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Composting of Solid Waste from Wet Market of Bandar Baru Bangi Malaysia

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Abstract: Composting is one of the most promising technologies to treat wastes in a more economical way for many centuries composting has been used as a means of recycling organic matter back into the soil to improve soil structure and fertility. Purpose of composting stabilization of waste for land filling, volume and mass reduction of solid waste and return of organic substances to the natural cycle .This study was about solid waste generation at wet market Bandar Baru Bangi Malaysia and potential treating waste. The parameters are moisture content (M%), density, pH, temperature (T), total nitrogen (TN), total organic carbon (TOC), heavy metals (Zn, Cu, Ni) and phosphorus (P). The daily amount of waste from the wet market is around 8 tonnes per day, based on an interviewed with Kajang Alam Flora Officer. There is two rorobin placed in the wet market with each capacity of 4-5 tones respectively. From the laboratory results, we note increase in temperature during first Mesophilic phase, phosphorus and nitrogen during composting process. Then, note increase of ph and reduce heavy metal during composting. Average values is moisture content 53.66 %, density 510.48 kg/ m^3, pH 8.45, P 189372.7 mg/L, Cu 51.50 ppb, Zn 233.75ppb, Ni 15. 28ppb, T 37.65 ^{0}C, TOC 44.75% and TN 3.19 mg/L. The physicochemical properties of organic wastes such as leftovers of raw fruit, chicken, food and vegetables (LRFV) during composting process obtained were in the range of good quality according to the standards to ensure safe application of compost. Bin Composter is one of ways to convert organic waste into valuable compounds and reduce the waste to be disposed into landfills.

Key words: Solid Waste, Waste Generation, Seeds and Bin Composter.

INTRODUCTION

Open dumping and sanitary landfill is a major method for waste disposal in Malaysia. The Landfilling of biodegradable waste is proven to contribute to environmental degradation, mainly through the production of highly polluting leachate and methane gas. Methane constitutes one of the six greenhouse gases responsible for the global warming, which needs to be reduced, in order to tackle climate change under the Kyoto Protocol. The methane emissions from landfills constitute about 30% of the global anthropogenic emissions of methane to the atmosphere. (Amos, 1998).

In total there are 290 landfill sites to manage the waste disposal and around 176 sites still on process. The problems are that the lifespan of existing landfill sites are nearing its end, whereas new landfill areas are scarce due to rapid urban development (Basri, 2001; Jabatan, 2009; Sivapalan *et al*, 2003). Composting could be a one of the options to manage the solid waste. Waste management in Malaysia is still facing the following problems such as (i) Inadequate resource mobilization; (ii) Over-reliance on imported equipment; (iii) Inappropriate methods of finance; (iv), Use of inappropriate technology; (v) Inequity in service provision; and (vi) Lack of technical expertise (Basri, 2001). And comprehensive data is not available such as generation rates, physical and chemical composition and particularly the heating value of the waste of campus (Sivapalan *et al*, 2003). The main objectives of this study are to reduces volume and mass of solid waste, return of organic substances to the natural cycle, stabilization of waste for landfilling, the physicochemical properties of the final compost obtain are in the range of high quality and stable compost. This paper will present the waste generation in Bandar Baru Bangi Malaysia and a potential of composting methods to manage waste.

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2.0 General Procedure:

2.1 Materials and Methods Section:

Generally the approach used in this study was focused more on composting of waste market by using bin composter which takes place at Wet market Bandar Baru Bangi as shown in figure 1. Types of wastes at wet market like solid wastes from vegetables stalls or shops, such as green vegetables, boxes, wooden, waste from meat such as chicken, fisheries shops and liquid waste from restaurants such as food stall used cooking oil and cleaning jobs go to drains. Approximate amounts of waste from Wet market: daily amount of waste from wet Market is around 8 tonnes per day, based on interviewed with Kajang Alam Flora Officer. Wet market was monitored by Majlis Perbandaran Kajang (MPKJ). (Kajang Municipal Council), waste collection is contracted to Alam Flora Company. There is 2 rorobin placed out site of the Wet market as the waste collection centre. Each capacity of the Rorobin is around 4-5 tonnes respectively. Alam Flora will collect both of the Rorobin daily at around 10-11 am. The waste will send to RDF station in Semenyih for sorting of the waste that may use for energy / recycle. The un recycle waste will go to land fill disposal in Sungai Kembong. (RDF is Refuse Derived Fuel). (Zuraidah *et al*, 2010).

