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Original Research Article

ORGANIC FERTILIZER DECOMPOSITION RATE AGAINST SOIL NUTRIENTS

ABSTRACT

Land is a non-renewable resource, if seen from the potential improvements caused by environmental damage. Damage to the land is caused by the degradation of soil organic matter. Formulation of organic fertilizer in planting media is an alternative in agricultural cultivation on marginal land. The study aims to obtain organic fertilizer formulations used in agricultural cultivation. The study was arranged using a completely randomized design with treatment: M1 (25% Biochar, 25% vermicompost, 30% chicken manure, 20% compost), M2 (25% Biochar, 25% vermicompost, 20% chicken manure, 30% compost) , M3 (25% Biochar, 25% Vermicelli, 30% Cow manure, 20% Compost), M4 (25% Biochar, 25% Vermicelli, 20% Cow manure, 30% Compost), M5 (25% Biochar, 25 % vermicompost, 30% Goat manure, 20% Compost), and M6 (25% Biochar, 25% vermicompost, 20% Goat manure, 30% Compost). Statistical test results obtained on the M3 treatment provide the availability of nutrients (C-organic, N-total, P-total and K-total) which are significantly different and the highest yield compared to other treatments. Whereas the results of FTIR analysis found that the treated media had experienced decomposition of organic matter, so that organic elements were produced which could support the availability of plant nutrients.

Keywords: Organic materials, Plant Nutrition and FTIR

1. INTRODUCTIONS

Land is a landscape that not only provides support for human settlements and some benefits for economic activities, but land is also a non-renewable resource, if seen from the potential improvements caused by environmental damage [1]. Land availability that has relevance to good ecosystem quality impacts, land use requires use based on the impact of these activities. so that land use that is integrated and harmonized with the impact indicators arising from these activities must be considered [2; 3].

The use of intensive agricultural cultivation has long been carried out in agriculture now, this is done to get high yields and quality production. To meet these needs, the use of chemical fertilizers and pesticides is carried out intensively, with high costs and creating environmental problems. The impact of environmental damage, agricultural cultivation began to be directed at sustainable and environmentally friendly agricultural cultivation [4]. The use of soil enhancers is increasingly important in sustainable agricultural systems, this is made possible by the low costs in farming, the use of non-renewable and environmentally friendly resources [5]. Soil enhancers are organic materials that are not easily biodegradable (resistant) or easily decomposed which are given to the soil with the aim of improving soil fertility, chemically, physically and biologically. The presence of soil enhancers is expected to improve soil physical properties, with the improvement of physical properties it is possible to increase the soil water content, so that it is possible to reduce the value of salt concentration in the soil. The soil conditioner ingredients that are commonly used are organic materials such as vermicompost which improves soil structure, drainage and enhances the ability to retain water by adding organic matter [6].

Organic matter naturally is at the surface of the soil, the organic material will decompose slowly due to the activity of microorganisms and produced nutrients called organic fertilizers. The process of decomposition of natural organic matter can be accelerated by the composting process. In the development of the modern industrial society the composting process is used to manage urban waste. The possibility of high demand for organic fertilizer, various types of crop residues, animal manure, urban sludge can be used as materials to be converted to a stable end product in the form of organic fertilizer [7].

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Exploration of the influence of organic fertilizer on sustainable land improvement is needed to maintain soil fertility, quality and productivity [8].

FT-IR spectroscopy is a method for characterizing and analyzing microorganisms and monitoring the biotechnological process with changes in the content of biochemical components [9; 10]. The method of using FTIR spectoscopy is based on the typical absorption of the Infra Red spectrum from an organic substance which is not only to identify compound purity, but also to analyze quantitative complex multi-component mixtures [11; 12]. Analysis was carried out in this method without separation of individual components, but also mixed numbers [13].

2. MATERIALS AND METHODS

This research was conducted using materials in the local environment to be used as research material. The land used as research media is derived from marginal land located east of Surabaya and Sidoarjo.

2.1 Research sites

The study was conducted in a greenhouse, UPN Veteran East Java, Indonesia. The experiment was conducted from April to September 2017, the weather conditions during the experiment were the lowest rainfall 4 mm to 128 mm month^{-1}, the air temperature between 24°C to 33°C and air humidity 41 to 51 percent.

2.2 Incubation Period

The treated media was then moistened and then incubated for 45 days. After the incubation period, the treated soil media is taken to take soil samples for soil chemical analysis and FTIR.

