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Chemical analysis of compost using pineapple leaves and cow dung as bio-activator

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Chemical analysis of compost using pineapple leaves and cow dung as bio-activator

Nurdini I. M. Fodzilah, Maryana Mohamad Nor, Fatimah Binti Kayat, Tengku Halimatun Sa'adiah T. Abu Bakar, Suhana Zakaria, Nik M. Sidik and Raimi M. Redwan*

Faculty of Agro Based Industry, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia

*E-mail: raimi@umk.edu.my

Abstract. The number of area planted with pineapple at Malaysia is now increasing, especially after the fruit was recognized as one of the key crop under National Key Economic Area (NKEA). In practice, the pineapple plant remains only for one round of harvest cycle. After the fruit harvest, the leaves is usually pruned in order to stimulate the growth of suckers for the subsequent planting cycle. The pineapple leaves contained immense potential to be developed into products such as compost. In this study, the pineapple leaves were developed into compost by using the cow dung as the bio-activator and its chemical composition was then compared with the commercial organic fertiliser by using the proximate analysis. The composting process was performed in a styrofoam box and the decomposition process took 24 days for the compost to reach the constant ambient temperature at around 35°C. At the end of the composting, the pile turned to darker black colour, and has inert earthy odour. The result showed that the compost produced using the pineapple leaves with the cow dung has 2.86% nitrogen content, 0.93% ash content, and 33.47 moisture level. These values are significantly lower in comparison to the commercial organic compost. The study signified the potential of the pineapple leaves to be developed into compost to improve the soil condition. Nevertheless, the method and its composition need to be expanded in order to improve its elements availabilities suitable as organic compost.

1. Introduction

The number of area planted with pineapple in Malaysia increased from 9,456 hectare in 2014 to 13,027 hectare in 2018 [1]. Pineapple is a plant that has only one cycle of growing, so after the fruits harvest, the leaves and stems from the plantation need to be cleared from the land for the next round of cultivation. The current practice in managing the pineapple waste is by in-situ burning as the practice is low cost or the leaves were shredded and ploughed into the soil before replanting. Previous study indicated that the fresh pineapple residue habors 678.6 gkg^{-1} organic matter, 10.75 gkg^{-1} total N, 0.83 gkg^{-1} P_2O_5 and 11.4 gkg^{-1} K_2O [2]. Several alternatives were proposed to utilized the pineapple residue either for its fiber to make coarse textiles and fiber composite [3], as biosorbent to remove heavy metal residue [4] or fermented pineapple waste for dairy feed [5]. A field experiment to investigate the effect of composted pineapple residue return (CPRR) on field revealed a positive impact on the physical-chemical and biological properties of soil which includes its fertility, enzyme activity and microbial diversity [2]. Moreover, it is proven that the pineapple leaves with the addition of chicken feed, chicken manure slurry and molasses could be developed into a valuable compost with low heavy metal content, phytotoxic-free, and contained significant amount of nutrients to support crop growth [6].

Increasing demand of organic fruits and vegetables has resulted in the usage of compost using organic manure, as it brings positive effect on soil amendment and will reduce the usage of synthetic fertilisers. Compost is a controlled biological decomposition process by which the activities of successive groups of microorganisms degrade organic materials [7]. This had been used for centuries in agriculture in order to improve soil fertility and crop quality. The most important step in composting processes is the decomposition of organic matter and this happens mainly through aerobic decomposition.[8]. In this study, the pineapple leaves were used to make compost by using cow-dung as the bioactivator as it already been cited to fasten the decomposition rate of the lignocellolusic material such as the leaves.

2. Methodology

2.1. Sample collection and composting

The study was conducted at Universiti Malaysia Kelantan, Jeli Campus from November 2020 to January 2021. The cow-dung was collected at the cow farm in campus and the leaves were collected from the pineapple farm around Jeli area. 24 kg of fresh pineapple leaves were chopped into small pieces prior to drying process. Then, they were dried in oven at 70°C for 72 hours to reduce their moisture content. After the fresh leaves were dried completely, they were grinded into smaller pieces before being mixed with cow dung in a polystyrene box. The mixture of pineapple leaves and cow dung were mixed in ratio cow dung: pineapple leaves which is 1: 3. Cow dung were used as a bio-activator as it has low carbon-to-nitrogen ratio and the decomposition rate is fast. Water was also added to the pile to increase humidity for the growth of microorganism. Every three days, the pile was turned for the aeration of the compost until the compost is ready. The temperature of the compost was recorded once daily at same time every day, which is at 3 p.m. At one point, there are no further change in temperature for few days, then the temperature reduced until it reached the ambient temperature. This process consumed 24 days for compost to mature. The ready compost is in black colour, has earthy odour, and the pH was near to neutral.