The material treated in the composter was composed of leftovers of raw fruit, food, chicken, fish and vegetables. This type of wastes is usually recommended for bin composting purposes. The composter size is 90 cm high and width 60 cm and the composter has system of natural ventilation of bottom and the plastic compost bin is made in dark color so as to absorb the heat from the sun. Through the access doors at the bottom, the finished compost can be moved out, the organic waste was poured to the upper part of the composter and it involves; waste collection waste collected from wet market removed non composting materials such as (plastics, metals,…etc) then; chopped or shredded to smaller sizes for faster decomposition and also, well mixed. Finally; another time weighted, put the waste in a bin composter. Figure 2 shows the flow chart of the composting experiment.

Fig. 1: Bin Composter.

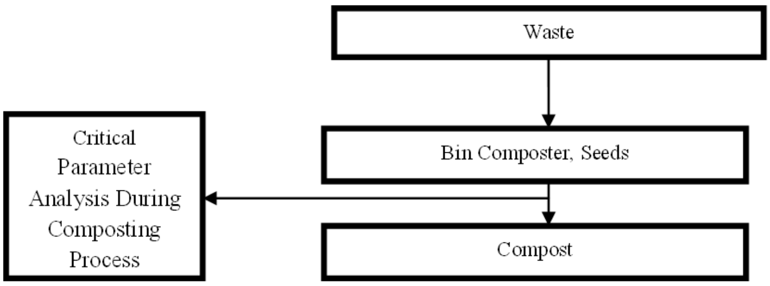

Fig. 2: flow chart of the composting.

2.2. Chemical and Physical-Analyses:

The pH value was determined using a method described by (Carnes, 1997). At least 10 gram sample of organic waste is poured into 500 ml distilled water and stirred vigorously for 3 to 5 minutes. Then, when the mixture was settled pH of the mixture was measured. The determination of the total moisture content was done according to (Romeela and Ackmez, 2005). Sample of waste is weight and dry it in a conventional oven at temperature (105 ^{0}C) for 24 hours, and weigh it again. Subtract the dry weight (D) from the wet weight (W), divide this result by the wet weight and multiply by 100 to obtain your percent moisture content. Nitrogen is often the limiting factor in biological systems, especially systems that depend on bacteria for breakdown of substances. Total Nitrogen was determined using Kjeldahl method which includes organic nitrogen compounds as well as ammonia nitrogen. Organic matter content was determined by burning the dried sample at 550oC for 1 hrs. The organic matter was converted to carbon content using a factor of 54% (Romeela and Ackmez, 2005). Heavy metal and phosphorus were measured by Inductively coupled plasma mass spectrometry (ICP-MS) is a type of mass spectrometry that is highly sensitive and capable of the determination of a range of metals and several non-metals at concentrations below one part in 1012 (part per trillion).

2.3. Activity Microorganisms (Microbes) and Seeds:

Microorganisms such as bacteria and fungi are responsible for breaking down the organic materials in waste. Although commercially packaged compost starter is available, adding a little soil or finished compost will supply all the microbes you need for composting. Microorganisms require a proper environment to work efficiently. Any factor which affects the microbial population will also affect the rate of decomposition. In this research we use commercial compost starter as figure 3 (Fauziah, 2009).

Fig. 3: Activity Microorganisms (microbes) and Seeds.

