Advanced and Sustainable Technologies (ASET) eISSN 2976-2294
Volume 2, No 2, December 2023 [11-18]

Composting of Market Waste using Bio-Decomposer

Shahira Huda Shabudin[1] and Tengku Nuraiti Tengku Izhar[1,2*]

[1]Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis, Perlis, MALAYSIA.
[2]Sustainable Environment Research Group (SERG), Centre of Excellence Geopolymer and Green Technologies (CEGeoGTech), Universiti Malaysia Perlis, Perlis, MALAYSIA.

Received 3 July 2023, Revised 23 July 2023, Accepted 25 July 2023

ABSTRACT

This work presents a study on the composting of market waste by using bio-decomposers, which are effective microorganisms (EM), indigenous microorganisms (IMO), and bokashi to compost the market waste. To investigate the effect of different bio-decomposers on the waste composting period in terms of the compost quality (pH, temperature, moisture content, and carbon to nitrogen ratio (C/N)) and also to investigate the nutrients content such as nitrogen (N), phosphorus (P), and potassium (K) in the compost. The compost has been prepared from different mixtures of market waste for 36 days. Market waste with IMO in bin B shows a good result in compost, where the temperature recorded was 28 °C and the pH was 8. The moisture content ranged between 50% and 60% in day 30 and showed the lowest C/N ratio, which was 7:1 and achieved the first maturity phase compared to other bins. The highest nitrogen, potassium, and phosphorus also resulted in compost with IMO, which were 2.3%, 5.2 mg/l, and 1.62 mg/l, respectively. The result showed that compost quality for IMO as a bio-decomposer was superior compared to EM, bokashi, and compost without a bio-decomposer because IMO compost is more effective at breaking down organic matter.

Keywords: Bio-decomposer, composting, compost quality, market waste.

1. INTRODUCTION

Bio-decomposers have been used to speed up the composting process and accelerate the composting of market waste [1]. A bio-decomposer is a substance or organism that can decompose organic matter. This includes bacteria, fungi, and other microorganisms that break down organic matter into simpler compounds, such as carbon dioxide, water, and nutrients. Bio-decomposers are essential for recycling nutrients in the environment [1]. Market or vegetable waste can be composted using bio-decomposer, a sustainable and ecologically friendly alternative for managing and recycling organic waste.

Composting is a process in which microorganisms break down and change complicated degradable materials into organic and inorganic wastes [2]. The main problem faced by the authorities in small and large cities in developing countries is the management of market waste produced from wet markets, which needs to be managed every day. Market waste can pollute the air, water, and soil; when it is not disposed of properly, it can release harmful chemicals and toxins into the environment. This can lead to respiratory problems, water contamination, and soil degradation. Market waste can also pose a public health risk. When disposed of improperly, it can attract pests and rodents, which can spread diseases. It can also produce foul odours that harm human health [3]. Conventional composting is a natural process that takes time and will make the farmer uninterested in composting. The decomposition of organic matter is a complex

*Corresponding author: nuraiti@unimap.edu.my

process that is influenced by a number of factors, including the type of material being composted, the moisture content, the temperature, and the presence of microorganisms. In conventional composting, the decomposition rate is limited by oxygen availability. The microorganisms that break down organic matter require oxygen to survive, and if the oxygen supply is limited, the decomposition process will slow down [6].

The purpose of this research is to increase efficiency in composting market waste quickly by using bio-decomposer as a decomposition agent compared to conventional methods that take 60 days or more to compost. In order to achieve this, the following research goals are planned throughout two phases: to investigate the effect of different bio-decomposers on the waste composting period and to investigate the presence of nutrients such as nitrogen (N), phosphorus (P), and potassium (K) in the compost. This research applied bio-decomposers such as effective microorganisms (EM), indigenous microorganisms (IMO), and bokashi powder to compost the market waste. The observations on market waste compost included physical and chemical components such as nutrients, pH, moisture content, temperature, and C/N ratio.

2. MATERIAL AND METHODS

2.1 Composting Bin Preparation

The size of the composting bin is 6 liters with dimensions of 40 cm height and 20 cm width. The composting bin was drilled with 1-inch holes on all sides and the bottom of the bin to allow airflow.