2.2. Proximate analysis

As for the proximate test to analyse the chemical composition of the pineapple compost, the Kjeldahl method from Bremner, J.M. [9] was used to determine the nitrogen content, the ash content was determined using the dry ashing method following Kailasa and Wu [10] and the moisture content was determined using the moisture analyzer. To determine the nitrogen content, 1 gram of sample were digested with the Kjedahl tablet (VWR Chemical) and addition of 12 ml of sulphuric acid, then the sample continue to the distillation process with the addition of 80 ml of water and 50 ml of sodium hydroxide. Lastly, the sample were titrated using using acid sulphuric as titrant and boric acid solution as the analyte to determine the nitrogen content. For the dry ashing method to determine the ash content, 2 grams of samples were heated in crucibles at 800°C for 12 hours in furnace. After heating, the crucibles were taken out and placed in desiccator for 20 minutes to cool down. After the crucibles was cool, the crucibles with ash residue were weighed. The ash content (%) can be obtained using the following formula:

$$\text{Ash content (\%)}=(W3-W1)\ \ W2 \times 100$$

W1 is weight of empty crucibles, W2 is weight of crucibles with 2 g of sample, and W3 is weight of crucibles with ash residue after combustion. For moisture analysis, 5g of sample was weighed using a moisture analyser. The sample was heated in the moisture analyser at 140°C for 27 minutes, and the moisture content was recorded. The procedure was repeated for three replications for both the compost and the commercial fertiliser samples. All of the analysis were done in triplicate and data is reported as mean and standard deviation.

2.3. Data analysis
The same proximate analysis was done on a commercial organic fertilizer to compare the chemical composition of the pineapple- based compost. Data for chemical composition which is Nitrogen content, ash content and moisture content of compost were analysed using Independent T test, to compare the chemical composition of pineapple-based compost and commercial compost. It aims to identify if there is any significant difference between the chemical composition of these two samples.

3. Results and Discussion

3.1. Composting of the pineapple leaves
From the 24 kg of pineapple leaves processed to drying, only 14% of the total weight of the leaves retained, leaving only 3.4 kg of the pineapple leaves ready to be composted with the cow-dung. The dried leaves were mixed with 850 g of cow-dung that were made into slurry by mixing with 3 litres of water. After the first day of incubation the temperature of the compost were monitored everyday to identify its maturing time. The temperature of the compost were taken until day 24 after the fist incubation day [Figure 1]. The compost temperature started to reach the peak for the first 2 days to the highest temperature which is 65°C. Then, the temperature dropped at certain temperature and begin to rise again after the pile turning. The pile turning was conducted every 3 days for the compost aeration for aerobic microorganism. At seventh day, which is during thermophilic stage, white spots were observed on the compost surface. They were identified as actinomycete, which are responsible to degrade sugars and protein during composting [11]. The presence of actinomycete during composting is an indicator that the compost is healthy. In comparison to the pineapple compost developed using the chicken dung, development of fungus known to be ink-Cap from the species *Corprinus* was identified only at the 28th day after composting process begin [6]. This indicates that the type of saprotrophic fungus that grow to help degradation of the lignocellulosic materials can be different depending on the bioactivator or EM used to inoculate the compost. The compost was considered matured when the temperature of compost reached the ambient temperature, which is at 35°C and remain constant even after pile turning for 5 to 7 days. According to Trautmann and Krasny [12], the temperature of the compost will remain at constant at the end of thermophilic phase and does not change even after turning and mixing the pile. The physical characteristics of the mature compost are black in colour, have earthy odour and the pH of the compost is near to neutral [Figure 2].

Moreover, the pineapple compost developed using the cow-dung also showed faster decomposition rate as compared to when using chicken dung as bioactivator. In this study, the temperature reach an constant temperature near to the ambient temperature at day 20 after the composting begun. Whereas for pineapple compost developed using the chicken dung, it took more than 30 days to reach to ambient temperature and remained stable [6].