2.3 Research Media

The soil media used for the study came from the Sidoarjo beach area with the type of soil entisol marine. Fresh soil (5 kg in the oven) is weighed and put in pots, then the soil is given manure according to the treatment that has been determined and mixed evenly to reduce heterogeneity.

2.4 Types of Treatment

The treatment used in the treatment is the comparison of the kinds of organic materials used for dosing of organic matter in the soil medium, which is 30 tons ha-1. Types of treatment are:

M1: 25% ww Biochar 25% w Kascing 30% ww Chicken Cage Fertilizer 20% ww Compost
M2: 25% ww Biochar 25% WWW 20% ww Chicken Cage Fertilizer 30% WWW Compost
M3: 25% ww Biochar 25% wWholesale 30% ww Cattle Fertilizer 20% ww Compost
M4: 25% ww Biochar 25% wWhough 20% ww Cattle Fertilizer 30% ww Compost
M5: 25% ww Biochar 25% wwercing 30% ww goat manure 20% ww compost
M6: 25% ww Biochar 25% w vermicompost 20% ww goat manure 30% ww compost
All treatments were repeated 3 times so that the total treatment was 18 treatments.

2.5 Kinds of Organic Ingredients

The organic material used in the study consisted of weathered organic matter and organic material that could decay. Weathered organic material in the form of biochar comes from chaff charcoal, while organic material that can decay consists of organic material derived from plant waste and organic matter derived from animal waste. Organic materials derived from plant waste use compost, while those from animal waste come from the worms, cattle, chickens and goats.

Biochar organic media comes from the rice husk that has been fabricated. Cassava's organic media was obtained from the dirt produced by the vermicompost process of organic matter, compost mixture and manure in the cultivation of *Lumbricus rubellus* earthworms.

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Organic media of manure from ayang comes from chicken manure, cow manure comes from cow manure and goat manure from goat manure.

2.6 Implementation

The study was carried out using experimental design methods that were prepared based on a completely randomized design. 5 kg of soil media is put in pots, then given a treatment in the form of a comparison of the kinds of organic matter with a dosage of 30 tons ha^{-1}. Soil media that have been treated are then incubated for 6 weeks, during the incubation period the soil moisture is maintained. The end of the experiment was to take soil to do soil chemical measurements. The observation parameters in this study include soil chemical analysis. The soil chemical properties parameters were C-organic levels using Walkey and Black method, N-total using micro-Kjeldahl, P-total using Bray and K-total method with 1 M Ammonium Acetate 1 N. extraction method.

2.7 Statistical Analysis:

Statistical analysis used to see the effect of treatment was used a complete randomized analysis (CRD) and continued with BNT test to find out the significant differences between treatments, using SPSS for windows version 14.0.

3. RESULTS AND DISCUSSION

After incubation, soil media were observed for nutritional elements in each treatment on the soil media. These observations include: levels of organic-C, N-total, P-total and K-total. The results of the analysis of the variance of each observation are presented in the table below.

Table 1.

Organic C

Soil C-organic is one indicator of soil quality that is used to determine the level of decomposition of organic matter in the soil [14]. Measurement of C-organic on the planting medium is done after incubation. The measurement is to determine the amount of organic material produced in the decomposition process of plant media after being treated, so that it can be known the difference in C-organic values produced in each treatment. Based on Table 1, it was found that the increase in the percentage of organic matter administration in manure gave higher yields, besides giving cow and goat manure gave different results than chicken. The highest C-organic yield was obtained in cow manure. This shows that organic fertilizers derived from cattle and goats are organic materials that have undergone further weathering compared to organic fertilizers derived from chicken manure, so that the organic material becomes faster and faster. said [15] that organic fertilizers derived from cattle and goat manure have very high microorganism activites and amino acids in the liquid phase of the livestock, so that the organic waste produced becomes organic fertilizer that is easily degraded.

N-total

The total N-yield on treated soil media (Table 1), shows that increasing organic fertilizer can increase total N-soil. Soil decomposition of organic matter will produce total N-soil nutrients that are needed by plants [15]. The results of research on the provision of organic fertilizers derived from chicken manure provide lower N-total soil yields compared to cow and goat manure, the N-total yield due to organic fertilizers derived from animal manure of cattle and goats. N-total in cow and goat manure has a high level due to animal dung mixed with amino acids from the animal's secretions. While in chicken manure, the dissolved nitrogen in the feces is very small, so the level of nitrogen in organic fertilizers derived from chicken manure is lower than that of cows and goats. Decomposed chicken manure has a lower Nitrogen content than cow and goat manure [17].