2.2 Effective Microorganism Preparation

Effective microorganisms are liquid probiotics of beneficial microbes, which are lactic acid bacteria. Firstly, 50 grams of rice was needed and soaked in 200 ml of non-chlorine water. The rice liquid was separated and fermented for approximately 7 days. After 7 days, the liquid changes to murky. The colour of the liquid was brown-yellow. The liquid was put in the jar, and added 1.5 liters of milk. Ferment it again for about 7 days. After 7 days, the curd was removed and the solution was filtered. 600 ml to 700 ml molasses was added and thoroughly combined. EM solution was put in the clean jar and rested for about 3 days before use, and EM was produced. All the material will help produce lactic acid bacteria.

2.3 Indigenous Microorganism Preparation (IMO)

Indigenous microorganisms (IMOs) are the naturally occurring bacteria and fungi in the environment. They are well-adapted to their local climate and conditions and are often more effective at breaking down organic matter than other types of microorganisms.

100 grams of rice were placed in a small plastic container and covered with white paper. The container was placed behind a group of bamboo plants to protect it from sunlight and rain. After 72 hours, the rice developed a light sour odour and was covered in a white mound (mycelium). This was the first stage of IMO production, called IMO I. Next, 1 kilogram of IMO I was mixed with 50 grams of granulated brown sugar in a 1:1 ratio. The mixture was placed in a plastic container and kept in a cold location for five days. This started the second stage of IMO production, called IMO II. After five days, 2 grams of IMO II were added to 2 kilograms of rice bran and 0.75 liters of fermented rice wash water. The mixture was stirred until it was semi-moist and the temperature was no higher than 70°C. The mixture was then poured into a bag and covered with 20 centimeters of dried leaves to keep it dry. This started the third and final stage of IMO production, called IMO III.

IMO III and soil were combined in a 1:1 ratio. The mixture was moistened with 0.25 liters of fermented rice rinse water and kept at a temperature of no higher than 70°C for five days. The mixture was not allowed to exceed 70 centimeters in height and was covered with 20 centimeters of dry leaves to protect it from rain. This process produced IMO IV. Next, 0.2 kilograms of IMO IV were mixed with 2 kilograms of dry goat manure. The mixture was moistened with 2 liters of fermented rice wash water to maintain a moisture content of 65%. The temperature of the mixture was monitored with a thermometer to ensure that it did not exceed 70°C. After 14 days, this process produced IMO V.

2.4 Bokashi Powder

Bokashi powder is a fermented bran that is inoculated with Effective Microorganisms (EMs). It is used in bokashi composting, a type of anaerobic fermentation used to break down market waste. Commercially manufactured bokashi powder was used. Bokashi is created by combining wheat bran, rice husks, and sawdust with various indigenous microbes.

2.5 Composting

Market waste, discarded vegetables, was collected from Pasar Besar Sena, Kangar and chopped into 3 cm thick and 3 cm long pieces. Four bins were filled with a 2:1:1 ratio of market waste and bio-decomposer, with rice husk added as a carbon source.

Bin A: Market waste + rice husk
Bin B: Market waste + IMO + rice husk
Bin C: Market waste + EM + rice husk
Bin D: Market waste + Bokashi poder + rice husk

The temperature was measured using a thermometer, and the pH of the compost was determined by using a soil pH meter. Moisture content was determined by using an oven dry test, where 5 g of the sample was collected for each bin and dried in the oven for 24 hours at 105 °C. Carbon was determined using the loss ignition method. The value of the C/N ratio was calculated by dividing the value of total carbon by the value of total nitrogen. Nitrogen was determined by using the Kjeldahl method. The phosphorus test was done using the PhosVer-3 method, and the potassium test using the Tetraphenylborate method.

3. RESULTS AND DISCUSSION

All of these mixture bins were characterized for pH, temperature, moisture content, nitrogen, carbon-to-nitrogen ratio, phosphorus, and potassium. Market waste with IMO compost matured on day 30 of the composting period.

3.1 Temperature (°C)

Figure 1 shows the temperature changes in the compost from day 1 to day 36. It was taken every three days, and bin B only took 30 days to be ready in an agricultural system. This is due to the fact that it achieved the curing phase first compared to other bins. The compost indicated good stability, in which all temperature phases occurred during composting, which are mesophilic, thermophilic and curing phases. Temperature is an important aspect of monitoring the progress of the composting process. On day 1, all bins entered the mesophilic period below 35 °C, and on day 3, all bins' temperatures increased. This phase is characterized by rapid temperature rise and the beginning of organic matter breakdown [4]. The temperature of bin B and bin D increased day by day due to the presence of more microorganisms except for bin A and bin C. On day 3, bin B exceeded 40 °C, indicating the thermophilic phase caused by indigenous microorganisms' metabolic activities [5]. The thermophilic period was 7 days for bin B, 4 days for bin D, 1 day for bin A, and 3 days for bin C. All treatments, except for bin A, met the criteria for "non-hazardous" compost products, indicating that a thermophilic time of 3 days or more was adequate for eliminating harmful microbes.

