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Improving Composting Process By Controlling Aeration Time

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***Abstract*—Composting is a biological treatment process to treat organic waste. There are many parameters that affecting it process. Temperature, pH, aeration, moisture content and microorganism are a few factors controlling composting process. Missing one of the parameter will result in incomplete process. Thus, the objective of this study is to improving composting process by controlling one parameter of composting which is aeration. Before starting the composting process, the food wastes are spread on a canvas to drain out excess water. After that, the food wastes are grinded and let out to rest about 1 day under sunlight. 12 kg of grinded and dried food waste was thrown into composting bin and the first data was recorded. The food waste in the composting bin has been rotated for 15 minutes and let to rest another 15 minutes. The data collection has been done for the total 53 hours in 3 days. Range for compost temperature, compost pH, surrounding temperature and surrounding relative humidity during the process are 26°C - 45°C, 4.24 – 5.81, 26.4°C – 35.2°C, and 54% - 81%, respectively. Results show that with the constant aeration time, time taken for composting process to complete become shorter. Further research can be done to compare various aeration times for composting. Thus, we can come out with the standard of aeration of composting process. This will enhance the composting process technique that help to solve the problem of increasing food waste and prolong the landfill lifetime.**

Keywords—Aeration; Composting; Food waste

I. INTRODUCTION

Composting is one of the treatments to treat increasing volume of solid waste especially organic waste. As the world population increased, the need for foods will also increase. This situation will lead and create to another thing which is waste. Food waste (FW) is a current worldwide issue and it will become a major problem to human if it is not managed properly. Food waste is one of the components that make up the solid waste stream in Malaysia [9]. Each year, food waste shows an increasing volume. Most of it will end up in landfill without proper management. In United Kingdom, WRAP [10] has conducted a research on hospitality and food services, and found that 920,000 tonnes of food is wasted at outlets each year, 75% of which is avoidable and could have been eaten. In Malaysia, there are many research has been done regarding waste. Most of the study shows that food waste dominates the composition of the solid waste [11]. However, most of the food waste will end up at the landfill without proper treatment.

Unfortunately in Malaysia, Hamid et al. [1] stated that at this moment, the authority is just trying to find the best solution to solve basic matter regarding the management of municipal solid waste (MSW) only. Even the issues of FW and MSW are the same which are very critical, the FW was not treated separately from the MSW due to extremely limited treatment and poorly MSW management in this country [1,2]. It is the challenging task to separate the compostable item with the non-compostable ones if the culture within the community was not really aware about that importance. In Malaysia, more than 50% of waste that being disposed to landfills is come from food waste. Abdullah et al. [3] stated that this waste has nutritious element and it is wasted if they cannot be converted into useful thing and just be dumped to the landfills. In the other hand, develop countries like Japan and Korea are do concerned about the management of waste and they segregate their FW from the MSW. The segregated food waste is treated to become another valuable thing which is compost.

Composting is one of the best and suitable ways to treat the organic wastes. Compost is a humus-like substance produced from the conversion of solid organic material under the controlled biological decomposition. The process of composting is known to be environmental friendly method that does not release any hazardous chemical which can affect human health. Compost itself has many beneficial ingredients that are crucial for organism like plants. Instead of reducing the investment to buy synthetic or chemical fertilizer from the outsiders [4], the usage of compost can reduce the anxiousness of people regarding the issues of environmental problems as well as their health.

Even though there are many advantages when practicing composting, this organic compost actually takes a longer time to produce before it can be used [5,6]. Thus, it was assumed that the market demand towards this product is less. Furthermore, as many parameters need to be observed, managing of food waste composting was not easy. Other studies done by researchers found that optimized formulation and composition of food waste was suitable to overcome the problem occurs during composting process as well as to increase the composting performance [7,3]. The optimized condition of food waste composting can be done through the uses of aeration to control the time taken for composting to complete.

II. METHODOLOGY

A. *Research Framework*

In this study, the food waste was collected from the café and brought to study site at INOCEM Research Station (IRS). At the site, the food waste was spread out to drain excess water and was grinded using heavy duty commercial blender. After the food waste was grinded, it will lay out to dry under direct sunlight for 1 day. 20 kg of grinded and dried food waste will be thrown into composting bin. The bin will be rotate in 5 minutes and rest for 15 minutes. Result will show temperature, pH, and moisture content value in hour basis. Fig. 1 shows the framework of this research.