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P-total

P-total in treated soil media (Table 1), generally shows that increasing organic fertilizer can increase P-total in soil. Soil decomposition of organic matter will produce P-total soil nutrients that are needed by plants [18]. In the provision of organic fertilizer derived from chicken manure, the yield of P-total soil is lower than that of cow and goat. The process of decomposition of organic fertilizer derived from cow dung and goat will quickly decompose, this is due to the components contained in cow and goat dung have a low level of hydrolysis, so that the carbon contained in animal dung will be able to decompose quickly [17]. The existence of a decomposition process that runs quickly, the availability of P-total in the soil will increase [19].

K-total

Potassium is an important element for plant growth, but in the cultural system of agriculture it receives less attention than Nitrogen and Phosphate [20]. The measurement results of K-total soil in the experiment found that the treatment of giving organic fertilizer produced from chicken manure resulted in a lower K-total (Table 1). This shows that the provision of organic fertilizer derived from cow dung and goat provides high K-total yield on the soil due to the organic fertilizer from cow feed ingredients that are rich in potassium, so that the cow or goat manure produced is rich in potassium. According to [21] said that feed ingredients that contain lots of potassium are consumed by cows or goats, so that the potassium formed in animal waste contains a lot of potassium. Further said [22] that the results of composting of poultry manure have lower potassium than manure from cow and cow dung.

C/N Ratio

The rate of degradation of organic matter can be seen from the ratio of C-organic and N-total. The greater the C / N ratio shows that the organic material undergoes a further process, so that the C-organic material content decreases. The results of the experiment showed that the rate of degradation of organic matter is presented in Figure 1.

Figure 1.

The C / N ratio is one of the parameters that is usually used to determine the stability and maturity of decomposition of organic matter [10]. The results of the C / N analysis ratio of the media due to administration showed that all the organic fertilizer in the soil was undergoing a decomposition process, this result was seen in the small C / N ratio. The use of organic material derived from cow and goat manure has a smaller value than chicken. Organic material derived from cow and goat manure has undergone a decomposition process during its digestive system, so that the carbon coming out of the animal's secretions has a smaller value. [23] said that during the process of decomposition of organic matter, the carbon contained in organic fertilizers (compost and animal waste) will decrease. Further said by [24] that the presence of impurities derived from earthworms and animals (cattle or goats) are rich in microorganisms, the presence of microorganisms in vermicompost will cause the level of mineralization of organic matter to be more high. The rate of degradation of organic matter is also influenced by the level of organic C. The content of C-organic in organic matter that will be decomposed quickly becomes a simple compound form by microorganisms [25].

FT-IR analysis

FT-IR spectroscopy techniques are used to determine the level of decomposition of an organic material through several functional groups. In the FT-IR spectrum, the presence of absorbance bands in functional groups shows the process of mineralization [26]. In FT-IR spectroscopy, the evaluation process is based on changes in the relative intensity of the

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tape [13], so that FTIR analysis techniques can be a reliable method for evaluating the maturity of an organic material medium.

The results of the measurement of FTIR analysis of treated soil media are shown in Figure 2.

Figure 2.

Figure 2 shows the FTIR spectrum for treated soil media, the FTIR spectrum results of some of these treatments show that the absorbance region is similar. Varying absorbance values in all treatments successfully measured gave values between spectrum 3,270 cm^{-1} to 3,284 cm^{-1} for peak 1st, spectrum 1,624 cm^{-1} to 1,630 cm^{-1} for the 2nd peak, spectrum 1,376 cm^{-1} to 1,397 cm^{-1} for the 3rd peak and spectrum of 1,027 cm-1 to 1,031 cm^{-1} for the 4th peak.

The absorbance spectrum at the 1st peak shows the presence of C-H and OH bond groups, as in the phenol and carboxylic compounds. At the 2nd peak, the absorbance spectrum shows the presence of carbonyl groups such as Alkene compounds. 3rd peak, absorbance spectrum on Nitro groups such as Nitro Aromatic compounds. While at the 4th peak, the absorbance spectrum shows polysaccharide compounds. According to [27] that the phenol and carboxylic compounds are shown by the presence of C-H and OH group spectros, while the alkene compounds are marked spectro with the carbonyl group.

The results of the absorbance spectrum of soil media treated with showed the dominance of carboxyl and phenol compounds, alkene compounds, nitro in aromatic bonds and polysaccharides. FT-IR results showed that the administration of organic matter in the soil media had undergone a process of mineralization of organic matter and degradation of aromatic compounds (lignin and polyphenols) into simpler compounds [27].

