Compostability of Restaurant Kitchen Waste Using "Effective Microorganisms" Preparations

Holger Kahl[1] and Mike Daly[2]

Christchurch Polytechnic Institute of Technology - School of Horticulture
PO Box 540, Christchurch, New Zealand[1]
New Zealand Nature Farming Society, 146 Halswell Road, Christchurch, New Zealand[2]

***Abstract** : Different ways of composting and fermenting restaurant kitchen waste with the assistance of Effective Microorganisms were investigated. Temperature and pH developments were described. The effect of two different EM techniques on common house fly (Musca domestica) attraction and yields of lettuces (Lactuca sativa) in a field trial were measured and analysed. The anaerobic fermentation of the kitchen waste in sealed drums achieved significantly the best results in both, decreasing fly attraction and fertilising effect on lettuces to increase yields.*

Introduction

Waste reduction and recycling have been on the agenda of city managers and environmentalists for some considerable time. Projects such as Zero Waste and Target Zero aim at encouraging companies and institutions to take steps towards waste reduction and recycling.Over the past years the Christchurch Polytechnic Institute of Technology (CPIT) has established a number of measures to conserve energy and reduce waste.

The CPIT training kitchens are producing a considerable amount of waste which is channelled into the main waste stream since there is no public facility available to compost putrescible waste (the existing City Council composting plant holds a resource consent for composting of garden waste only). On the other hand, the horticulture facilities at the School of Horticulture are in constant need of materials for producing compost and potting mixes. It is desirable to take all the Hospitality kitchen and restaurant waste to the School of Horticulture facilities at Seven Oaks and compost them there. The resulting compost material can then be used to produce vegetable crops. The necessary separation and collection of compostable waste in the Hospitality kitchens will require staff and student participation and will ultimately result in an increased level of environmental awareness and thus contribute to the "Greening of the Curriculum". Two trials were carried out to explore the feasibility of composting kitchen waste to produce sufficiently decomposed organic material which can be used as a soil conditioning compost for growing crops.

Materials and Methods

First Trial

Kitchen waste from the CPIT restaurant was separated and collected by hospitality students and transported to the Seven Oaks Campus (Monday - Friday). Daily amounts were received and were split evenly to supply two parallel composting containers.
The weekly average amount added to each container was 50.5 kg. The collection went

on for six weeks. During the six weeks of the trial the materials were accumulated in a wooden bin (approximately 1x1x1 m). Fine bark was sprinkled over the newly added material to cover. For the six weeks of material accumulation readings of temperature were taken thrice a week and four the following four weeks twice a week. A Reotemp compost thermometer with a 90 cm wand was used. Readings were taken from a depth of approximately 50 cm. Two parallel readings were performed and the average recorded. In week 3,4,5,6,8,10 and 14 after stating the material accumulation, two mixed samples were taken from each container and analysed for the pH value as well as NO_3 content. For the NO_3-Nitrogen test fresh samples from each container from a depth of approximately 30 cm were mixed and added to 30 ml of 0.01 M calcium chloride solution until the level of the solution rose to 40 ml. After an hour the clear zone at the top was decanted and used for the Merckquant? Nitrate test strips. Results were statistically analysed using One-way and Two-way ANOVAs.

Results and Discussion

Temperature

The graph of the temperature development during the course of decomposition shows considerate heat development even without turning, sufficient to meet the BioGro standards for the use of compost material in certified organic production (Figure1).
A temperature of over 50°C was maintained for about one month. Only the first container treatment dropped briefly slightly below 50°C for a few days during that period.