RESULTS AND DISCUSSIONS

3.1. Bulk Density:

We used Box has; size: length 35.5cm, width 27cm, height 30cm. For calculating composting waste bulk density, and measured three times with the average. Bulk density = $\frac{W}{V}$ where W: weigh of the waste inside box; W = 14.7018 kg, V: volume the box; = 0.0288 m^3. The average bulk density was 510.48 kg/ m^3.

3.2. pH:

The pH level of the composting mass typically varies with the passage of time during composting process. Figure 4 indicated the curve of pH with days of composting , where pH level reached in the initial to 6.2 and it reached to levels as high as pH 8.56 during 22 days of composting. Bin composter was packed of mixer wastes like waste food, chicken, fish and vegetables. Where Increasing of level pH is caused by amounts of vegetables waste are decomposed where, released proteins from vegetable waste.

Table 1: Values of PH during composting process.

PH	Days
6.2	1
8.04	2
8.48	3
8.54	4
7.8	5
8.32	6
7.9	7
8.91	8
8.84	9
8.95	10
8.198	11
8.71	12
8.78	13
8.76	14
8.85	15
8.81	16
8.97	17
8.29	18
8.61	19
8.51	20
8.56	21

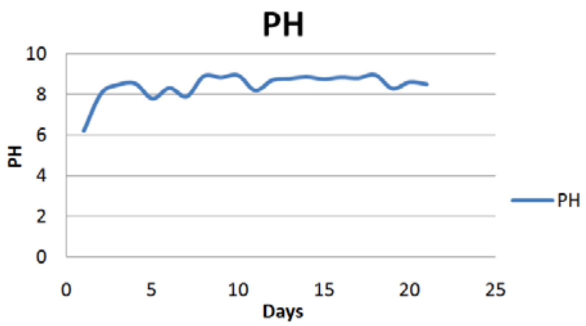

Fig. 4: pH with days of composting.

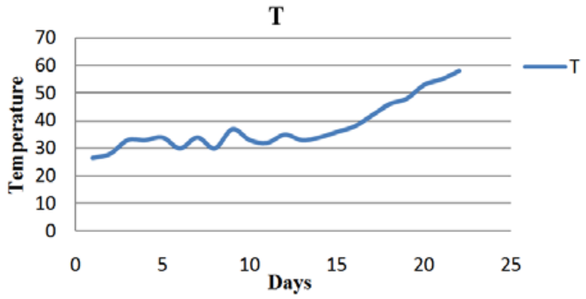

Fig. 5: Temperature with days of composting.

***3.3: Temperature (T)*:**

Temperature notes were taken at center from Bin Composter. A graph showing the variation of temperature of composting material with time is described in figure 5. The mesophilic and thermophilic are described. Where, the initial temperature was 26.5°C and increased up to 58°C and started the thermophilicphase during 4 days of composting. Composting begins at ambient temperature (mesophilic range) and progresses to and through a thermophilic phase. The amount of increase depends on the amount of substrate waste and aeration. The values of temperature during composting process in the Bin composter are presented in Table 2.

Microorganisms such as bacteria and fungi are responsible on heat generation during composting cause in lost moisture content. Moisture content at the beginning was 60% and reduced to 53.054 % as figure 6. The moisture content was within an acceptable range of 45% to 65%.

Table 2: Values of T during composting process.

T	Days
26.5	1
28	2
33	3
33	4
34	5
30	6
34	7
30	8
37	9
33	10
32	11
35	12
34	13
36	14
38	15
42	16
46	17
48	18
53	19
55	20
58	21
3.4	Moisture Content (% M)

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Microorganisms such as bacteria and fungi are responsible on heat generation during composting cause in lost moisture content. Moisture content at the beginning was 60% and reduced to 53.054 % as figure 6. The moisture content was within an acceptable range of 45% to 65%.

