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Oil Addition in Food Waste Composition and Amount Biodegraded at Various Food Waste Loading

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***Abstract*— Oil was added (20%) to the food waste composition used in this part of the study and the extent of biodegradation of food waste and oil was investigated. The biological solubilization system was operated at different food waste loading (10, 20 and 40 kg/m^3/d) with the food waste containing 20% of oil. At 10 kg/m^3/d food waste loading, almost 50% of the total oil input was decomposed and even though food waste loading was increased, the amount of decomposed oil for each run remains the same (0.78 kg/m3/d on the average). Oil input of 1 kg/m^3/d or lower is acceptable to the biological solubilization system and could result to total decomposition while increasing the oil loading beyond 1 kg/m^3/d will not result to further oil decomposition. The oil loading to the system was considerably high resulting to difficulty in achieving higher percentage of oil decomposition. Thus, the system can probably lead to a higher rate and more efficient oil decomposition and waste mineralization when oil loading is reduced (1 kg/m^3/d or lower).**

Key words: amount biodegraded, biological solubilization, food waste loading, oil

INTRODUCTION

Large amounts of food wastes generated from kitchens, restaurants and food industries is a growing concern especially in Japan. Incineration and landfill of food wastes are conventional methods but are becoming inattractive due to problems on hazardous emissions and lack of space, respectively [1]-[3]. Thus, researches in trying to find the proper treatment technology for these wastes are continuously being undertaken. Biodegradation has been one of the most attractive methods of treatment for food waste since aside from water content (about 80%), food waste is composed of biodegradable organic matter [4]-[6]. Other components of food wastes however, are not easily biodegraded. This adds to the difficulty in finding the appropriate treatment procedure. Oil for instance, is present in considerable amounts. A study conducted by Minowa et al. [7] regarding the direct conversion of garbage (another term for food waste) to oil by thermochemical liquefaction proved that food wastes contain substantial amounts of oil. From the results of their findings, 27.6% (on an organic basis at certain conditions set for the operation) was the highest oil yield obtained. Even with the application of on-site treatment technology, such as the use of garbage disposers or grinders, wastewater discharged from domestic and industrial sources after crushing food waste, often include lipid materials such as fats, oil and grease [8],[3],[9]. This therefore results to an increase in the organic loading in sewage systems and other operational disturbances including clogging of pipes due to deposition [10],[11].

The new food waste treatment technology, known as biological solubilization and mineralization system, introduced in our previous study [12], reduces the organic loading to sewage systems because food wastes are not only solubilized but part is mineralized prior to disposal as wastewater. In this part of our study, various amounts of oil were incorporated in the food waste composition and using the new technology we proposed, we investigated the extent of biodegradation of food waste and oil.

II. MATERIALS AND METHODS

A. Food Waste Composition

The food waste composition used in this part of the study, as listed in Table 1, was varied in such a way that 20 % of salad oil was added to the mixture.

Table 1. Composition of food waste used (Standard Garbage – SG)

Components		Composition (% w/w – wet basis)
Vegetables	Cabbage	14
	Carrot	14
Fruits	Apple	11
	Banana	13
Meat	Fried Chicken	8
Others	Rice	8
	Egg	8
	Used Tea Leaves	3
	Oil	20
Total		100

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B. Support Media and Microorganisms

Similar to the previous experiments done, rice hulls were used as support media in this set of experiments. Activated carbon pellets (130 g) and solid activated sludge (200 g) were also used to inoculate the reactor contents prior to operation.

C. Sampling and Analyses

Effluent samples were collected periodically and subjected to various analyses. Dissolved organic carbon (DOC), suspended solids (SS), carbon content, nitrogen content and oil analyses were done for all the samples obtained.

The amount of oil and grease extracted was calculated using equation 1.

$$\text{mg oil and grease/L} = \frac{(A - B) \times 1000}{\text{sample volume (mL)}} \qquad (1)$$

where A = total gain in weight of the tared flask
B = calculated residue from solvent blank

Daily monitoring of the weight of reactors were also done. All the analyses were done according to Standard Methods (APHA-AWWA-WPCF, 1989).

D. Operating Conditions

The operating conditions set for this part of the study are listed in Table 2. Only the food waste loading was varied to determine the extent of biodegradation of oil as well as waste.