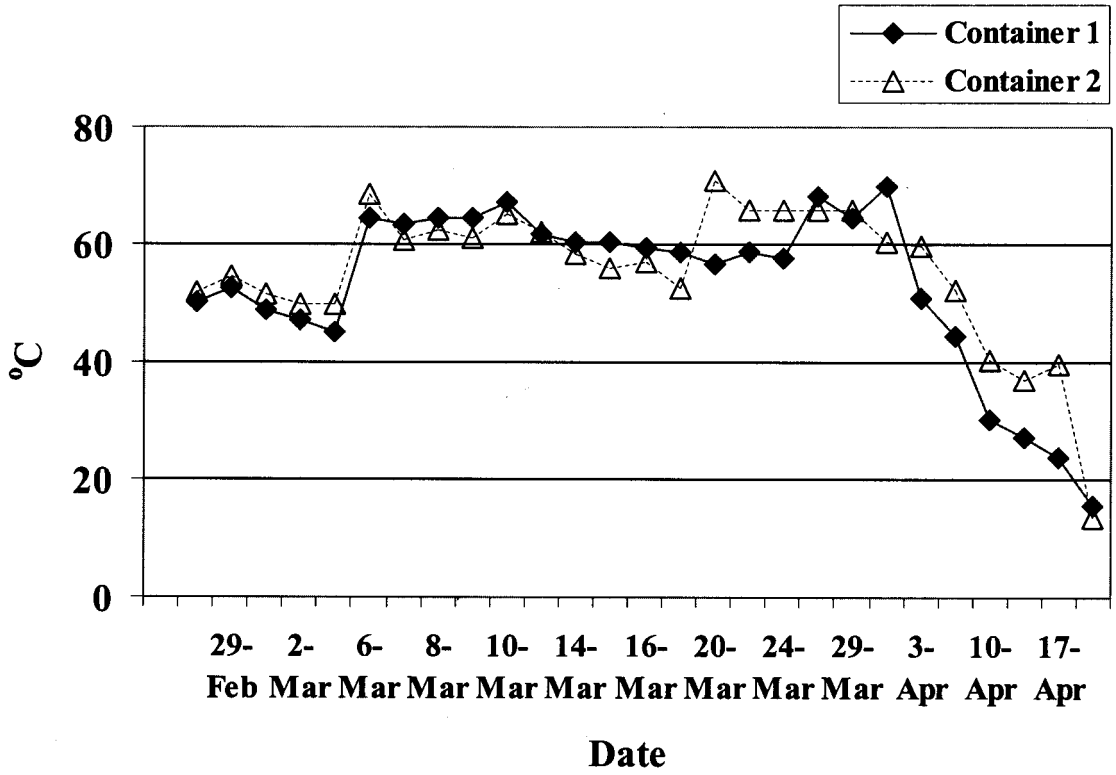

Figure 1. Temperature Development in the Two Composts

pH

The two treatments show very similar pH developments. The initially acid material increases in pH to over 7 and levels around more or less around a pH of 6 at the end of the trial (Figure 2).