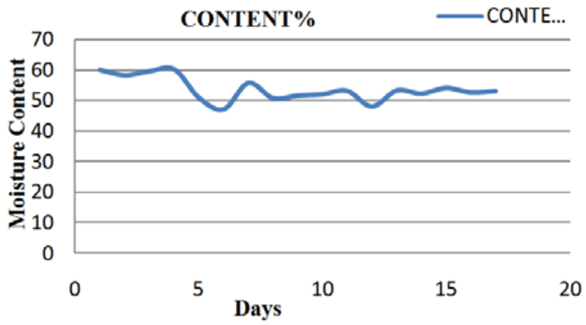

Fig. 6: Percentage of moisture with days of composting.

Table 3: Values of M during composting process.

M%	Days
60	1
50.27	2
61.55	3
60.24	4
50.91	5
47.04	6
55.722	7
50.74	8
51.59	9
52.022	10
53.11	11
47.98	12
53.24	13
52.22	14
54.064	15
52.604	16
53.0541	17

Table 4: Values of TOC during composting process.

TOC%	Days
45.167	1
45.822	2
45.75	3
44.67	4
45.57	5
45.492	6
44.93	7
43.44	8
47.02	9
43.710	10
45.17	11
45.12	12
45.1	13
43.2	14
44.3	15
44.89	16
44.98	17
44.8	18
44.3	19
43.6	20
43.7	21
44	22

3.5: Carbon Decomposition (TOC):

Change in the total organic carbon content during the composting period is showing in figure 7. The content of organic carbon reduces as the decomposition progressed. First, amount of total organic carbon was 45.16% and reduced to 43.2 %.

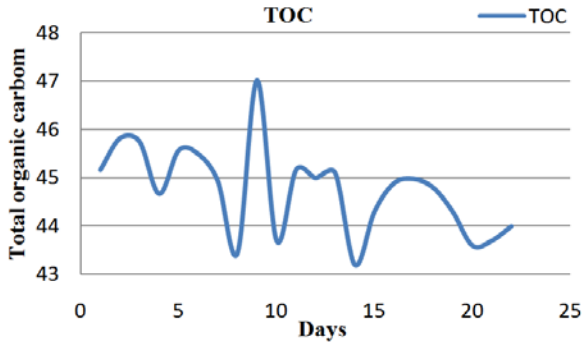

Fig. 7: TOC with days of composting.

3.6: Nitrogen Dynamics (TN):

Figure 8 displays the total nitrogen (TN) with time of composting where beginning of nitrogen was 1.4 reached to 5.52 during days of composting. The increased amounts of mineralized nitrogen that they make available for the plant growth. This increase was due to loss of dry mass in terms of carbon dioxide, as well as the water loss by evaporation caused by heat evolved during oxidization of organic matter .Nitrogen fixing bacteria might also have contributed to the increase in NT in the later stage of composting (Bishop *et al*, 1983, Fang *et al*, 1999, Haung *et al*, 2004).

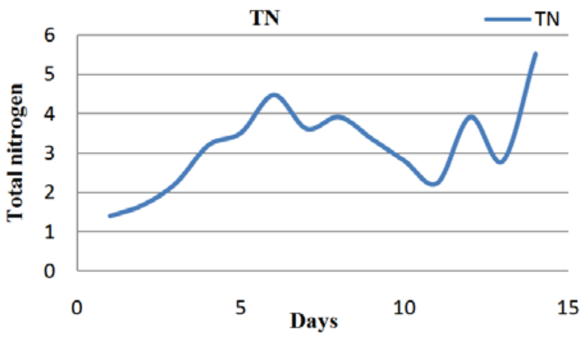

Fig. 8: TN with days of composting.

Table 5: Values of TN during composting process.

TN (mg/L)	Days
1.4	1
1.68	2
2.23	3
3. 2	4
3.52	5
4.48	6
3.62	7
3.92	8
3.36	9
2.8	10
2.24	11

2.24	12
3.92	13
2.8	14
5.52	15

3.7: Total Phosphorus (P):

Figure 9 shows values of phosphorus versus time of composting where beginning of phosphorus was 110970.826 (ppb) and reached to 81003.853 (ppb). Composting process in Bin Composter works on increase in phosphorus in last phase and nitrogen and reduce heavy metal harmful for plant. Where this increase caused high content of vegetables waste in Bin Composter.