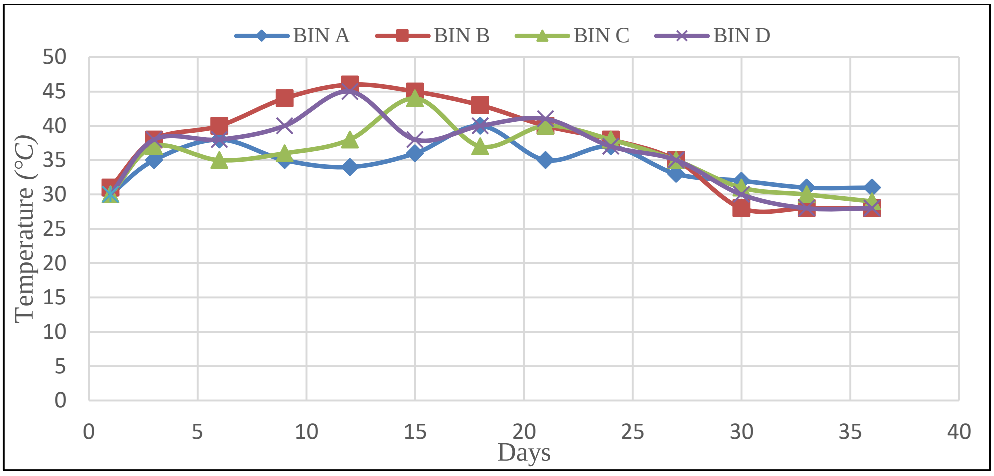

Figure 1: Compost temperature.

3.2 Moisture Content

Figure 2 shows that the moisture content of each bin was monitored during composting. Compost in bin A had the lowest moisture percentage on day 12 compared to bins B, C and D, with moisture content of 62 %, 50 % and 59 %, respectively. Heat produced by microorganisms is the source of moisture content loss. The compost was an open aerated bin containing EM, IMO, and Bokashi powder, but the percentage of moisture content was not at an acceptable level until days 10 and above. Temperature and moisture content are linked and impact the degradation rate and microbial activity [6]. At high temperatures, greater moisture content was seen due to increased microbial activity, which encouraged the growth of microorganisms necessary for composting. The ideal moisture content for a successful composting process is 50-60%, which can be controlled by watering each bin twice a week. The physical state, particle size, and composting procedures affect the ideal moisture content [1].

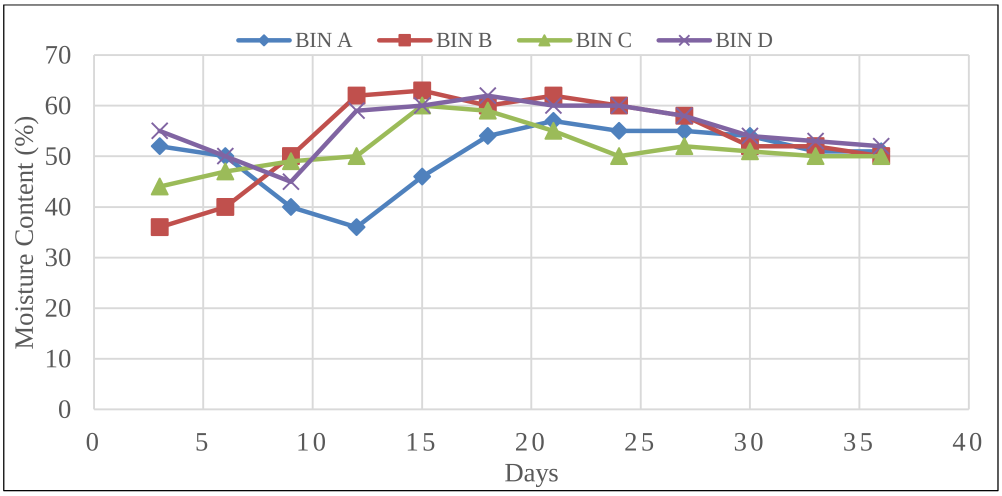

Figure 2: Compost moisture.