Table 2. Operating conditions of the runs

CONDITIONS	RUN 1	RUN 2	RUN 3
Food Waste Loading ($kg/m^3/d$)	10.0	20.0	40.0
Water Supply Volume (L/h)	7.0	7.0	7.0
Water Supply Frequency (times/h)	2	2	2

III. RESULTS AND DISCUSSION

A. DOC and SS in effluent

Similar trends as of the previous experiments were obtained for the DOC and SS analyses done. For the first few hours after feeding food waste into the reactors, concentrations increased and started decreasing until the values leveled off after twelve hours. This trend has been observed in all the experiments (previous and current) performed. An increase in the DOC concentration in the beginning signifies the dissolution of the soluble components of the waste and leveling off implies that most of the waste had been solubilized. For SS however, since the waste was just fed to the reactors at the start, there was large amount of SS produced from solubilization, and as the waste was solubilized, SS concentrations became constant. It can be observed from Figure 1 that as the food waste loading increases, the DOC concentrations in effluent also increase. The same behavior was observed for SS as shown in Figure 2. Doubling the food waste loading also doubles the DOC and SS concentrations. There is a direct relationship between time and DOC or SS concentrations.

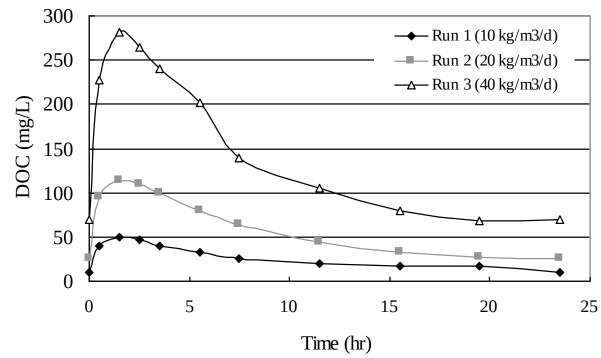

Figure 1. DOC concentrations within 24 hours after feeding food wastes into reactors

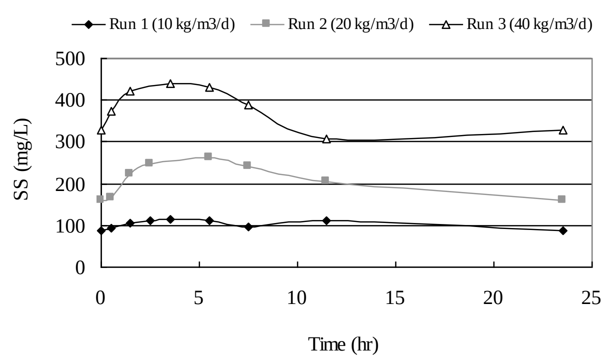

Figure 2. SS concentrations within 24 hours after feeding food wastes into reactors

B. Oil Concentrations in Effluent (n-Hexane extracts)

The concentrations of n-hexane extracts are shown in Figure 3. Increase in food waste loading increase the concentration of n-hexane extracts in effluent. This observation is just reasonable since the percentage of oil added to food waste

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also increased. It can be observed however, that beyond the food waste loading of 10.0 kg/m3/d, the concentrations of n-hexane extracts determined were fluctuating. At a loading rate of 10.0 kg/m3/d, the concentrations are stable.

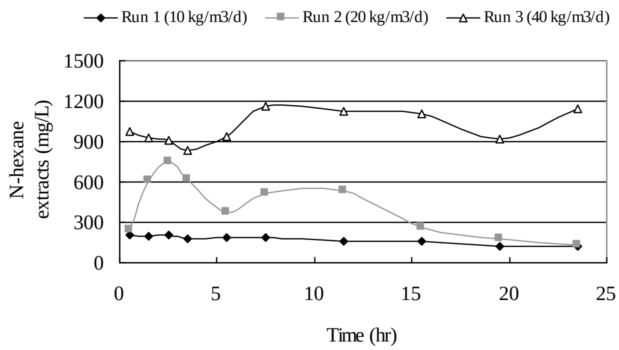

Figure 3. N-hexane extracts concentrations within 24 hours after feeding food wastes into reactors