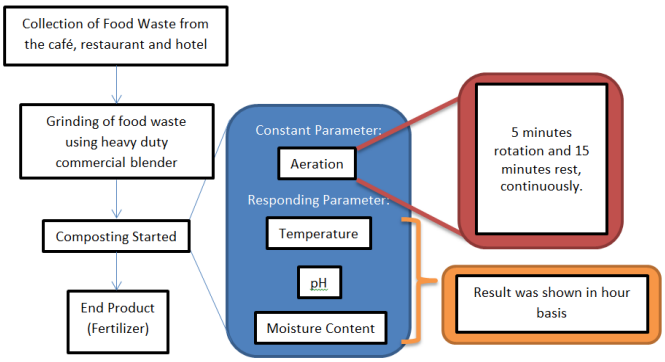

Fig. 1 Research Framework.

B. *Study Site and Sampling*

All the fieldwork and laboratory work was done at the Inocem Research Station (IRS). It is located at Kg. Cherok Paloh. Sampling was done in 3 days.

C. *Apparatus and Equipment Used*

For the composting bin, a tank with a height of 40cm, width of 90cm and length of 90cm was installed with a rotator. The rotator was built using PVC pipe as shown in Fig. 2.

Fig. 2 Composting Bin Design

Humidity and temperature recorder (RH 520) by Extech Instruments (Fig. 3) were used to record the surrounding temperature and RH values. The recorder was set up 50 cm from ground.

Fig. 3 Humidity and temperature recorder.

To record compost temperature, digital thermometer (GMH 11150) was used as shown in Fig. 4. The probe was stab into compost and wait around 10-15 second before taking reading.

Fig. 4 Digital Thermometer.

Fig. 5 pH meter.

For pH readings, as shown in Fig. 5, pH meter by Mettler Toledo was used. The probe was dip into compost mix in deionized water with 1:5 ratio weight/volume.

All the parameters reading except moisture content were taken every 1 hour. For moisture content, the reading was taken every 24 hours. Fig. 6 shows the flow during composting.

