THE EFFECTS OF SALT INHIBITATION ON DEGRADATION PROCESS OF EASILY BIODEGRADABLE SOLID WASTE

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INTRODUCTION

Biodegradable solid waste is just one, which is 100% able to be recycle by composting and reuse as fertilizer in agriculture, horticulture etc. It is a unique waste management option because the waste producer is also the processor and end-user of the product. This, however, results in a large variety of operation schemes, which means that there is no standardized procedure for home composting. This is one of the reasons for the lack of scientific knowledge in this field, comparing to centralize composting (J.K. Andersen et. al. 2010). In addition, organic compound of municipal solid waste ranged 14% to 51% in OECD countries in 2005 (OECD Environmental data compendium 2006-2008 thus prefers to be recycling for nutrients turnover to the soil than dispose at the landfills. The large quantity is composed from kitchen leftovers (Hanc, A et.al. 2011). Recycling food waste by EM Bokashi is applicable method in households owing to capability decomposing most part of kitchen waste (Sung Ch. 1999) as well as is odourless. The aim of this research is to warn on potential hazard from compost products especially from soluble salt which includes kitchen leftover in many countries. The experiment was conducted to verify salt influence on biodegradation process therefore salt remains and desalination process by simulating rainfall. Hence, this study focused on the biodegradability particularly on change of physical parameters representation by total organic carbon in addition ion concentration in time.

MATERIALS AND METHODS

1. Materials

Five cylindrical plexiglass columns (0.1 m diameter and 0.25m height) were designed to conduct the lab scale experiment. Easily biodegradable solid waste, in this case cooked rice (1.4Kg; moisture content 61-71%) consisting mainly of carbohydrates, was used as sample material and mixed with particular amount of soluble salt NaCl and also EM Bokashi (60g) to enhance anaerobic process. Used EM Bokashi was product of Irisplaza Corporation. Columns were filled by hand compaction therefore density created 228.7 kg/m^3. According to appropriate method (Higa and Parr 1994) the waste in columns were closed and fermented for 10 days. During that period no leachate was collected due to low moisture content (58%). Afterward, fermented waste was mix with sandy loam soil at rate 1:3 (waste:soil) and continue degradation process for 20 days.

During the degradation process, 250 ml of water per week was added to columns to simulate rainfall therefore it created leachate which was five times collected and analysed. The ambitious temperature was in range at 27-33^{o}C and the columns were covered by aluminium foil to prevent light influence.

2. Analyse methods

Dissolved organic carbon was measured using a TOC-TN analyser (TOC-V/CPN TNM-1, Shimadzu co.), pH by Horiba Cond Meter and EC by Horiba Conductivity meter DS-14 at room temperature. In addition, loss on ignition testing was conducted at furnace at 800 ^{o}C for two hours. Carbon and Nitrogen in solid phase was measured by JM1000 HCN. Ion chromatography DX-120 was used to detect ions from leachate especially Na^+ and Cl^- and experimental data were subjected to analysis of regression and correlation by Microsoft Excel Data Analysis.

RESULTS AND DISCUSSION

The attention was paid mainly to change of pH, electric conductivity and ions and also change of total carbonic carbon in dissolved phase. Hence, the leachate showed very low acidity pH (3.5 - 4.5) gradually decreasing due to acid fermentation, the influence of salt was negligible and result was not considerably influenced. EC result show high impact of salt on leachate viz. figure 1. The trend was increasing due to slowly releasing of salt than the concentration start decrease as a result of water supply which is also one of desalination methods. Total organic carbon dissolved in leachate showed the highest rate for column 1 which was filled only with pure waste. It was caused mainly from volatile fatty acid release and reached to 16 000 mg/l. Column 2 containing EM, showed notably lower concentration than column 1 and carbon was more captured in waste. Other columns 3, 4 and 5 affected by salt showed notably lower TOC concentration than without NaCl therefore the biodegradation process was inhibited and carbon was kept in solid phase. Total nitrogen results resemble TOC results Fig. 3. The results showed mainly strong positive correlation between salt concentration in the sample and level of electric conductivity in leachate ($r = 0.8571$). In addition, concentration of Na^+ and Cl^- ions were compared to initial salt input and calculated. Since the leachate contains high concentration TOC and Na^+ and Cl^- ions, it is harmful to environment thus must be treat before disposing.

