Effects on application of the organic waste compost on the plant growth performance: A review

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Abstract

Organic wastes have become a huge environmental issue in urban area. Food waste as a part of organic waste are from households and food business industries contributed to 49% of the total waste disposed in the landfills. Not only taking huge land usage for disposal, the wastes also causes serious greenhouse gas emission. In fact, disposing the food waste create methane gas, which is harmful to the environment and cause global warming. In order to avoid the mass production of methane gas from food waste, it is essential to minimise the disposal of food waste in the landfills by encouraging waste recycling such as utilising these wastes as organic fertilizer in agricultural. Utilisation of organic fertilizers is an environmentally friendly substitute for harmful chemical fertilizer and one of the favoured methods of rejuvenating depleted soils and sustaining fertility levels. Organics fertilizers enrich the nutrient quality of soil and transform organic matter into nutrients that can be used to make plants healthy and productive. In addition, the utilisation of the organic waste in urban farming may promote sustainability practice that full fills the environment, social and economic aspects. This paper presents a review on the application of compost from a various sources of food waste and its effects to the plant growth performance in urban farming. The study shows that various sources have been used in food waste composting such as fruit, vegetables, plant fibres and farm wastes. Results also shows a great plant growth performance in terms of plant height, fresh weight, number of leaves, biomass and nutrient uptake for most of the organic wastes used. Thus, the application of organic waste compost will support nutrient cycling and provide a sustainable solution in community farming in Malaysia.

Keywords: *Organic waste; Nutrient cycling; Urban farming; Plant performance*

1. INTRODUCTION

Most of community activities in urban areas will definitely produce waste. An estimated solid waste generation of 14 million tonnes of waste per year will be collected by 2022 (Muhammad Saufi et al. 2021). The increasing economic status, population growth, changing of lifestyle and sosio-economic and urbanization are among the driving factors to the increasing rate of waste production in urban area. Weaknesses in solid waste management are becoming increasingly worrisome due to lack of infrastructure facilities, limited capital allocation and low technology. This situation becomes more serious as the amount of waste increases with the increase in population. The problem also becomes more complex as the composition of the waste becomes more diverse. Indirectly, generation, disposal and decomposition waste contribute to the generation of greenhouse gases (GHGs) as well as change world climate (Mohd Suffian 2018). Hence, sustainable waste management practices will be the best solution to reduce GHG emissions. Besides that, good waste management especially organic waste will reduce foul odors, prevent reproduction of creature's pests and at the same time ensure a more comfortable and healthier environment to be inhabited. Composting is one of the waste management that may be practised in urban area.

Composting is the process of decomposing organic waste such as agricultural waste, food waste, kitchen waste and garden waste to compost naturally. Compost is an organic matter that has decomposed and recycled as fertilizer and has been used widely in organic agriculture. Basically, composting requires only a pile of organic waste in the outdoor area and wait for the ingredients to decompose from six weeks or more. Composting technology such as windrow systems, aerated and in-vessel static stacks constitute conventional methods implemented on a small and commercial scale (Mohd Suffian 2018). During composting, various organic residues mixed with mineral components are aerobically and biochemically decomposed macro and micro-organisms. This microbial process allows stabilization of the organic matter and effective sanitization of the product if controlled and appropriately monitored. This well-established recycling process can therefore provide organic fertilizer for urban farming (Schroder et al. 2021). There are various types of wastes that available in urban to use as compost. Due to the increasing number of cases caused by COVID-19, most people are forced to be at home either working from home full time or on a regular basis. This situation results in more organic waste being generated. According to Siti Rohana et al. (2019), major constituent of food waste is those associated with cooking activities which consists of two to three serving per day. Kitchen waste consisted of vegetable peels, spoiled fruits, food remains after consumption, spoiled food, and other eatable items such as meat and fish wastes. Vegetable peels, cooked food remains, and spoilt food are the most regularly generated food waste. Therefore, considering urban waste as a resource is essential, and the use of locally available waste for the production of organic waste recycling fertilizer and soil amendments is of particular economic interest. The objective of this paper is to present a review on the application of various types of organic waste compost to the plant growth performances for implementation in urban farming.

2. MATERIALS AND METHODS

This study started with literature review by analyzing academic databases. The keyword-based search was performed in the main academic search engine including IOP Science, Research Gate, Scopus and Google Scholar. The keywords used (combined with "organic waste" and "effect

to plant growth" are: urban farming, sustainability and composting. The recent publication (ranging from 2012 to 2021) comprising books, conference publications and journal articles were reviewed and selected based on preliminary skim reading of the abstracts and main body of the literature. Additionally, relevant handbooks, policies, and regulations related to the waste management in Malaysia that could be used in the study were reviewed. The study explored past and current research on the various types of organic wastes and the effects on plant growth performances in urban farming to identify the feasibility of implementing the suitable method in urban area in Malaysia. Analysis of the literature further discussed the various possible composting method to choose and the suitability of organic wastes that generally used in urban farming.