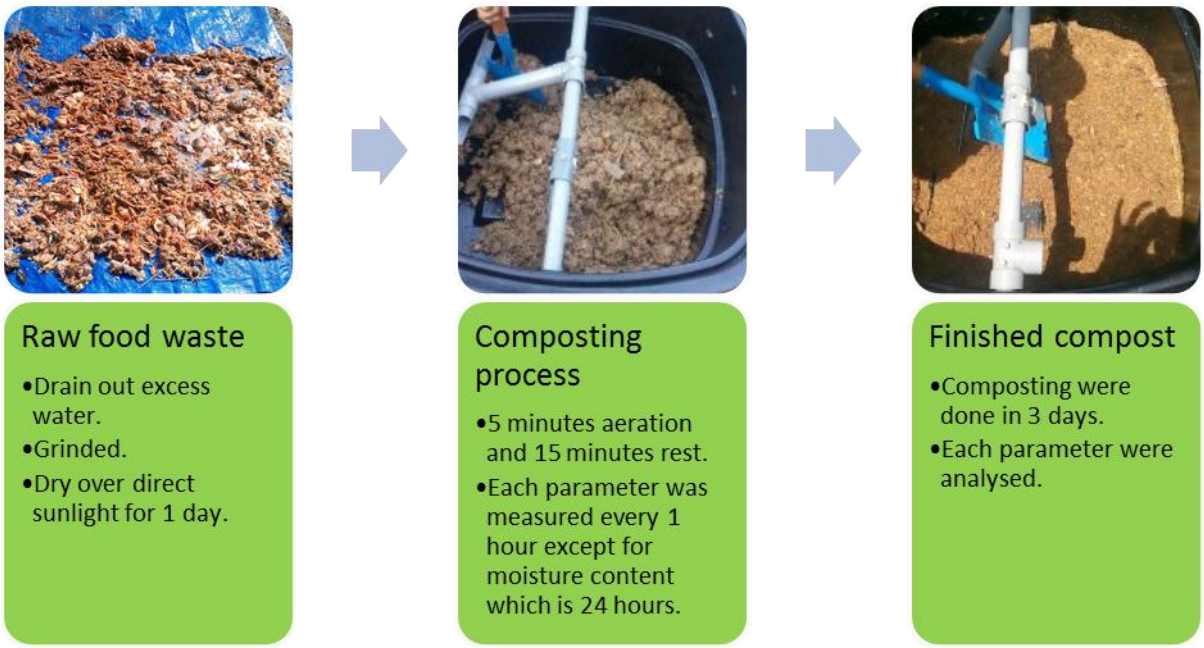

Fig. 6 Flow of Composting Process.

III. Result & Discussion

Total data recorded during sampling is 73 data in 3 days. Table I shows all the parameter recorded during sampling. The highest compost temperature recorded is 44°C while the lowest is 28°C. pH for compost shows the highest at 5.33 and the lowest at 4.40. For surrounding temperature and RH, the highest is 35.3°C and 85%, while the lowest is 25.7°C and 57%, respectively.

Table I. The Total Data Collection in 3 Days Sampling.

TIME (HRS)	COMPOST		AMBIENT	
	TEMPERATURE (°C)	pH	TEMPERATURE (°C)	RH (%)
1	39	4.53	33.5	59
2	39	4.48	32.7	60
3	35	4.50	31.6	62
4	35	4.43	32.2	63
5	34	4.36	31.0	67
6	31	4.40	30.3	68
7	29	4.49	29.5	71
8	29	4.44	28.7	75
9	29	4.53	28.7	76
10	28	4.51	28.7	76
11	28	4.55	28.7	77
12	28	4.51	28.8	76
13	29	4.52	28.6	76
14	30	4.52	28.7	77
15	30	4.52	28.4	76
16	31	4.50	28.2	76
17	32	4.49	28.2	77
18	31	4.50	28.2	78
19	31	4.47	28.3	77
20	32	4.54	28.0	76
21	30	4.53	27.5	78
22	30	4.49	29.9	71
23	33	4.51	33.4	60
24	35	4.50	33.1	61
25	34	4.55	33.0	60
26	37	4.52	33.2	58
27	39	4.49	33.0	60
28	40	4.72	32.2	64
29	34	4.53	31.6	65
30	34	4.48	30.7	68
31	31	4.50	30.2	72
32	33	4.51	29.3	74
33	31	4.49	29.3	78
34	32	4.42	29.1	77
35	32	4.54	29.1	76
36	33	4.55	28.8	75
37	33	4.47	28.7	75
38	32	4.51	28.8	78
39	33	4.50	28.5	76
40	31	4.53	27.1	81
41	36	4.51	26.8	83
42	37	4.59	26.6	82
43	38	4.63	26.1	84
44	34	5.22	25.7	85
45	32	5.11	25.8	85
46	35	5.21	31.3	68
47	39	5.24	34.1	59
48	42	5.22	35.3	57
49	42	5.13	31.6	69
50	44	5.33	33.8	62
51	36	5.09	33.1	64
52	40	5.28	31.8	63
53	37	5.20	32.0	67
54	34	5.15	31.1	69
55	35	5.18	30.2	71
56	33	5.20	29.6	76
57	33	5.23	29.3	78
58	32	5.16	29.4	77
59	31	5.25	29.3	77
60	30	5.27	29.0	80
61	31	5.28	28.9	78
62	31	5.25	29.0	78
63	32	5.21	28.8	79
64	31	5.22	28.6	77
65	34	5.20	28.4	77
66	34	5.24	28.6	77
67	32	5.23	28.6	77
68	31	5.28	26.9	84
69	29	5.25	29.1	76
70	32	5.15	32.1	66
71	34	5.25	33.1	62
72	36	5.23	31.8	66
73	39	5.08	33.3	62

Fig. 7 shows the graph of compost temperature versus time. Based on the figure, the graph shows a fluctuate line. As for Fig. 8, it also show a fluctuate line and in increasing manner for graph of compost pH versus time. For Fig. 9 (Graph of ambient temperature versus time) and Fig. 10 (Graph of ambient relative humidity versus time), it related to each other. If ambient temperature is high, ambient relative humidity will low and if ambient temperature is low, ambient relative humidity is high.