C. Carbon Mass Balance

The distribution of carbon in each run was determined by carbon balance. The results of the calculations were plotted and are shown in Figures 4a and 4b. It can be observed that almost the same percentages of carbon in SS and DOC (about 20 and 10%, respectively) resulted for all runs (run 1 to 3). On the other hand, the percentage of carbon in oil calculated for the runs ranged from 38% to 62% while that converted to inorganic carbon (carbon in CO2) ranged from 15% to 40%. It is very apparent that the increase in food waste loading decreased the percentage of mineralization in the system. The difference among the runs performed lies on the amount of carbon in oil or amount of carbon in CO2 and not on the concentration of organics (DOC and SS) in effluent.

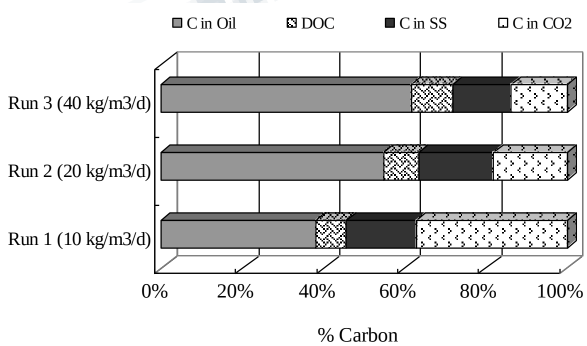

Figure 4a. Carbon balance (percentage of carbon distribution)

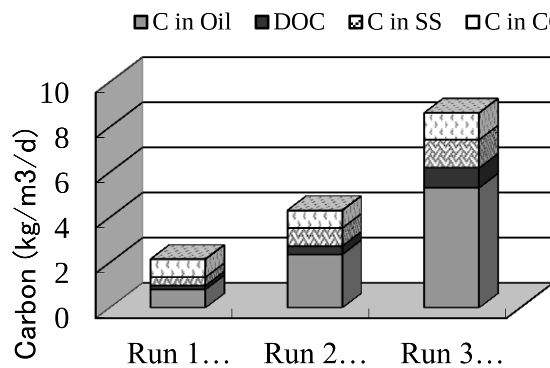

Figure 4b. Carbon balance (actual amount of carbon distribution)

Upon determining the amount of decomposed oil in each of the runs, the results were compared. Figure 5 shows the n-hexane extracts concentration in effluent. It can be observed that at 10 kg/m3/d food waste loading, about 50% of the total oil input was decomposed. It is evident that regardless of the food waste loading, the amount of decomposed oil for each run remains the same (0.78 kg/m3/d on the average). With the results obtained, it was found out that beyond 10 kg/m3/d food waste loading (containing 20% of oil equivalent to 2 kg/m3/d), the same amount of oil decomposition resulted. This implies that beyond 2 kg/m3/d loading of oil to the system, no further oil decomposition will occur. Almost 50% of the total oil input of 2 kg/m3/d was decomposed. This suggests that 1 kg/m3/d of oil was decomposed. Thus, this loading of oil (1 kg/m3/d or lower) to the system will result to total decomposition and is acceptable in the system. The oil loading to the system (20% of food waste composition) could have been high causing difficulty in attaining higher percentage of oil decomposition. In addition, since it was found out that excess oil in food waste could inhibit the biodegradation [8], this could have contributed to the obtained percentages of conversion of carbon to CO2 (15% to 40%). Lowering the oil loading to the system could probably lead to a higher rate and more efficient oil decomposition and waste mineralization. Thus, through the biological solubilization system, oil input of 1 kg/m3/d or lower could result to total decomposition.

