Household food waste management through Smart Compost Bin (SaCoB)

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ABSTRACT:
Household food waste accounts for the majority of global food waste. The Smart Compost Bin (SaCoB) was invented to make the composting of food waste more effective, simpler, and time-saving. The compost bin, sensor interface, database, and mobile application are the four key components of a smart compost bin. The installation of a stainless steel blade shaft in SaCoB is necessary for speeding up the composting process by reducing time and the size of food waste particles. The Takakura method's composting technique has been used in the research. The weight of food waste added on SaCob was measured regularly. The temperature, pH and moisture content of the compost were recorded using sensors. Compost in SaCoB was mixed on regular basis using the shaft blade. A total mass of 38.94kg of food waste was obtained.
Keywords: *food waste*, *takakura method*, *composting, smart compost bin*

INTRODUCTION

The environmental, economic, and social effect of household food waste (HFW) has attracted people's curiosity all across the world [1]. According to Malaysia's solid waste management and public cleansing organization (SWCorp), the amount of food waste generated in the country by 2020 will be enough to fill 16 of the twin buildings [2]. Food waste management alternatives include redistribution for human consumption, animal feeding, anaerobic digestion, and composting [3]. Composting is the best alternative approach for environmental sustainability. This alternative technique gave the best option because it can turn waste to another valuable product. This alternative technique will help achieving several Sustainable Developmental Goals (SDGs) proposed by United Nation which are SDG 11 (Sustainable cities and communities), SDG 12 (Responsible consumption and production), SDG 13 (Climate action) [4].

MATERIALS

Sampling site

The experiment was carried out in Taman Merbau, Changlun, in a residential area. The exact location lies within latitudes 6˚26' 23.7" North and longitudes 100˚25' 58.2" East. The smart compost bin was set up in the backyard's corridor.

Smart Compost Bin

The innovative compost bin size was (1m height h x 0.48m diameter, r). It has a 200-liter composting capacity . The recycled bin made from High-Density Poly Ethylene (HDPE) materials was used as in Figure 1(a). An outlet with the size (16cm x 21cm) was created at the bottom of the bin for harvesting purposes. Stainless steel shift blade with the size of (120cm) long for the mixing and blend was equipped as in Figure 1(b) with the small handle which was attached. Several sensors in Figure 2, have been consolidated for the temperature and humidity sensors (AM2301, DS18B20, Si7021) to collect the data. The data can be monitored 24-hours.

Figure 1: a) Compost bin from HDPE materials, b) Stainless steel shift blade

METHODOLOGY

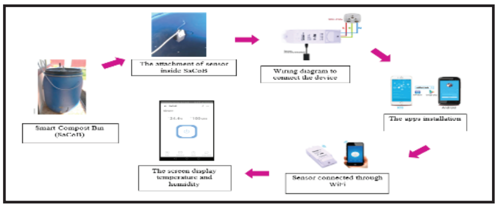

Figure 2: Device installation for SaCoB

Takakura home methods

Effective microorganisms (EM) solution was prepared as in Figure 3. The EM solution was blended with 1 kg of dried leaves and 2 kg of compost soil and fermented for 5 days in a sealed container. Food waste continually fed to the compost container for the next 3 to 6 months.

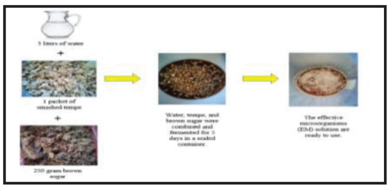

Figure 3: EM preparation methods

RESULT AND DISCUSSION

There are a few factors that may influence the composting process such as aeration, EM used application of worms, and frequent turning [4]. In this study EM and mixing blade has been applied to fasten and enhance the composting process. A regular mixing step has been applied in SaCoB to give better aeration for the compost. *Rhizopus* sp. is a type of EM that has been detected in fermented tempe [5] and has been identified as one of the fungal communities in the composting process [6]. Furthermore, the use of smart sensors in SaCoB can help in the production of high-quality compost by enabling for regular monitoring of when the composting process is complete and ready to be sold.

Figure 4, represent the temperature variation in SaCoB. The temperature of compost in SacoB shows it reached maximum value of 45˚C at the third weeks. This shows that the compost have undergo thermophilic phase from the high level of microorganisms activity. Our results is similar as compare to [7] whereby the thermophilic phase occurred at third weeks with the average temperature is above 45℃. The process of degradation of organic matters occurs by the thermophilic microorganism [8]. Figure 5 represents the variation of pH for the compost, pH tends to be acidic at week 1 and slightly neutral at week 3 due to an increase in microbial activity on degradation of organic acid. The acidic ingredients in food waste may have influenced the pH reduction from week 4 to week 7. Figure 6 demonstrates a slight decrease in compost moisture content as the temperature rises in the third week. The moisture content appears to remain above 50% until week 8.

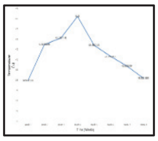

Figure 4: Temperature of compost in SaCoB

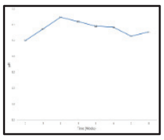

Figure 5: pH of compost in SaCoB

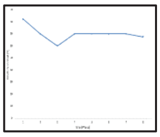

Figure 6: Moisture content of compost in SaCoB

Table 1 showed that there is a negative correlation between temperature and moisture content, however, positive correlations were obtained between pH and temperature. Temperature and moisture contents seem to be negatively correlated related whereby with increase temperature moisture content will be decreased. According to [9], the moisture content is affected by temperature distribution in the compost medium. Otherwise, a higher value of pH (alkaline) was observed with a high temperature. The generation of more ammonium throughout the decomposition process could represent an alkaline environment [10]. Based on Table 2, it can be observed that SaCoB processed 0.06kg food waste daily per 5 persons for household usage.

Table 2: Food waste monthly and daily production

Food waste sources (per house)	Total Food Waste kg [a] (L)	Monthly Food Waste per Capita (kg month $^{-1}$ cap $^{-1}$)	Daily Food Waste Processed per SaCoB (kg day $^{-1}$ SaCoB $^{-1}$)
5	38.94	1.95	0.06

[a] Period: Feb to May, 2021

CONCLUSION

As stated by the United Nations, this innovation can aid in the achievement of SDG 11, 12 and 13. It can be stated that implementation of SaCoB in a household community will contribute to a healthy environment and is one of the most effective climate-protection strategies.

Table 1: Analysis on the relationship of temperature, moisture content and pH from SaCoB

		Temp	pH	MoistureContent
Temp	Pearson Correlation	1	.330*	-.082
	Sig. (2-tailed)		.033	.607
	N	42	42	42
pH	Pearson Correlation	.330*	1	.018
	Sig. (2-tailed)	.033		.909
	N	42	42	42
MoistureContent	Pearson Correlation	-.082	.018	1
	Sig. (2-tailed)	.607	.909	
	N	42	42	42

*. Correlation is significant at the 0.05 level (2-tailed).

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