3.3 pH

The pH value of market waste must be evaluated to identify the quality of the compost product. It should be between 7.5 and 9.0 for composting, 6.0 and 7.5 for bacterial decomposition, and 5.5 and 8.0 for bacterial breakdown [7]. Figure 3 shows the pH recorded from day one until day 36. The pH of the compost in bin B increased from 8 on Day 15 to 8.5 on day 36. All the compost bins reached an optimum pH value, as recommended by M. Ge [7]. However, compost bin B was considered to be slightly better than other bins because the initial pH value at the beginning of the process was 5 more acidic than bins A, C, and D. Bacteria are the principal decomposers in the early step of composting, releasing acids to break down organic materials. Microbial activity produces ammonia during the ammonification and mineralization of organic nitrogen, which causes an increase in pH values in all compost bins. During this investigation, all of the compost bins were within the ideal pH range for the development of bacteria and fungi but slowly happened to bin A due to the fact that the compost contained fewer microbes [3].

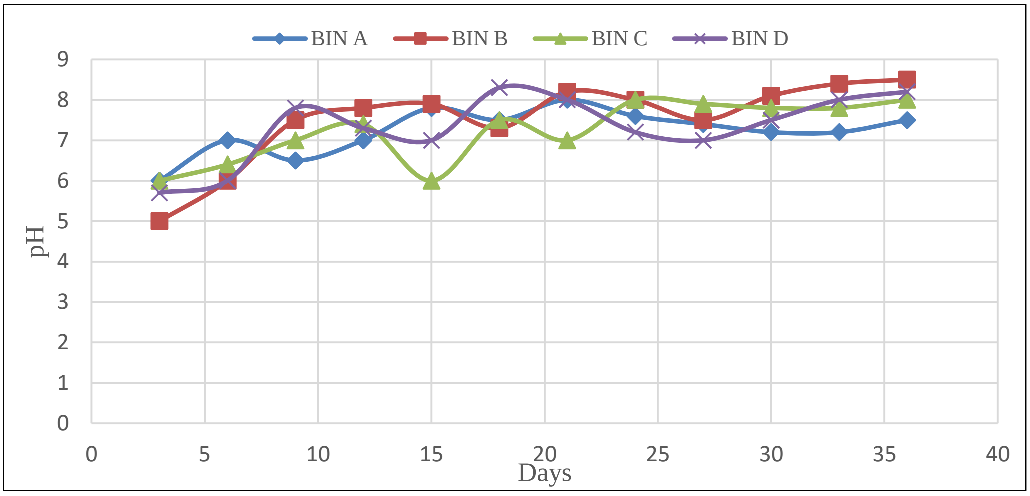

Figure 3: Compost pH.

3.4 C/N Ratio

Table 1 shows the C/N ratio of the final compost on the 36th day. Bernal [8] discovered that a C/N ratio of less than 12 indicates that the compost is stable. When the C/N ratio is between 1 and 15, fast mineralization and nitrogen release occur, making nitrogen available for plant uptake [9]. A compost with a lower C/N ratio is more mature and ready to use, while a greater C/N ratio suggests that the compost is not yet mature and may require more time to compost. The C/N ratio is an excellent predictor of maturity and can be used to identify whether compost is ready to be used.

Table 1: C/N ratio of the final compost on the 36th day.

Bin	C/N Ratio
A	16:1
B	7:1
C	11:1
D	8:1

3.5 Nitrogen

Table 2 shows that bin B had the highest nitrogen content compared to the other three bins after one month of composting. This was due to dry mass loss from carbon dioxide emissions, water loss from evaporation, and nitrogen-fixing bacterial activity. The highest nitrogen content on the

36th day of composting was driven by a net loss of dry mass induced by heat evolved during organic carbon oxidation. Furthermore, an increase in nitrogen content is generated by an increase in inorganic nitrogen due to the concentration effect caused by the intense breakdown of organic carbon compounds.

Table 2: Nitrogen in compost on the 36th day.