4. CONCLUSION:

The results concluded that the addition of organic matter to the soil medium had a significant effect on the amount of organic C, N-total, P-total and K-total. During the process of decomposing organic matter on the soil, it was found that giving cattle and goat manure was faster than chicken manure. The results of FITR provide all the provision of organic matter has undergone a decomposition process, this is shown by the presence of simple compounds derived from organic matter.

REFERENCES

[1] D. Pimentel *et al.*, “World Agriculture and Soil Erosion,” *Bioscience*, vol. 37, no. 4, pp. 277–283, 1987.

[2] E. Lindeijer, R. Müller-Wenk, and B. Steen, “Impact assessment of resources and land use,” *Life Cycle Impact Assess. Striving Towar. Best Pract.*, pp. 11–64, 2002.

[3] L. Milà I Canals, C. Bauer, J. Depestele, A. Dubreuil, and R. F. Knuchel, “Key elements in a framework for land use impact assessment within LCA,” *Int. J. Life Cycle Assess.*, vol. 12, no. 1, pp. 5–15, 2007.

[4] a Eşitken, H. Karlidağ, S. Ercişli, and F. Şahin, “Effects of foliar application of Bacillus subtilis OSU-142 on the yield, growth and control of shot-hole disease (Coryneum blight) of apricot,” *Gartenbauwissenschaft*, vol. 67, no. 4, pp. 139–142, 2002.

[5] S. Gopalakrishnan, V. Srinivas, B. Prakash, A. Sathya, and R. Vijayabharathi, “Plant growth-promoting traits of Pseudomonas geniculata isolated from chickpea nodules,” *3 Biotech*, vol. 5, no. 5, pp. 653–661, 2015.

[6] B. Appleton *et al.*, “Trees and Shrubs that tolerate saline soils and salt spray drift,” pp. 1–9, 2009.

[7] A. J. Biddlestone and K. R. Gray, “Composting of organic wastes,” *Soil Fertil.*, vol. 28, 2001.

[8] X. Wang, Y. Ren, S. Zhang, Y. Chen, and N. Wang, “Applications of organic manure increased maize (Zea mays L.) yield and water productivity in a semi-arid region,”

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Agric. Water Manag., vol. 187, pp. 88–98, 2017.

[9] E. Y. S. Sim and T. Y. Wu, "The potential reuse of biodegradable municipal solid wastes (MSW) as feedstocks in vermicomposting," *J. Sci. Food Agric.*, vol. 90, no. 13, pp. 2153–2162, 2010.

[10] S. L. Lim and T. Y. Wu, "Characterization of Matured Vermicompost Derived from Valorization of Palm Oil Mill Byproduct," *J. Agric. Food Chem.*, vol. 64, no. 8, pp. 1761–1769, 2016.

[11] T. A. Butler, L. J. Sikora, P. M. Steinhilber, and L. W. Douglass, "Compost age and sample storage effects on maturity indicators of biosolids compost.," *J. Environ. Qual.*, vol. 30, no. 6, pp. 2141–2148, 2001.

[12] R. P. Singh, A. Embrandiri, M. H. Ibrahim, and N. Esa, "Management of biomass residues generated from palm oil mill: Vermicomposting a sustainable option," *Resour. Conserv. Recycl.*, vol. 55, no. 4, pp. 423–434, 2011.

[13] S. L. Lim and T. Y. Wu, "Characterization of Matured Vermicompost Derived from Valorization of Palm Oil Mill Byproduct," *J. Agric. Food Chem.*, vol. 64, no. 8, pp. 1761–1769, 2016.

[14] R. Bommarco, D. Kleijn, and S. G. Potts, "Ecological intensification: Harnessing ecosystem services for food security," *Trends Ecol. Evol.*, vol. 28, no. 4, pp. 230–238, 2013.

[15] C. Wang, X. Guo, H. Deng, D. Dong, Q. Tu, and W. Wu, "New insights into the structure and dynamics of actinomycetal community during manure composting," *Appl. Microbiol. Biotechnol.*, vol. 98, no. 7, pp. 3327–3337, 2014.

[16] A. Gelaw, B. Singh, and R. Lal, "Soil Quality Indices for Evaluating Smallholder Agricultural Land Uses in Northern Ethiopia," *Sustainability*, vol. 7, no. 3, pp. 2322–2337, 2015.

