B−21 THE IMPACT OF SALT INHIBITION ON DEGRADATION PROCESS OF EASILY BIODEGRADABLE SOLID WASTE IN ANAEROBIC CONDITION

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INTRODUCTION

Biodegradable solid waste has a high potential as a raw material for compost which can be used as a fertilizer in agriculture, horticulture etc. However, heterogeneous nature of solid waste makes it difficult to be recycled and which lead to dispose without resource recovery.

Organic compound of municipal solid waste (MSW) ranged 14% to 51% in countries[1)] which are members in Organization for Economic Co-operation and Development (OECD). In addition, the large quantity is as well composed from kitchen waste[2)]. Western cuisine contain around 0.2 to 2.2% of NaCl salt[3)] therefore NaCl might cause concern during biodegradation process in composting or MSW landfill.

Around 38% of MSW in European Union is still dispose in landfill[4)] moreover, new member states reports more than 75% of MSW landfilled without any treatment. Leachate affected by salt contamination has been found out[5)] could cause problems during leachate treatment. Solid waste biodegradation process has been described by many researchers[6)], however salt effect on biodegradation of kitchen waste has not been clearly studied under anaerobic condition[7)]. The aim of this research is to evaluate anaerobic biodegradation process under salt influence by simulating kitchen waste buried in landfill.

The change of organic mass was analysed by thermogravimetry and different thermal analysis (TG-DTA). It is based on programmed heating of the samples in controlled atmosphere which in conclusion give qualitative and quantitative information regarding to chemical parameters of organic matter[8, 9, 10)].

MATERIALS AND METHODS

1. Materials

Five cylindrical plexiglass columns (0.1 m diameter and 0.25m height) were used to conduct the lab scale experiment. To verify the biodegradation process within short period of time, easily biodegradable solid waste, in this study cooked rice which mainly consists of carbohydrates was used as a sample material.

The characteristics of solid waste were: moisture content 61±2%, TOC 44.5±2%, pH 6.2, C/N ratio 36.1, electric conductivity 1.1dS.m^{-1}. Subsequently, 2.0 kg of waste was mixed with particular amount of soluble salt NaCl (Table 1) and filled into columns by hand compaction. Initial density was 1061 kg/m^3.

The columns were kept closed except sampling during all period to simulate anaerobic condition in landfill site. The temperature in columns were controlled by electric heater and measured by ECT Air temperature sensor (decagon devices) in the centre of waste every 30 minutes. The temperature range was between 27-30 °C to simulate summer months. The experiment was conducted for period of 65 days. There was no considerable amount of leachate generation from Columns.

2. Analyse methods

Sampling

Approximately 100g of waste was sampled every ten days from Columns. Then solid samples were dried in laboratory oven at 40 °C until constant weight was achieved to obtain the moisture content. Afterward, solid samples were grinded in laboratory grinder and sieved by 2mm and 45μm mesh sieve. The prepared solid samples were used for elemental and thermogravimetry analysis.

Chemical parameters

The dried and sieved samples (2mm) were mix with deionized water in rate 1:10 and shake for one hour at 200 rpm by laboratory horizontal shaker. Followed by pH and electric conductivity (EC) were measured at room temperature of 20°C by using pH meter (Horiba Cond Meter) and EC meter (Horiba Conductivity meter DS-14). Each parameter was measured three times and the mean results are shown in Table 1.

Ion chromatography

After measuring pH and EC, samples were centrifuged at laboratory centrifuge at 3000 rpm for 20 minutes.

Table 1 Characteristics of the solid waste in experimental columns

Salt concentration % (w/v)	TOC content (%)		Correlation coefficient TOC to EC	EC ($dS.m^{-1}$)		pH		C/N ratio	
	Initial	Final		Initial	Final	Initial	Final	Initial	Final
0	45.45	29.25	-0.74	0.37	1.10	6.27	3.42	36.1	26.28
1	44.55	31.48	-0.86	1.62	4.25	6.23	3.41	36.2	28.40
2	45.38	32.26	-0.82	0.45	9.20	6.28	3.55	36.2	29.08
4	43.50	33.91	-0.86	9.45	15.30	6.15	3.72	34.8	30.15
6	44.50	36.81	-0.92	17.80	21.50	6.11	4.05	35.6	30.80

Afterwards solution was filtered with laboratory 0.45 µm filter and diluted by 1000 times. Filtered solution were analysed for Na+ and Cl- by using ion chromatography apparatus (Dionex DX-120). Experimental data were subjected to analysis of linear regression to find out relationship and correlation to verify dependency. The used software was Microsoft Excel Data Analysis.