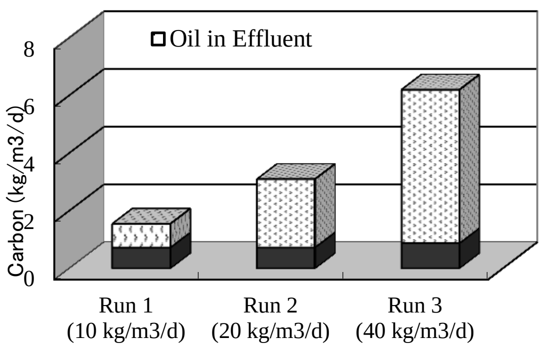

Figure 5. Amount of oil decomposed at different food waste loading

IV. CONCLUSIONS

The biological solubilization system was operated at different food waste loading (10, 20 and 40 kg/m3/d) with the food waste containing 20% of oil. At 10 kg/m3/d food waste loading, almost 50% of the total oil input was decomposed and even though food waste loading was increased, the amount of decomposed oil for each run remains the same (0.78 kg/m3/d on the average). Thus, through the biological solubilization system, oil input of 1 kg/m3/d or lower is acceptable to the system and could result to total decomposition. Meanwhile, increasing the oil loading beyond 1 kg/m3/d will not result to further oil decomposition. Difficulty in achieving higher percentage of oil decomposition may be due to the high oil loading to the system. Thus, the system can probably lead to a higher rate and more efficient oil decomposition and waste mineralization when oil loading is reduced (1 kg/m3/d or lower).

V. REFERENCES

[1] Hemmi, H., Shimoyama, T., Nakayama, T., Hoshi, K. and Nishino, T. 2004. Molecular Biological Analysis of Microflora in a Garbage Treatment Process under Thermoacidophilic Conditions. J. Biosci. Bioeng. 97(2), 119-126.

[2] Wang, Q., Narita, J., Xie, W., Ohsumi, Y., Kusano, K., Shirai, Y. and Ogawa, H.I. 2002. Effects of Anaerobic/Aerobic Incubation and Storage Temperature on Preservation and Deodorization of Kitchen Garbage. Biores. Technol. 84, 213-220.

[3] Nakano, K. and Matsumura, M. 2001. Improvement of Treatment Efficiency of Thermophilic Oxic Process for Highly Concentrated Lipid Wastes by Nutrient Supplementation. J. Biosci. Bioeng. 92(6), 532-538.

[4] Haruta, S., Nakayama, T., Nakamura, K., Hemmi, H., Ishii, M., Igarashi, Y. and Nishino, T. 2005. Microbial Diversity in Biodegradation and Reutilization Processes of Garbage. J. Biosci. Bioeng. 99 (1), 1-11.

[5] Wang, Q., Yamabe, K., Narita, J., Morishita, M., Ohsumi, Y., Kusano, K., Shirai, Y. and Ogawa, H.I. 2001. Suppression of Growth of Putrefactive and Food Poisoning Bacteria by Lactic Acid Fermentation of Kitchen Waste. Process Biochem. 37, 351-357.

[6] Yun, Y.S., Park, J.I., Suh, M.S., Park, J.M., 2000. Treatment of Food Wastes Using Slurry-Phase Decomposition. Bioresource Technol. 73, 21-27.

[7] Minowa, T., Murakami, M., Dote, Y., Ogi, T., Yokoyama, S. (1995). Oil Production from Garbage by Thermochemical Liquefaction, Biomass and Bioenergy., 8(2), 117-120.

[8] Aoshima, M., Pedro, M.S., Haruta, S., Ding, L., Fukada, T., Kigawa, A., Kodama, T., Ishii, M. and Igarashi, Y. (2001). Analyses of Microbial Community within a Composter Operated using Household Garbage with Special Reference to the Addition of Soybean Oil, J. Biosci. Bioeng., 91(5), 456-461.

[9] Wakelin, N.G. and Forster, C.F. 1997. An Investigation into Microbial Removal of Fats, Oils and Greases. Biores. Technol. 59(1), 37-43.

[10] Becker, P., Koster, D., Popov, M.N., Markossian, S., Antranikian, G. and Markl, H. 1999. The Biodegradation of Olive Oil and the Treatment of Lipid-Rich Wool Scouring Wastewater Under Aerobic Thermophilic Conditions. Wat. Res. 33(3), 653-660.

[11] Lefebvre, X., Paul, E., Mauret, M., Baptiste, P. and Capdeville, B. 1998. Kinetic Characterization of Saponified Domestic Lipid Residues Aeobic Biodegradation. Wat. Res. 32(10), 3031-3038.

[12] Gonzales, H.B., Takyu, K., Sakashita, H., Nakano, Y., Nishijima, W., Okada, M. 2005. Biological Solubilization and Mineralization as Novel Approach for the Pretreatment of Food Waste. Chemosphere. 58(1), 57-63.