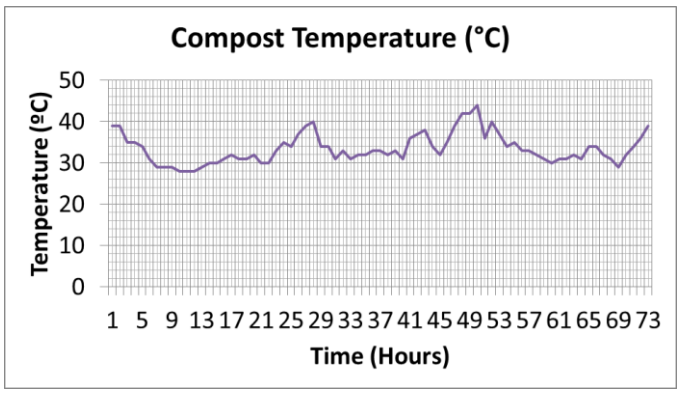

Fig. 7 Graph of Temperature vs. Time

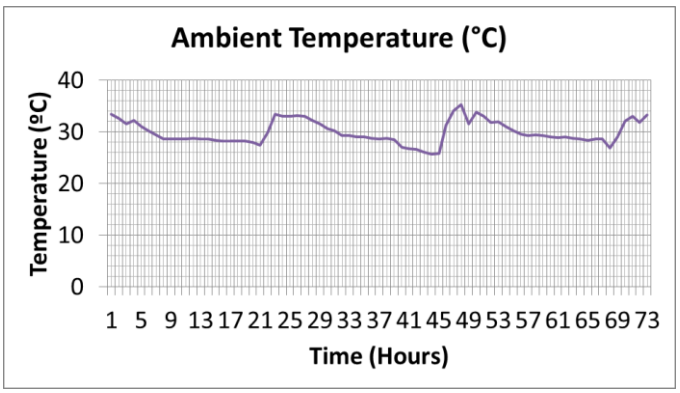

Fig. 9 Graph of Ambient Temperature vs. Time

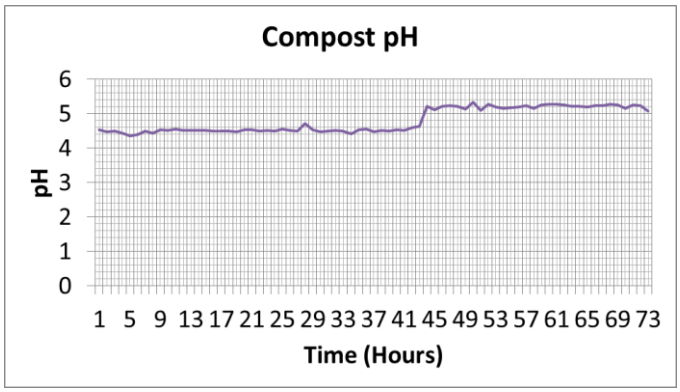

Fig. 8 Graph of Compost pH vs. Time

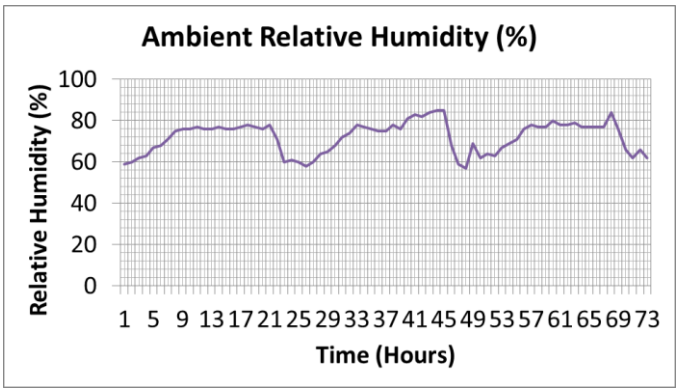

Fig. 10 Graph of Ambient Relative Humidity vs. Time

All of the graph (Fig. 7, 8, 9, and 10) was combined in Fig. 11. Based on the graph, temperature for composting are higher than temperature in surrounding. As for surrounding relative humidity, an increasing value indicated that ambient temperature was decreasing while decreasing value indicated that ambient temperature was increasing.