Elemental composition

Total carbon and total nitrogen in solid phase was measured by JM1000 HCN elemental analyser (J-Science Lab Co., Ltd) at temperature of 800 °C and than C/N ratio was calculated. Total organic carbon was analysed by TOC-V/CPN TNM-1 apparatus (Shimadzu co.).

Thermogravimetry

Determination of organic matter during waste maturation was conducted by thermogravimetry apparatus (TG-DTA 2000 SA Bruker AXS product). The following conditions were used: heating rate of 10°C/min from 20 to 1000°C, oxidizing atmosphere synthetic air (composition 21±1% O_2 and 79±1% N_2; purity≥99.9995%) was maintained with flow set to 150 ml/min, platinum crucible, α-aluminium Al_2O_3 as a reference and samples weight around 25mg. Following reaching 1 000°C the temperature were kept for 10 min to cease the weight loss as well as to achieve TG curves flat and stable. The Bruker AXS applied software was used for data processing. Thermal analyses were repeated 3 times for each sample to eliminate errors moreover, mean values of measures are reported in the figure 4

RESULTS AND DISCUSSION

The TOC and physical parameters results are reported in Table 1. TOC concentrations decreased rapidly during the first 20 days particularly in 0% NaCl column then slow down process due to anaerobic condition in the column. Results in other columns containing NaCl apparently show that a decreasing rate of TOC is lower than 0% NaCl column due to salt inhibition. The salt inhibition is expressed by osmosis which drew available water from the waste to the outside till reached equilibrium with the salt content which it was in contact. Regarding TOC and EC results, it has been confirmed even 1 % NaCl influence carbon change by inhibition and EC. The C/N ratio is commonly used index of the compost stability as it is more sensitive to chemical changes in the organic matter than N or C contents alone. The C/N ratio gradually decreases with time. Results of pH show decreased during the first 20 days then stabilized at range between 3-4. Electric conductivity results proved salt contents in waste therefore the highest salt concentration confirmed the highest EC value.

Thermogravimetry (TG) is based on the rate of weight loss and DTA on the temperature change in a small sample of organic matter in comparison with an inert sample while both are submitted to the same temperature program. TG profiles allow expression for each sample weight loss which is taking place at each temperature during combustion. The higher the temperature at which weight loss occur the more resistant and ordered structurally is the organic fraction which is combusting. Comparing samples with a different stability degree, temperature changes at which occurs the main weight