3. RESULTS AND DISCUSSIONS

The analysis of the literature is divided into three sections. The first section searches the availability of organic wastes in urban area. Second section searches on potential of composting methods that may be practiced in less space environment. Meanwhile, section three focuses on the effects on various types of compost to the plant growth performances.

3.1 Availability of organic waste in urban farming

Organic wastes are increasingly becoming a valuable resource and have the potential to significantly spur the transition towards a sustainable future (Mahjoub & Domscheit 2020). Food waste serves as a valuable and sustainable resource, which can alleviate the environmental and health problems associated with organics in landfills (Sun et al. 2021). Based on the waste collection and segregation process in urban area, there are consist of a high variety of produce, with vegetables such as broccoli, spinach, tomato, cabbage, as well as fruits such as apple, banana, melon, orange, mango and pear. Consumption of carbohydrates are also varied, as wastes also consist of rice, noodles, bread, potatoes and various types of legumes. Apart from that, protein wastes for example eggs, seafood and remains of meat fat were also amongst the various types of food wastes observed, as well as small amounts of eggshells and used tea leaves/bags (Siti Rohana et al. 2019). In study conducted by Amirhossein et al. (2017), the food waste was collected from a nearby restaurant and comprised rice, chicken, potatoes, sausages, cooked spaghetii and green vegetables. Kadir et al. (2016) used two class of food waste which are processes and raw food wastes. Processes food waste consist of candy and chips. Meanwhile the raw food wastes consist of banana peel, tapioca peel and coconut husk. These observations show that there is a huge organic waste available to use in composting. Besides kitchen wastes, some important wastes for composting are garden and green waste, garbage, wastewater sludge (raw), wastewater sludge (anaerobic stabilized), dung of cattle, liquid manure of cattle and chickens, beet leaves, straw, fresh bark, bark mulch, wood chips, leaves, peat and paper (Sun et al. 2021). The use of wood chips in composting increases the efficiency nutrient retention from food waste and in turn increases nutrient recycling in urban environments (Small et al. 2017).

3.2 Techniques in composting process

The selection of composting methods may due to land availability, operating cost, and potential nuisance problems. There are various techniques of composting that are available to use

in urban farming. While considering the urban area that only consist of just limited space, earthworm composting (vermicomposting) can be considered. Small-scale vermicomposting is a method whereby the stabilization process of organic waste is achieved with earthworms. The microbial decomposition rate can be enhanced by adding worms in the process. This method is low-odor and requires less space and effort (Schroder et al. 2021). Through microorganism composting, food waste decomposed and converted into microbial fertilizers rich in diverse nutrients that can improve soil quality and productivity (Sun et al. 2021). Although more expensive compared to other methods, in-vessel composing can be considered to be practiced in urban farming as it is more controlled and required less space. In-vessel composting technique allows the highest degree of temperature control. In addition, it can be used to shorten the time needed for production of compost drastically (An et al. 2012).

3.3 Effects of the application of organic waste compost to the plant performance

Overall, the results show the suitability of the tested composts produced from urban waste as organic fertilizers for plant performances. Table 1 shows some significant effects of compost application on plant growth performance. Most of the composts provided sufficient nitrogen to the plant growth, thus the application of organic waste compost may utilize urban nutrient sources for urban farming in the long term. Hence, organic waste compost can be a driver to a sustainable circular economy with nutrient recycling.

Table 1. Effects of compost application on plant growth performance.

Author	Compost feedstock	Effect	Plant tested
D'Hose et al. (2012)	Farm compost	Significant increase in dry matter yield	Potato, beet, maize and brussels sprouts
Namasivayam and Bharani (2012)	Fruit wastes	Improved in plant growth parameter in terms of plant height, shoot length, leaf surface area, number of branches	Mung bean (*Vigna mungo*)
Louisa & Taguiling (2013)	Green biomass	Significantly stimulated plant growth in terms of plant height, number of leaves, size of leaves, number of buds, and total weight of fresh plant biomass	Eggplant (*Solanum melongena*) and green pepper (*Capsicum annuum*)
Liu et al. (2013)	Pineapple residue	Improved in plant growth parameter in terms of plant height, leaf length and width, root length, number of leaves and fresh weight	Pineapple
Aishah et al. (2020)	Empty Fruit Bunches (EFB)	Significantly stimulated plant growth in terms of root weight and number of leaves	Tomato (*Lycopersicon esculentum*)
Gonzalez-Hernandez et al. (2021)	Compost teas	Advance flowering date, increase the diameter of stem and total weight of fruit	Pepper plant
Mutiara Dewi & Inanpi 2021	Starfruit waste	Best treatment for plant height, leaf width and fresh weight	Pakcoy

4. CONCLUSION

This study presented literature review on the effects of application of organic waste compost to the plant growth performance from 2012 to 2021 that may practice for urban farming. The analysis of the literature shows that there are various sources of organic wastes available that can be converted to fertilizer and provides positive sustainability benefits for environment, social and economic. For future work, the composting processing may be further developed to include different class of wastes or effective microorganism (EM) that may fasten the composting processes. Furthermore, to optimize the compost feedstock for enhancing the effects in terms of soil performance and plant protection.

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