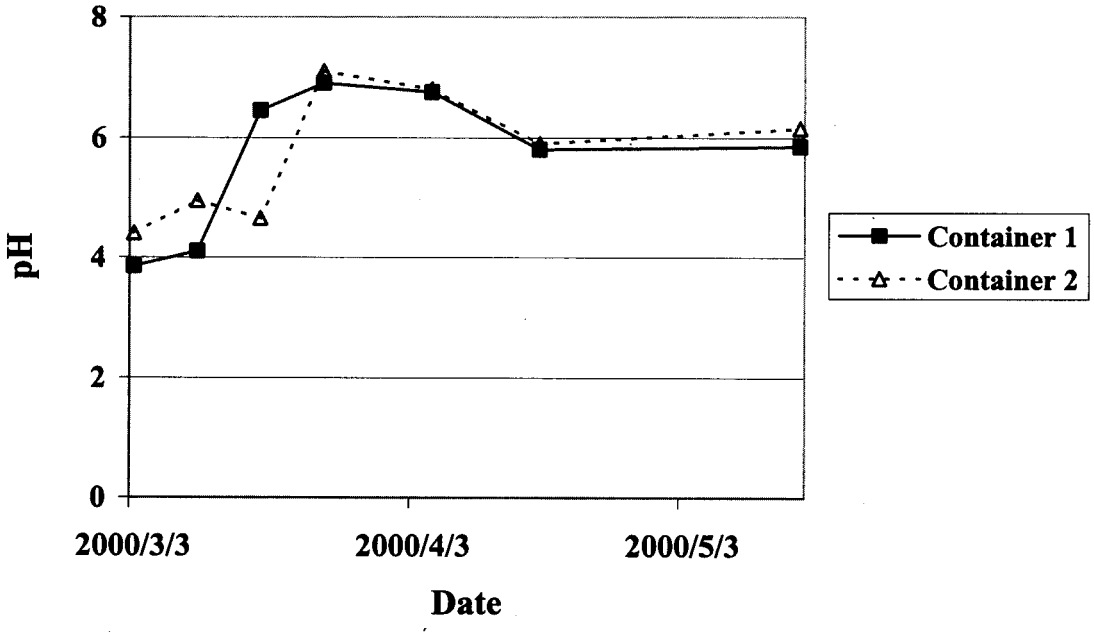

Figure 2. Development of pH in the Two Composts

Nitrogen

The graphs indicate a sufficient aeration and oxidation during the course of the decomposing process (Figure 3).

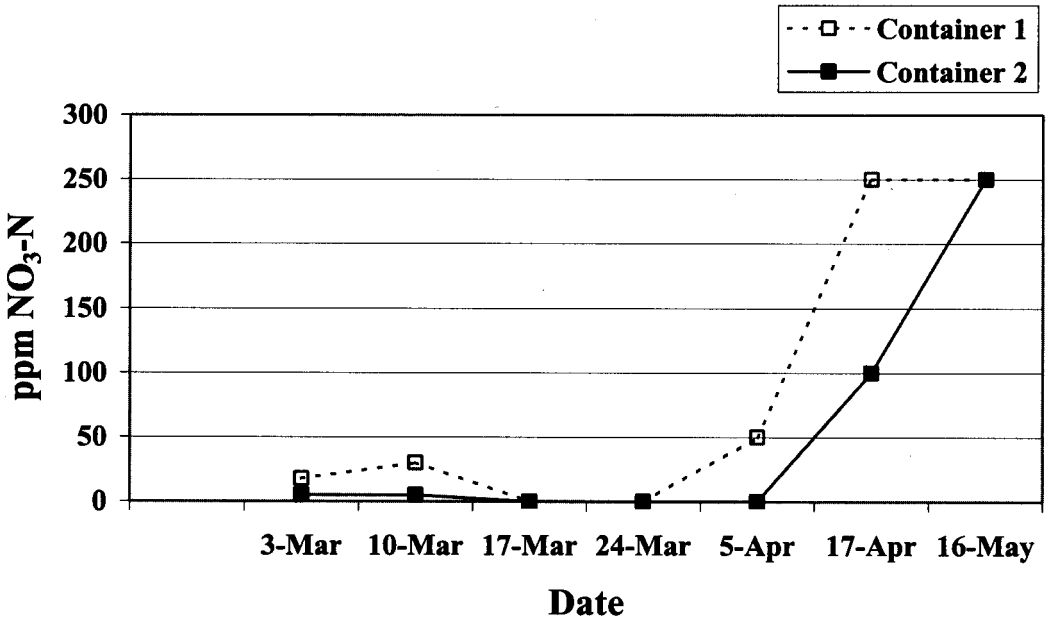

Figure 3. Development of NO_3 - N in the Two Composts

Other observations

Other problems occurring with the handling of the material were odour and large amounts of common house flies (*Musca domestica*) which not only made the adding and shifting of material very unpleasant, but also created a substantial nuisance for staff and students on campus.

A feasible city composting process using larger amounts of fresh kitchen waste will have to ensure that these problems are adequately dealt with.

Introduction

Second Trial

While we were struggling with above mentioned fly and odour problems we were approached by Mike Daly (NZ Nature Farming Society). He proposed using Effective Microorganisms (EM) (Higa, 1991) to minimise these problems.

With the help of EM the organic kitchen wastes are undergoing a fermentation process which stabilises the material and prevents the development of bad odours and decreases the attraction to flies (Higa, 1997).

Materials and Methods

An open bin (aerobic) EM fermentation was compared to a sealed drum (anaerobic) variation. During the filling and accumulation of the materials the fly problem was monitored. After decomposition the two different composts were used in a field trial with “no fertiliser” controls to assess the effect on a crop of lettuces.

Methods of “EM composting”

A) Open bin with alternating layers of kitchen waste sprayed with a liquid formulation of EM and bark treated/inoculated with EM. Left for 3 ñ 4 months.

