., L., Kay, D., Murphy, D. W., Hoitink, H. A. J., and Brinton, W. F. (1992). *On-Farm Composting Handbook*, NRAES-54, Natural Resources, Agriculture, and Engineering Service, Cooperature Extension, 152 Riley-Robb Hall, Ithacy, NY 14853-5701.

[40] Bishop, P. L. Godfrey, C., 1983. Nitrogen transformation during sewage composting. *Biocycle* 24, 34-39