[17] K. Wang *et al.*, "Transformation of dissolved organic matters in swine, cow and chicken manures during composting," *Bioresour. Technol.*, vol. 168, pp. 222–228, 2014.

[18] W. G. Mhango, S. S. Snapp, and G. Y. K. Phiri, "Opportunities and constraints to legume diversification for sustainable maize production on smallholder farms in Malawi," *Renew. Agric. Food Syst.*, vol. 28, no. 3, pp. 234–244, 2013.

[19] K. Wang *et al.*, "Transformation of organic matters in animal wastes during composting," *J. Hazard. Mater.*, vol. 300, pp. 745–753, 2015.

[20] R. Mikkelsen, "Managing Potassium for Crop Production," *Better Crop. with Plant Food*, vol. 7, no. Vol. 92, No. 2, pp. 26–29, 2008.

[21] Z. Yang, L. Zhou, D. Sun, H. Li, J. Cao, and Q. Ling, "The effect of cow dung and Red Bean straw Dosage on soil nutrients and microbial biomass in Chestnut orchards," *Procedia Environ. Sci.*, vol. 10, no. PART B, pp. 1071–1077, 2011.

[22] A. Haně, P. Tlustoš, J. Száková, and J. Balík, "The influence of organic fertilizers application on phosphorus and potassium bioavailability," *Plant, Soil Environ.*, vol. 54, no. 6, pp. 247–254, 2008.

[23] J. Singh, A. Kaur, A. P. Vig, and P. J. Rup, "Role of Eisenia fetida in rapid recycling of nutrients from bio sludge of beverage industry," *Ecotoxicol. Environ. Saf.*, vol. 73, no. 3, pp. 430–435, 2010.

[24] J. Román-Sierra, J. J. Muñoz-perez, and M. Navarro-Pons, "Influence of sieving time on the efficiency and accuracy of grain-size analysis of beach and dune sands," *Sedimentology*, vol. 60, no. 6, pp. 1484–1497, 2013.

[25] A. Hadas, L. Kautsky, M. Goek, and E. Erman Kara, "Rates of decomposition of plant residues and available nitrogen in soil, related to residue composition through simulation of carbon and nitrogen turnover," *Soil Biol. Biochem.*, vol. 36, no. 2, pp. 255–266, Feb. 2004.

[26] R. Gupta and V. K. Garg, "Vermiremediation and nutrient recovery of non-recyclable paper waste employing Eisenia fetida," *J. Hazard. Mater.*, vol. 162, no. 1, pp. 430–439, 2009.

[27] S. A. Bhat, J. Singh, and A. P. Vig, "Instrumental characterization of organic wastes

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for evaluation of vermicompost maturity," *J. Anal. Sci. Technol.*, vol. 8, no. 1, p. 2, 2017.