B) Sealed drums filled with alternating layers of kitchen waste (ca. 15 cm) and a sawdust based formulation of EM (‘Bokashi’) (ca. 1 cm). Left for 2 weeks for mainly anaerobic fermentation before burying in the experimental plots (covered with 10 - 20 cm of topsoil).

Monitoring

Monitoring for common house flies (*Musca domestica*) was carried out for a period of two weeks with two yellow sticky cards, and counts every two to three days at each treatment. Monitoring was also carried out at two other stations (with two cardboards each) where there was no known expected attraction to flies whatsoever (Controls).

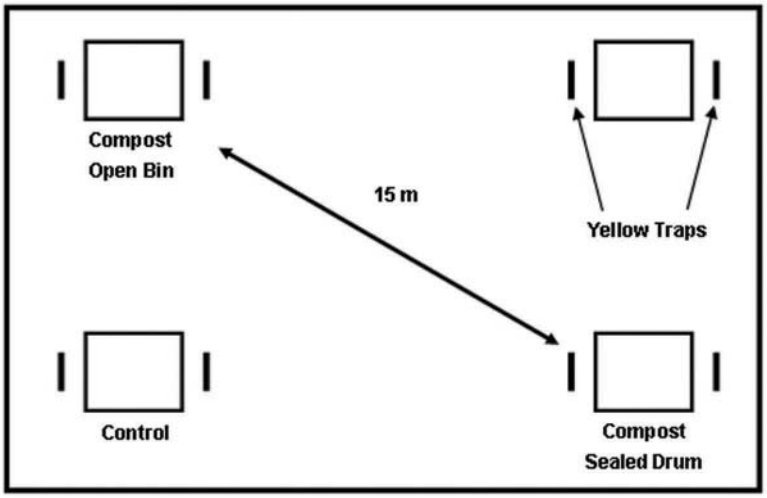

Figure 4. Lay-out of Fly Monitoring

Field Trial

The field trial was carried out in a "Latin Square" design having two compost treatment plus a control with three replications each. The sealed drum plots received the kitchen waste immediately after it had been fermented for two weeks. The open bin plots received the decomposed kitchen waste a week before the planting out of lettuce seedlings at the same rate as the sealed drum plots (approximately 40 kg per plot)

Lettuce seedlings (*Lactuca sativa* "Black Seed Simpson") were transplanted in each plot (1.2 m x 3 m) in three rows at 0.3 m distances on 4 October 2001 (sown on 30 August 2001). Lettuces were harvested on 20 November 2001 (six plants from the middle section of the centre row of each plot) washed and individually weighed. Fresh weights and dry weights (after drying at 60^{o}C for 24 hours) were recorded.

A representative sample of the soil in the field trial area was taken at transplanting and analysed for nitrogen content. Separate treatment-samples (combined respectively) were taken at harvest and analysed for N-content again