Table 1. Characteristics of the solid waste in experimental columns

Column number	Salt concentration (w/v)	EM content (grams)	C/N ratio after fermentation	R^2 TOC to TN,EC	LOI* before fermentation (%)	LOI after fermentation (%)	Salt removal rate (%) through leachate**
1.	0%	0	29:1	0.953	90.88	94.02	n/a
2.	0%	60	26:1	0.666	90.64	89.91	n/a
3.	1%	60	24:1	0.865	88.48	87.67	30.2
4.	2%	60	21.5:1	0.320	82.98	88.48	32.4
5.	3%	60	20.2:1	0.979	79.19	89.51	35.1

*LOI: Loss on ignition; **the rate was based on the initial salt content of the solid waste, leachate amount, ions concentration.

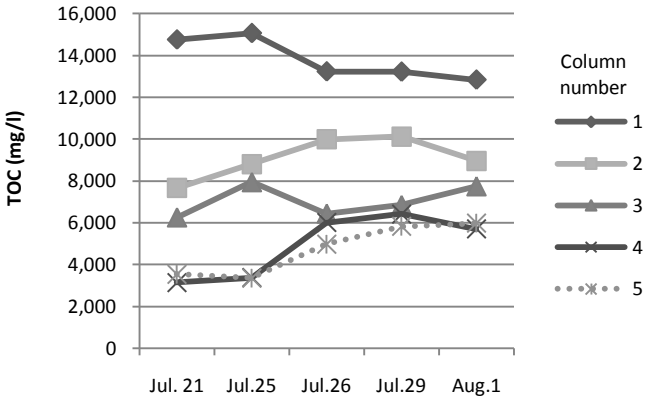

Fig. 1. Total organic carbon in leachate

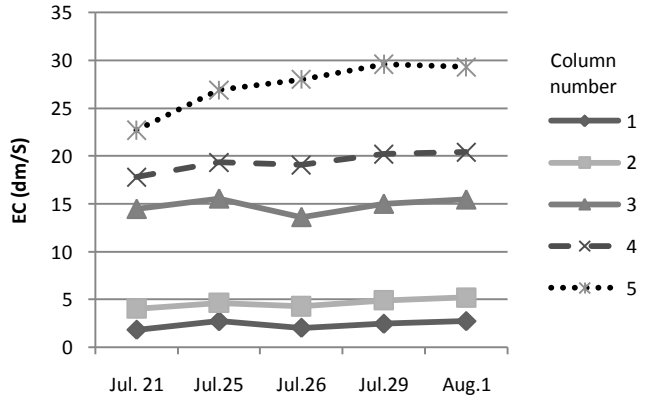

Fig.2. Electric conductivity in leachate

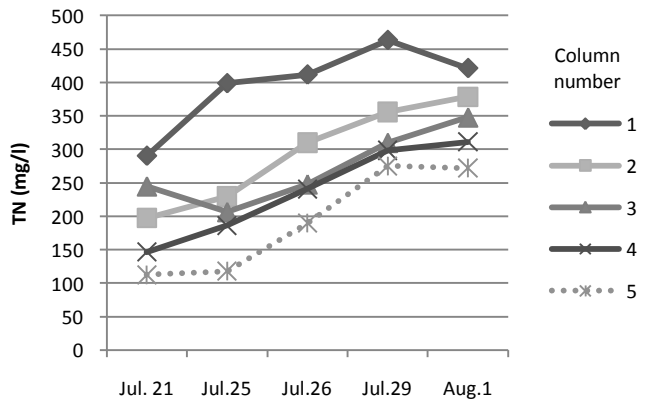

Fig. 3. Total nitrogen in leachate

CONCLUSION

The impacts of salinity and EM Bokashi addition on the biodegradation of easily biodegradable solid waste were studied using laboratory columns experiment. The result of this study revealed that the composting of salt affected waste using EM impacted the biodegradation kinetics therefore the process was slightly inhibited. The impacts of salt concentration were distinct at 1% concentration however 2 and 3% was not significant for TOC and TN results, although EC results showed high value. Water supply into columns proved soil desalination process during 20 days whereas the whole process was not clearly clarified due to short period experiment. To verify whole process it would be recommended to conduct experiment for period of 60 days. The highest concentration of NaCl showed the fastest salt removal through leachate respectively 35.1% was leached out. This research was conducted mainly for kitchen leftover and we confirmed NaCl as a potential harmful element on the environment to cause soil salinity besides inhibiting biodegradation.

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