3.2. Comparison of physiochemical composition between pineapple-based compost and commercial organic compost
In order to determine the suitability of the pineapple compost developed as organic fertiliser, its chemical composition were investigated with the commercial organic compost. Table 1 shows the chemical composition of the pineapple based compost and organic compost for nitrogen content, as content and moisture content. The nitrogen, ash and mineral content for the pineapple based compost were significantly lower as compared to the commercial organic compost at $P<0.05$. The commercial organic compost were made from the palm oil empty fruit bunch with the addition of Effective Microorganism (EM) which may help in increasing the nitrogen content of the compost. Previous study by Jusoh *et al*. [13] highlighted that compost that were made with the addition of effective

microorganism produced compost with greater amount of nitrogen content as compared to using goat dung alone. Moreover, technique such as the application of biochar in composting can also help to reduce the high losses of N through NH3 volatilization [14]. Moisture content of commercial compost is also higher than pineapple-based compost, which is due to leaching of water that occur during composting of the pineapple-based compost. Heat generated by the pineapple-based compost during composting is higher, thus cause leaching of water through water vapour. Ash content in commercial compost is significantly higher than in pineapple-based compost, and it indicates that the amount of organic matter in commercial fertiliser is higher than in pineapple-based compost. Organic matter includes hydrogen, nitrogen, oxygen and other elements needed by plants. In order to increase the ash content of the compost, technique such as vermitechnology can be used which incorporates the use of earthworms and microorganism to stabilize the organic waste [15]. In addition, the use of earth worms and other additives can significantly increase the plant nutrient availability, reduce nitrogen leaching and fasten the composting time [16].

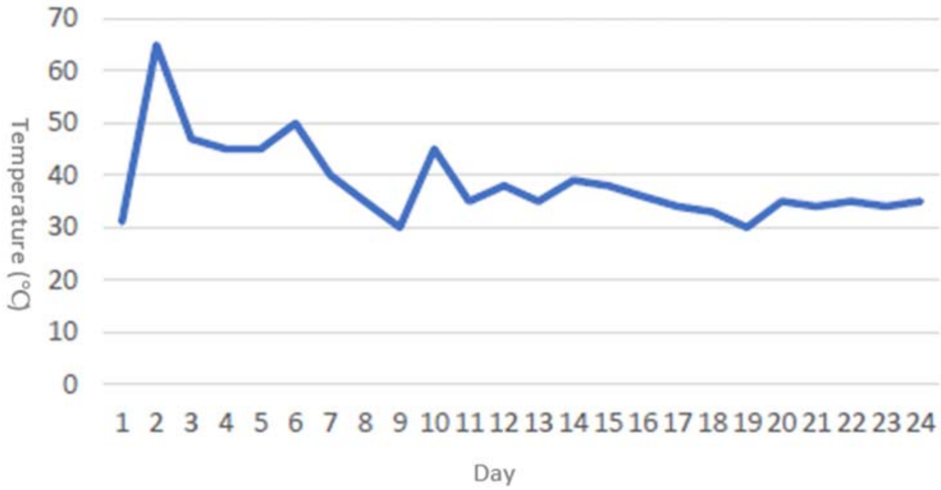

Figure 1. Temperature during the 25 days composting process of the pineapple leaves in addition to the cow dung as the bio-activator.

Figure 2. From the left is the picture of the pineapple leaves compost in mixed with cow dung as bioactivator and on the right is the pineapple leaves compost after 24 days of composting.

Table 1. Mean value of the nitrogen, ash and moisture content of the pineapple based compost and commercial organic compost.

Sample	Nitrogen content (%)	Ash content (%)	Moisture content (%)
Pineapple based compost	2.86±0.49[a]	0.93±0.07[a]	33.47±0.17[a]
Commercial organic compost	6.10±0.41[b]	1.80±0.06[b]	47.22±0.93[b]

*Means sharing the same superscript are not significantly different from each other (P<0.05).

4. Conclusion

Overall, the study signifiy that further improvement need to be done in order to improve the elements avaibility of the compost especially on the nitrogen content. This can be done either by adding effective microorganism or biochar to reduce the nitrogen loss. This factor is important to justify the usability of the compost as fertilizer. Nevertheless, the study proved that by using cow-dung instead of the chicken dung as the bio-activator, the composting process can be fasten to 20 days. Alternative method to utilize the pineapple residue is highly critical in order to maximize income generation from pineapple farming activities and to reduce the activity of open burning to eliminate agricultural residue.

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