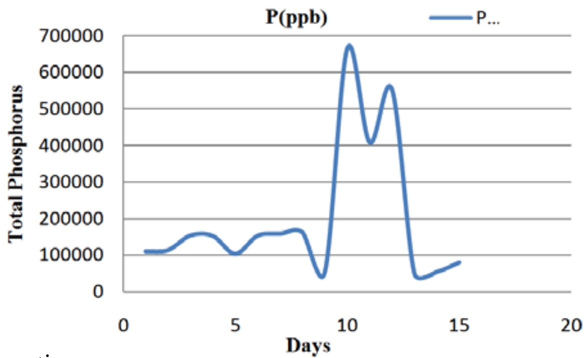

Fig. 9: P with days of composting.

Table 6: Values of P during composting process.

P (ppb)	Days
110970.826	1
114388.111	2
154772.071	3
153176.445	4
104220.979	5
154141.284	6
158934.674	7
162761.389	8
54490.761	9
665252.375	10
408750.933	11
552638.230	12
49696.274	13
54987.474	14
81003.853	15

3.8: Heavy Metal (Z_n, C_u and N_i):

Composts made from the organic material in solid waste will inevitably contain these elements, although at low concentrations after most contaminants have been removed. The most common heavy metals in composting (boron (B), zinc (Zn), copper (Cu), nickel (Ni), arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg)). In small amounts, many of these trace elements (e.g., boron, zinc, copper, and nickel) are essential for plant growth. However, in higher amounts they may decrease plant growth. In this study included three of elements Z_n , C_u and N_i. Table 7 and Figure 10 shows decrease elements during composting process in Bin Composter.

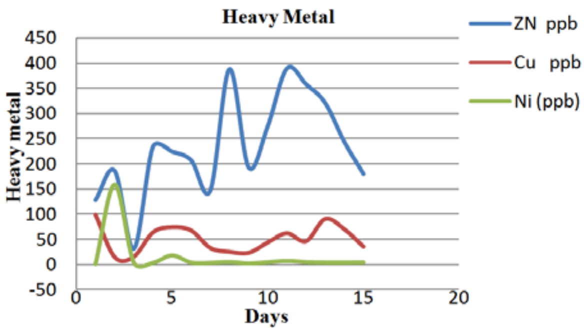

Fig. 10: Removal of heavy metal with days of composting.

Table 7: Values of Heavy Metal during composting process.

Days	Cu ppb	Zn ppb	Ni ppb
1	99.763	127.908	1.117
2	14.966	186.058	158.644
3	15.927	30.971	3.931
4	64.501	234.086	3.469
5	74.903	224.303	18.184
6	68.111	206.943	3.859
7	33.202	147.022	3.519
8	25.681	388.309	5.165
9	23.581	192.774	2.363
10	44.297	62.854	46.678
11	91.333	70.868	35.857
12	274.897	389.742	358.435
13	321.073	243.698	180.16
14	54.704	7.186	4.899
15	4.066	3.910	4.313

Table 8:

References	pH	Ni	P	Zn	Cu	T ^{0}C	M%	TKN	TOC	Treatment system
Bin Composter 2011	8.44	15..3 ppb	189372.7 mg/L	233.75 ppb	51.50 ppb	37.65	53.66	4.05	44.822	Bin Composter at Wet Market
Joan Col´n 2010	8.3	-	-	-	-	37.4	44.9	2.4		Home Composting
Shu-Hsien Tsai 2006	5.78	-	-	-	-	50	13.63	2.10	49.53	mechanical composter(Biorich Technology Corporation)
Marco Grigatti 2003	8.67	46	-	212	146	-	38	2.22	-	static pile
Ajay S. Kalamdhad 2009	8.39	-	6 g/kg	-	-	65	70	2.6	23	a rotary drum composter
Ajay S.2007	8.3		0.6 g/kg			60	56	-	35.29	Rotary Drum Composting
Kian-ghee Tiew 2011	5.76	-	-	-	-	63	26	5.26	39.48	Optimal vermicomposting by layering method
C.Tognetti, M.J. Mazzarino 2006	8.5	-	263mg/kg	-	-	60-70		1.2	35	Compost pile and vermicompost bed establishment

