PCDDs, PCDFs, PCBs, Chlorophenols (CPs), and Chlorobenzenes (CBzs) in Samples From Various Types of Composting Facilities in The United States

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Due both to state and local ordinances, as well as to a recent U.S. Environmental Protection Agency recommendation[1], a rapidly increasing number of United States communities have been banning yard waste disposal in landfills and incinerators and establishing composting facilities to accommodate this significant component of the waste stream. In addition the U.S. landfill shortage, and the unpopularity of municipal waste incinerators have encouraged waste management officials to seriously consider the composting of other organic components of the waste stream. A commercial Solid Waste Composting Council has been created to promote mixed municipal solid waste (MSW) composting and several such facilities are now either operating, under construction or being planned.

These developments have resulted in concern about the potential environmental contaminants associated with different types of composting and compost use[2]. Since only metal ion and PCB concentrations are limited by most existing U.S. and European compost standards[3], no assessment of compost contamination by PCDDs or PCDFs has been reported until recently. At the Dioxin 90 symposium, Wilken et. al. presented the results of a German study of potential PCDD/PCDF contamination associated with alternative waste management technologies including composting[4]. These researchers found concentrations in various types of composts ranging from 0.8 to 35.7 pg TCDD toxic equivalents (TEQ)/g. They point out that all but four of the 22 samples exceeded the German recommended soil limit of 5 pg TEQ/g for unrestricted agricultural use. Subsequently we published data on the PCDD, PCDF, CP and CBz concentrations in 17 compost samples obtained from a large Long Island, New York municipal yard waste composting facility[5]. The mean value of 31 pg TEQ/g for the finished yard waste samples was considerably higher than for the plant waste and bark waste composts reported in the German study[4]. An analysis of PCDF isomer abundance profiles led us to propose that PCP treated wood used as a bulking agent in the yard waste composting process may have been the principal source of PCDD/PCDF contamination of our samples.

In a recent critique of an attempt to use the German results to compare the risks to human health from waste composting and incineration, one of us has stressed the need for a more thorough assessment of the levels and sources of chlorinated dioxins and related compounds in composts produced from various types of feed stocks[6]. We have recently initiated such a research effort as part of a more comprehensive environmental assessment of MSW composting. We wish to report the results obtained to date from this ongoing study.

SAMPLING

Samples have been obtained from a variety of composting facilities which we will refer to as follows:

MSW 1 -- a large mid-western United States facility that collects municipal waste from several communities and composts this feed stock after some post-collection sorting to remove non-compostable components.

MSW 2 -- a large east coast United States facility that composts pre-sorted municipal waste mixed with dewatered sewage sludge.

YW 1 -- the same large Long Island, New York municipal yard waste composting facility sampled for our previous study[5], which accepts grass, leaves and brush trimmings from both households and commercial lawn and garden businesses.

YW 2 -- a smaller Long Island, New York municipal yard waste composting operation that composts mostly leaves.

YW 3 -- a large north-western United States facility that composts yard waste from a city and its suburbs that is approximately the same size and receives similar feed stock to YW 1.

The protocol used for obtaining samples from a given compost pile includes a coning and quartering procedure similar to the method described in ASTM (C 702-87), "Standard Practice for Reducing Field Samples of Aggregate to Testing Size." Given the inherent heterogeneity and variability, this sampling method does not, of course, assure that a given sample is representative of the compost produced by a given facility. An effort to explore the variability of compost composition is part of our overall research program.

ANALYTICAL METHODS

The methods of sample preparation, extraction and analysis were identical to those detailed in our report of our prior compost research results[5]. The procedures used for PCDDs, PCDFs, CPs and CBzs include room temperature air drying, spiking with isotopically labelled internal standards, soxhlet extraction using hexane/acetone (40:60 v/v), extraction with 2M NaOH to remove CPs, chromatographic cleanup and separation of CBzs, PCDDs, PCDFs, and GC-MS analysis using a HP 5971A mass selective detector interfaced with a HP 5890A gas chromatograph fitted with a HP5 column. For the PCBs a modification of USEPA SW-846 Method 8080 employing a Varian 3740 GC, equipped with an electron-capture detector and a packed glass column with 1.5% OV1 and 1.95% QF1, was used.

RESULTS AND DISCUSSION

The mean values of the concentrations of total tetra- through octachloro PCDDs, PCDFs and TCDD TEQs (calculated using ITEFs) for the samples analyzed to date from the facilities included in this study are shown in Table 1. Similar results for total tri- through pentachloro CPs, tetra- through hexachloro CBzs and total PCBs are given in Table 2.

TABLE 1: PCDDs and PCDFs in COMPOST SAMPLES

COMPOST FACILITY	TOTAL PCDD ng/g	TOTAL PCDF ng/g	TEQ pg/g
MSW 1	45.4	1.13	68.7
MSW 2	51.7	0.96	72.5
YW 1	6.9	0.21	8.7
YW 2	6.9	0.51	9.4
YW 3	25.1	0.71	35.0

TABLE 2: CPs, CBzs and PCBs in COMPOST SAMPLES

COMPOST FACILITY	TOTAL CP ng/g	TOTAL CBz ng/g	TOTAL PCB ng/g
MSW 1	45.4	1.13	730
MSW 2	51.7	0.96	17,700
YW 1	6.1	0.92	360
YW 2	6.9	0.51	84
YW 3	25.1	0.71	NA

NA = not analyzed

For most of the samples the PCDD and PCDF contents consisted primarily of the octa- and heptachlorinated species with low pg/g concentrations of the hexachlorinated isomers but little or no penta- or tetrachlorinated species. The variability of the samples is evident from the fact that one of the MSW 1 compost samples contained 56 pg/g of 2,3,7,8 - TCDF and 7.5 pg/g of total TCDD, whereas none of the other samples had detectable levels of either TCDF or TCDD at the ppt level. Only four samples had measurable levels of PCDD or PCDF, however one MSW 2 sample contained 71 pg/g PCDD and one YW 3 sample contained 41 pg/g of PCDF.

Similarly CP content was primarily tetra- and pentachlorophenols and the CBz content was mostly hexachlorobenzene, but a couple of samples contained significant concentrations of trichlorophenol or tetrachlorobenzene.

It should be noted that the TEQ content of the YW 1 sample was about a factor of 5 lower than the mean value obtained for the samples in our previous study[5], and is in the same range as the results for the plant waste composts reported by the German workers[4]. We plan further sampling of this facility in an effort to explain this difference.

An examination of the PCDF isomer patterns indicates that not all of the composts have the ratios typical of PCP contamination, as was the case for our previous YW 1 samples. Thus the samples from YW 2 exhibit isomer patterns more characteristic of PCDFs from combustion sources whereas the YW 3 samples (which had a considerably higher TEQ content) showed the PCP contamination pattern.

The mean PCB content of our MSW 2 samples exceeds the New York State standards of 1 ppm for Class 1 compost (usable on agricultural crops not destined for direct human consumption) as well as the 10 ppm Class 2 standard (not suitable for agricultural use.) This value is higher than the values reported in test data we received from the operators of the facility. Although the mean value for the MSW 1 samples was below the 1 ppm limit one of the individual samples from that facility contained PCBs at a level of 1.4 ppm. Again the values reported by the facility operator are lower than our results.

Finally, we note that the general result that contamination by PCDDs, PCDFs, CPs CBzs and PCBs is significantly higher in our MSW compost samples than in most of our yard waste compost samples.

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