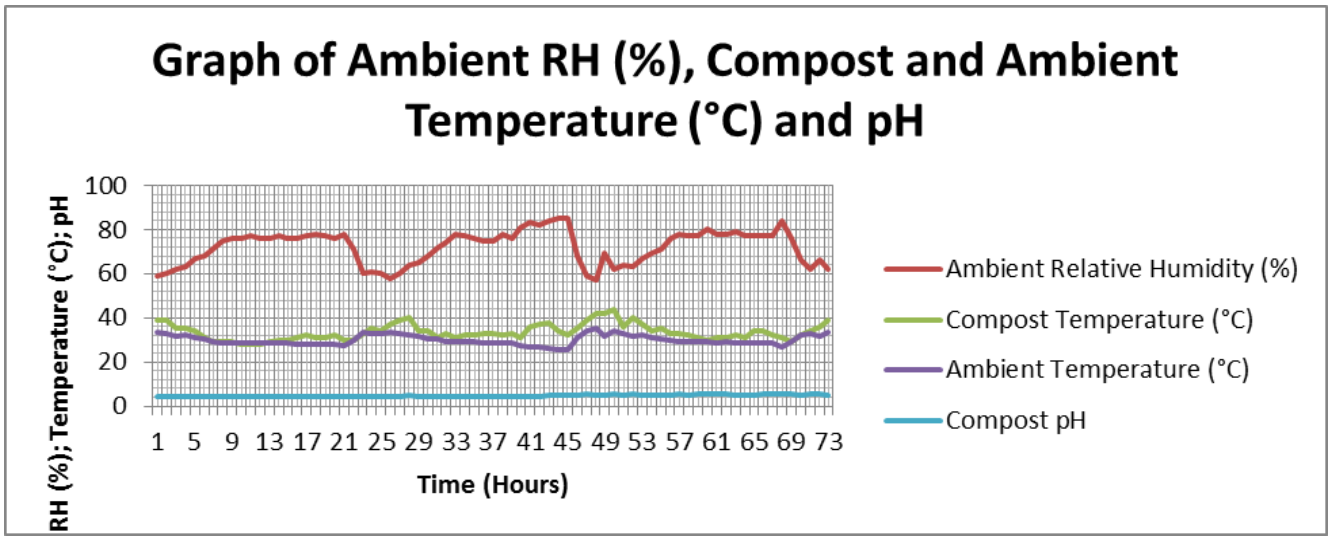

Fig. 11 Graph of Overall Parameters Data vs. Time

TABLE II. MOISTURE CONTENT DATA FOR EACH DAY OF SAMPLING

TIME (HRS)	MOISTURE CONTENT (%)	CALCULATION
00	21%	(171.4155 – 136.2240)g ÷ 171.4155g × 100% = 21.53%
24	12%	(165.2302 – 145.0525)g ÷ 165.2302g × 100% = 12.21%
48	5%	(148.1889 – 140.3209)g ÷ 148.1889g × 100% = 5.31%
72	4%	(131.2756 – 125.3847)g ÷ 131.2756g × 100% = 4.49%

For moisture content, result in Table II shows that every 24 hours, the percentage of moisture content is decrease. This indicated that aeration plays an important role to lower the percentage in moisture content in shorter time. The longer rotation time; lower the moisture content of the compost.

IV. CONCLUSION

Based on the result, with the 5 minutes aeration time and 15 minutes rest time, all the parameter shows an increasing value meaning that it reach their optimum value in faster time. It caused the composting process completed quickly. Besides that, grinding the food waste before composting also helps in the process. Because of the total surface of the food waste increase, it is easier for microbe to degrade the food waste. Thus, the time taken will be less. Further study with various aeration times can be done to compare. The suitable aeration time to enhance composting can be determined. With the standard parameter, it will ensure that composting process can be completed in 3 days.

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