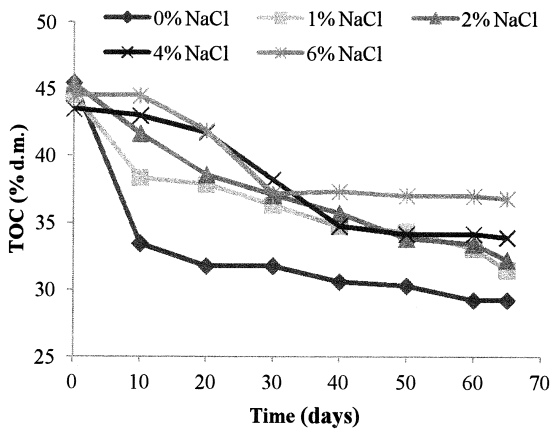

Fig.1 Total organic carbon in solid phase

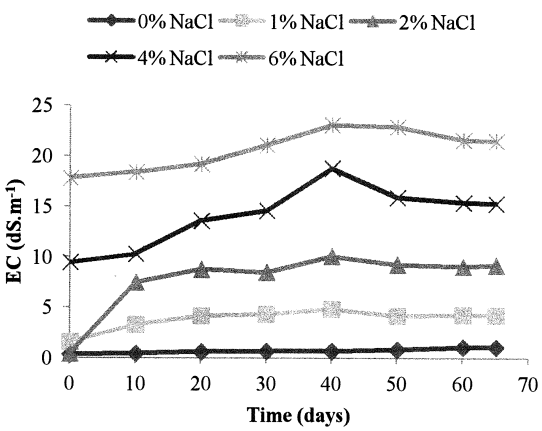

Fig.2 Electric conductivity in solid phase

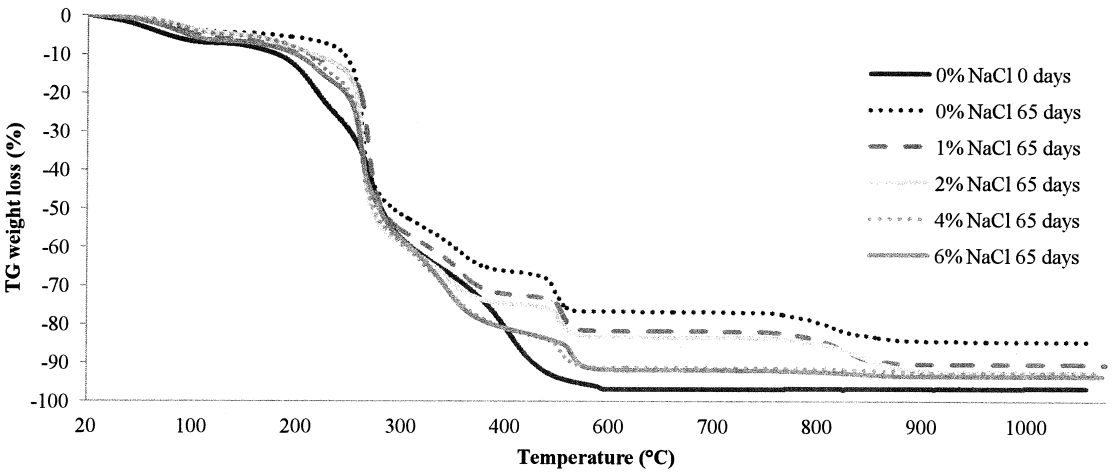

Fig.3 TG curves of extracted sample from waste at different salt addition

loss during combustion should be analytic about the organic fraction characteristics. TG results (Fig. 3) show in the 50-200 °C range a weight loss comprised of the dehydration reaction. Between 200 and 480 °C interval representatived of combustion of carbohydrates and between 480 and 530 °C range ascribed to thermal degradation of aromatic structures. Finally, between 530 and 800 °C range, slight weight loss account for the carbonated thermal degradation. Hence it is apparent that initial sample was characterized by high carbohydrates content which has a tendency to vanish during biodegradation process. On the other hand, the aromatic components did not change considerably.

CONCLUSIONS

This research has given an account of different salt addition into waste and its influence during biodegradation process. Combination of five experimental columns which contained 0, 1, 2, 4 and 6 % of NaCl were examined to investigate the changes in organic carbon behaviour along with Na^+ and Cl^- ions content in waste and thermogravimetry to verify degradation level. It has been concluded that even 1% of NaCl affect the degradation by inhibiting organic carbon release and higher concentration significantly impact the degradation process.

Chemical parameters results verified strong negative regression between EC which represented NaCl content and TOC therefore we could estimate organic carbon behaviour. Moreover, C/N ratio tended to tie TOC results in each column so that it also verified inhibition on biodegradation. TG results demonstrate maturity of organic matter by TG curves. Immature samples results show higher weight loss as the organic matter was released. Contrary the lower weight loss show more mature samples due to degradation and stabilization which means the column 0% NaCl 65 days, 1% NaCl 65 days and 2% NaCl 65 days. However DTA results fully did not responds as TG curves.

Finally, further investigation needs to be carried out on larger variety of waste composition and mainly longer periods to clarified impact on the whole degradation process. However, even this short period confirmed potential of salt inhibition and salt contents in kitchen waste. Furthermore, thermogravimetry appears to be a useful tool at investigating organic matter and could be apply in further research.

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