Bin	**Nitrogen (%)**
A	1.0
B	2.3
C	1.5
D	2.0

3.6 Phosphorus

Figure 4 shows the trends of the phosphorus concentration in the bins, which slightly increased from day 1 until day 36. Bin B had the highest phosphorus concentration, 1.62 mg/l, on day 36. This is due to the concentration effect generated by the increased rate of carbon loss and the available phosphorus content in organic waste released through the mineralization process [10]. Phosphorus-solubilizing bacteria contribute to increased phosphorus release due to the richness of microbial populations in compost bins. Phosphorus is a difficult element to dilute, but it is required by microorganisms for synthetic nucleate acid [8]. The enzyme phosphatase aids in the process of converting the element mineral phosphorus, causing the microbes in compost to flourish and blossom. The amount of phosphorus in compost is determined by the amount of phosphorus in the basic material and the number of microbes active in the composting process. The content of phosphorus is dependent on the content of nitrogen, and as the number of microorganisms ripping down phosphorus increases, the level of phosphorus will increase. Indigenous microorganisms have the highest concentration of phosphorus, followed by other bio-decomposers such as bokashi powder and effective microorganisms [10].

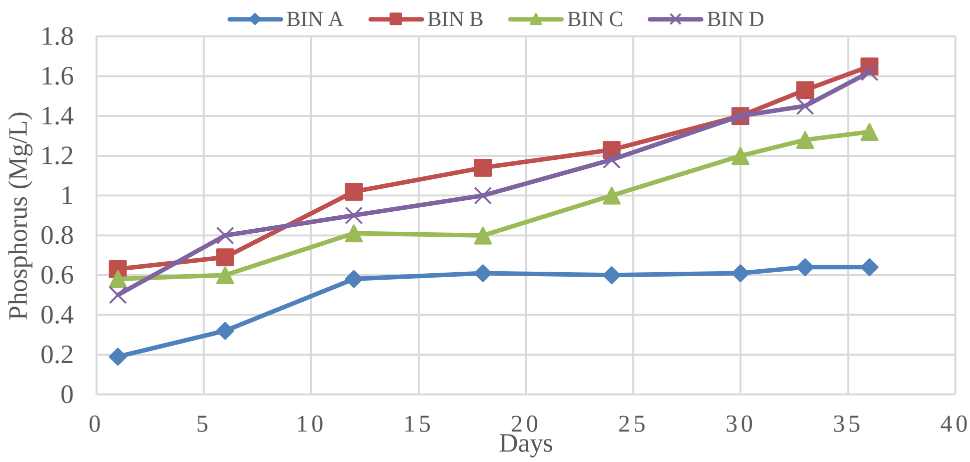

Figure 4: Phosphorus content.

3.7 Potassium

Figure 5 shows the final result of potassium obtained on day 36 for each bin A, B, C and D were 2.5, 5.2, 4.5 and 4.9 mg/l, respectively. The highest potassium concentration was in compost bins B and D due to the presence of microorganisms with the highest potassium levels. The potassium concentration is lower in bin A due to the small quantity of bacteria produced. The study by Zakarya [11] showed that the potassium concentration in 36 days of making mature compost with a bio-decomposer is higher than that in compost without a bio-decomposer. Compost's primary component, potassium, is used in the metabolism of microbes [12], causing the concentration of potassium to develop at the beginning and end of the composting process. The compost material consists of potassium in the form of a complex organic compound that plants cannot use directly. The bacterial solvent phosphate can dilute the element potassium in the organic material [2].

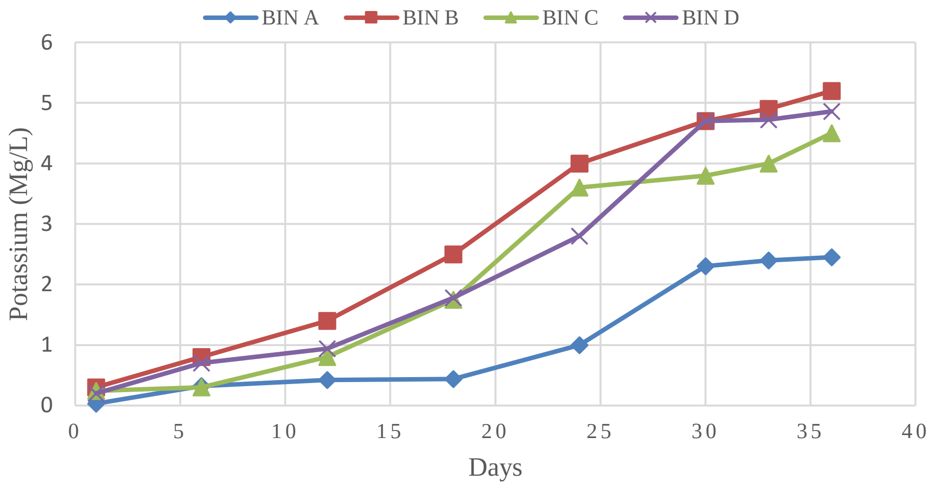

Figure 5: Potassium content.