4. Summary of the Composting parameters estimated and their comparison with values in the literature:

5. Conclusion:

Bin composter is a suitable treatment option for organic wastes such as leftovers of raw fruit, chicken, food and vegetables (LRFV), from the technical and environmental point of view. The bin composter method is useful to convert organic waste to useful products and that would otherwise have been land filled. Our research established the possibility of recycling biomass waste by composting vegetables waste with chicken waste and food waste in order to obtain biofertilizer compost, with a high nutritive value for plants and good amendments of soil physical and chemical properties. The physicochemical properties of organic matter during composting process obtained were in the range of good quality according to the standards to ensure safe application of compost. During the thermophilic phase, the temperature was increase to 58 ^{0}C and this increase is necessary for the destruction of pathogens within 21 days. Then, decrease of heavy metal and increase of total nitrogen during composting process within 15 days.

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REFERENCES

Amos. Kyoto, 1998. Protocol to the United Nations framework. Convention on clima techange. United Nations.

Ajay, S., Kalamdhad and A.A. Kazmi, 2007. Rotary Drum Composting of Mixed Organic Waste based on Different C/N Ratios.

Ajay, S., Yatish. Kalamdhad, K. Singh, Ali. Muntjeer, Meena Khwairakpam, A.A. Kazmi, 2009. Rotary drum composting of vegetable waste and tree, leaves.

Bishop, P.L., C. Godfrey, 1983. Nitrogen transformation during sludge composting.Biocycle, 24: 34-39.

Carnes, R.A., 1970. An Investigation of the pH Characteristics of Compost. Compost Science, Sept-Oct. Unit Operations in Resource Recovery Engineering Prentice- Hall, Inc., 1997.

Fauziah, S.H. and P. Agamuthu, 2009. Sustainable Household Organic Waste Management Vermicomposting. Malaysian Journal of Science, 28(2): 135-142.

Hsien, Shu., Liu. Tsai, Ching-Piao, Yang. Shang-Shyng, 2006. Microbial conversion of food wastes for biofertilizerproduction with thermophilic lipolytic, microbes.

Hassan, Basri., 2001. Solid Waste Management in Malaysia: Technical Perspectives. Dasar Memperbaiki Pengurusan Sisa Pepejal, Perbandaran.

Jabatan Pengurusan Sisa Pepejal Negara, 2009. Seminar pengurusan sisa pepejal.Universiti Kebangsaan Malaysia. Bangi, 13.

Joan, Col´n, Julia. Martinez-Blanco, Xavier. Gabarrella, Adriana. Artola, Antoni. Sancheza, Joan. Rieradevalla, 2010. Xavier Font. Environmental assessment of home, composting.

Marco. Grigatti, Claudio. Ciavatta, Carlo. Gessa, 2003. Evolution of organic matter from sewage sludge and garden trimming during, composting.

Romeela, Mohee., Ackmez Mudhoo, 2005. Analysis of the physical properties of an in-vessel composting, matrix.

Sivapalan, Kathirvale., Muhd. Noor, Muhd. Yunus, Kamaruzzaman Sopian, Abdul. Halim, Samsuddin, 2003. Energy potential from municipal solid waste in Malaysia. Renewable Energy, 29: 559-567.

Tognetti, C., M.J. Mazzarino, F. Laos, 2006. Improving the quality of municipal organic waste, compost.