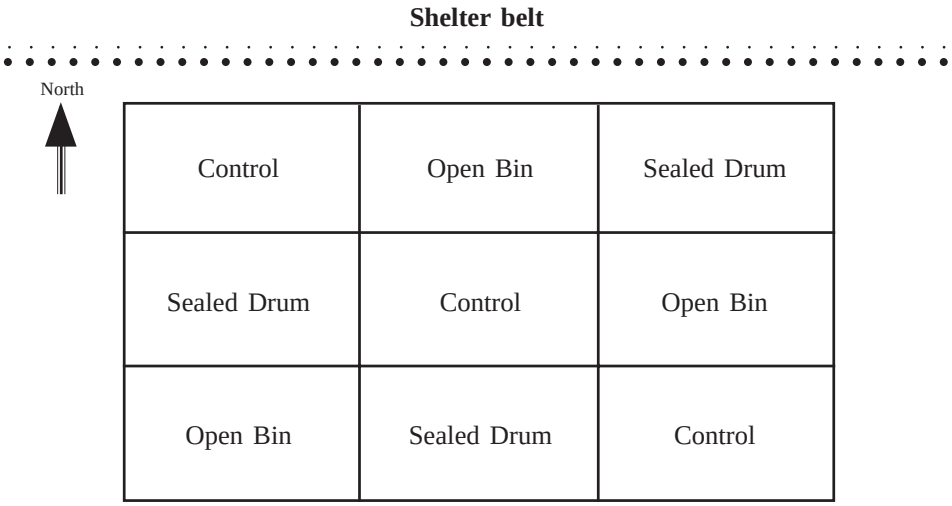

Figure 5. Lay-out of Field Trial

Results and Discussion

Monitoring for Flies

Table 1. Numbers of Common House Flies (*Musca domestica*) on Yellow Card Traps

	Location A (Open Ground Container)	Location B (Control)*	Location C (Control)*	Location D (Sealed Drum)
Count 1	5	0	2	1
Count 2	4	2	2	2
Count 3	5	1	2	3
Count 4	8	2	6	6
Count 5	12	5	5	4
Totals	34^{a}	10^{b}	17^{b}	16^{b}

** Results from Control B and C were combined for the One-way ANOVA statistical analysis*

^{a,b,c} Results followed by different letters were significantly different at $P < 0.05$

This trial was carried out in spring when temperatures were cooler and the fly problem was not as prevalent as in the warmer summer months. Therefore total numbers observed were low. However, there was still a significant difference detectable in the two treatments. The sealed drum method was significantly reducing the fly problem. Level of flies were comparable to the two controls (the lower results of Location B could be due to the fact that the traps were in a shadier and cooler position than the other ones).

Field Trial

Table 2. Total Fresh and Dry Weights of Centre Row Lettuce Plants (6) in grams

	Open Bin		Sealed Drum		Control	
	Fresh	**Dry**	**Fresh**	**Dry**	**Fresh**	**Dry**
Replication 1	1292	87	2328	133	782	50
Replication 2	1529	112	2380	221	737	59
Replication 3	973	142	1457	168	414	95
Totals	**3794**[a]	**341**[a]	**6165**[b]	**522**[b]	**1933**[c]	**204**[c]

[a,b,c,] Results followed by different letters were significantly different at $P < 0.05$, Two-way ANOVA

The differences detected were significant. Both EM treatments performed significantly better than the control. The sealed drum treatment performed significantly better than the open bin treatment, although plots had received approximately equal amounts of similar kitchen waste material. The more anaerobic fermentation in the sealed drum could have had an effect on nutrient mineralisation and mobilisation, and nutrient uptake.

The statistical analysis revealed a plot effect as well, which as we later discovered, was due to the fact that the predominantly strong easterly winds had prevented the plots in replication 3 to receive the same amounts of sprinkler irrigation water as the other plots. Therefore yields of fresh matter are decreased and the relative amount of dry matter yield is unproportionally increased. However, the overall trend is still clearly mirrored in replication 3 as well.

Soil Nitrogen Content

Table 3. Nitrogen Content of Field Trial Plots

	Treatment Open Ground Container	**Treatment Sealed Drum**	**Treatment Control**
Pre Trial N Content	0.35 %	0.35 %	0.35 %
Post Trial N Content	0.43 %	0.33%	0.36 %

The “open bin” treatment shows a considerably higher amount of total nitrogen in the mixed soil sample than both, the control and the “sealed drum” treatment. This points to a delayed mineralisation process and decreased release of nitrogen to the lettuce plants which is reflected in the fresh and dry matter results.

Conclusions

Composting and fermenting kitchen waste material with the help of Effective Microorganisms under sealed, anaerobic conditions can significantly reduce fly problems.

The resulting fertilising effect on horticultural crops can be significantly higher than the one achieved by using compost material from the open bin method.

Kitchen waste which had decomposed with the assistance of Effective Micooroganisms (no matter which system) and used as fertiliser achieved a substantial and significant

increase in lettuce yields.

Further trials need to be conducted to ascertain the exact nature of the differences in the fertilising effect. There is a need for organic certified potting mixes which provide a long lasting fertilising effect. Treatments with EM may achieve improved results here as well.

References

Higa, T. 1991. Effective Microorganisms: A Biotechnology for Mankind. In: Proceedings of the First International Conference on Kyusei Nature Farming. Ed. J.F. Parr et al., USDA, Washington, USA, 20-22.

Higa, T. 1997. Effective Microorganisms: Their role in Kyusei Nature Farming and sustainable agriculture. In: Proceedings of the Third International Conference on Kyusei Nature Farming. Ed. J.F. Parr et al., USDA, Washington, USA, 20-23.