4. CONCLUSION

The temperature of the matured compost was below 30 °C, and the pH was between 7 and 8. Then, the moisture content showed between 50% and 60% in bin B with IMO, which shows good-quality compost, especially in terms of temperature and pH, and it achieved the first maturity phase on day 30. Bin B, with IMO, had the highest nitrogen and phosphorus readings, 2.3 % and 1.62 mg/l, compared to bin A without bio-decomposer, bin C with EM, and bin D with bokashi powder on day 36. Bin B with IMO also got the highest reading of potassium, which was 5.2 mg/l, which is used to promote plant growth and early root growth. Plant-derived anti-nematode, viricide, bactericide, and fungicide can be added to compost to make it more effective and less hazardous to the environment. Then, the composition of the raw materials used to produce compost affects the quality, stability, and maturity of the finished compost.

ACKNOWLEDGEMENTS

This work was supported by Universiti Malaysia Perlis (UniMAP).

REFERENCES

[1] Suwoyo, H. S., Tuwo, A., Anshary, H., & Mulyaningrum, S. R. H. The effect of various decomposers on quality of organic fertilizer originated from solid waste of super intensive shrimp pond. In IOP Conference Series: Earth and Environmental Science, vol 860, issue 1, (2021 October) p. 012035.

[2] Budiyanto, G. The effect of combination of sugarcane pressmud compost and potassium fertilizer on vegetative growth of corn in coastal sandy soil. Food Research, vol 5, issue 3 (2021) pp. 289-296.

[3] Palaniveloo, K., Amran, M. A., Norhashim, N. A., Mohamad-Fauzi, N., Peng-Hui, F., Hui-Wen, L., ... & Razak, S. A. Food waste composting and microbial community structure profiling. Processes, vol 8, issue 6 (2020) p. 723.

[4] Sardar, M. F., Zhu, C., Geng, B., Ahmad, H. R., Song, T., & Li, H. The fate of antibiotic resistance genes in cow manure composting: Shaped by temperature-controlled composting stages. Bioresource Technology, vol 320, (2021) p. 124403.

[5] Wang, W., Zhang, L., & Sun, X. Improvement of two-stage composting of green waste by addition of eggshell waste and rice husks. Bioresource Technology, vol 320, (2021) p. 124388.

[6] Hafeez, M., Gupta, P., & Gupta, Y. P. Rapid composting of different wastes with yash activator plus. Int. J. Life Sci. Sci. Res, vol 4, issue 2 (2018) pp.1670-1674.

[7] Ge, M., Shen, Y., Ding, J., Meng, H., Zhou, H., Zhou, J., ... & Liu, J. New insight into the impact of moisture content and pH on dissolved organic matter and microbial dynamics during cattle manure composting. Bioresource Technology, vol 344, (2022) p. 126236.

[8] Li, S., Xu, S., Chen, S., Zhang, H., Zhan, Y., Jia, K., ... & Wei, Y. Carbon-containing additives changes the phosphorus flow by affecting humification and bacterial community during composting. Bioresource Technology, vol 379, (2023) p. 129066.

[9] Qiao, C., Penton, C. R., Liu, C., Tao, C., Deng, X., Ou, Y., ... & Li, R. Patterns of fungal community succession triggered by C/N ratios during composting. Journal of Hazardous Materials, vol 401, (2021) p. 123344.

[10] Du, T. M., Yang, H. S., & Niu, X. F. Phosphorus-containing compounds regulate mineralization. Materials Today Chemistry, vol 22, (2021) p. 100579.

[11] Zakarya, I. A., Suhaimi, N. S., & Kamaruddin, A. Comparative evaluation of compost quality, process and organic materials and adoptability potential to complement by Compost Quality Index (CQI). In IOP Conference Series: Earth and Environmental Science, vol 616, issue 1 (2020, December) p. 012042.

[12] Lu, M., Feng, Q., Li, X., Xu, B., Shi, X., & Guo, R. Effects of arginine modified additives on humic acid formation and microbial metabolic functions in biogas residue composting. Journal of Environmental Chemical Engineering, vol 10, issue 6 (2022) p. 108675.