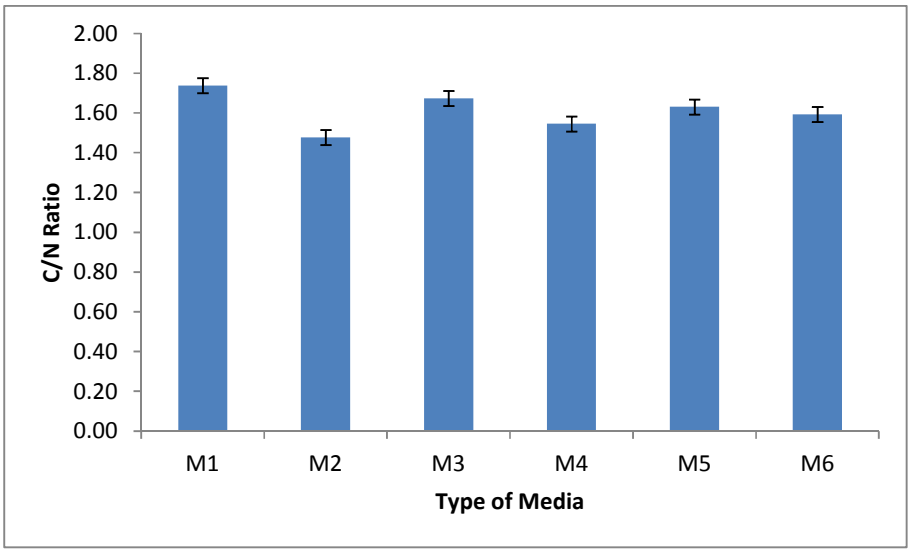

Figure 1. Histogram C / N ratio of media due to treatment

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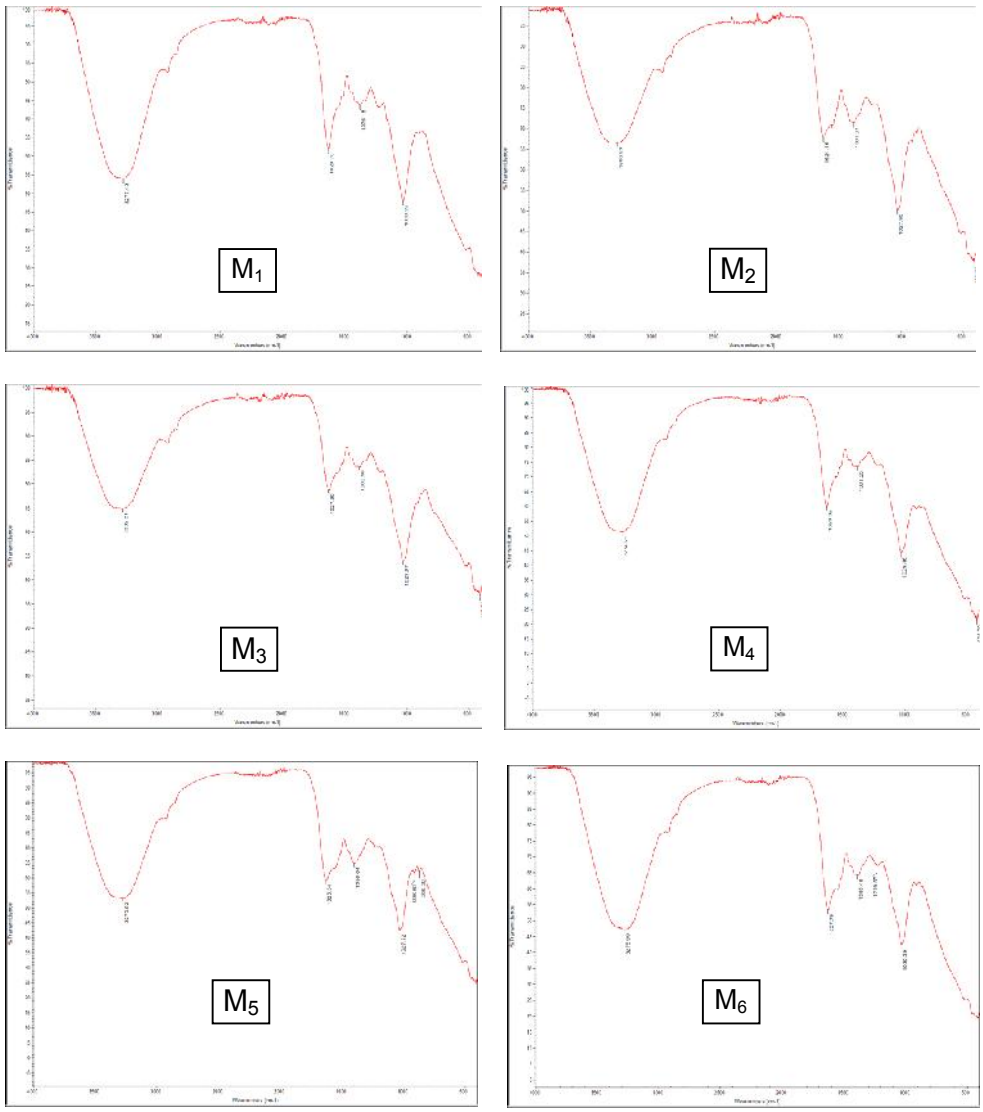

Figure 2. Results of FTIR analysis in all treatments

Table 1. Observations of chemical elements in soil media due to treatment after the incubation period

Treatment	Observation of chemical elements in the media			
	C-organik (%)	N-total (%)	P-total (%)	K-total (%)
M1	2,36 a	1,36 a	1,13 a	0,85 a
M2	2,25 a	1,52 b	1,21 b	0,99 b
M3	2,92 e	1,74 c	1,32 e	1,19 e
M4	2,63 bcd	1,70 c	1,30 cde	1,15 de
M5	2,78 de	1,71 c	1,23 b	1,14 cde
M6	2,75 cde	1,73 c	1,31 de	1,15 de
T-test 5%	0,17	0,06	0,03	0,05

Description: The numbers followed by the same letter in one column do not show a significant difference (p = 0.5).