RAW ORGANIC MATERIAL ORIGIN AND COMPOST HEAVY METAL CONTENTS

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ABSTRACT

The heavy metal (HM) content of organic waste (OW) is a parameter of great importance to prevent its transfer to soil-plant systems when OW are applied to agricultural soils, for that this content has been included in current legislation for OW land reuse.

HM content could be considered in relation to different points of view: source, soil behaviour, soil-plant transference, its relationship to the organic matter or the nutrients levels and also according to the sort of OW and the treatment applied.

The total HM content of compost samples from different origin, mainly from municipal solid waste (MSW), was determined by AA after dissolution of OW ashes (ignition at 470ºC) in 3M HNO_3. The results show a HM content decrease with time in composts, it is due to better mechanical separation systems in treatment plants or to the composting after organic fraction separated collection. For some HM the same contamination origin is suggested. The raw material quality is the most important factor to produce compost with low HM content.

INTRODUCTION

In the European Union, since beginning of 1990's different sort of rules have been established to protect environment and public health from waste management systems and also to take profit from different waste components. In south European countries, soil recycling after composting had been one of the most encouraged technologies to maintain or to restore soils organic mater depletion. In Spain, for instance, the applicable national plans -Municipal Solid Waste (MSW) and Sewage Sludge (SS) from Wastewater Treatment Plants- promote composting and their agricultural use. In Catalunya (northeast region of Spain), waste regulation (Llei 6/93) established the basis for MSW separate collection. Composting organic waste (OW) has progressively been recognised as one of the best alternatives to waste management, consequently the number of operating composting plants around the world had been increased latest years.

To predict successful when waste are used for plant grown is necessary to evaluate its composition and low pollutants content (heavy metals, organic compounds and pathogenic organisms) are also desirable. The heavy metals content has been included in the current legislation for land reuse of compost. In Spain land application is regulated (Orden 2/11/1999), and a new proposal is in discussion by European Communities (EC, 2001).

There are a lot of studies on OW composition of compost but in general studies had been done with a short number of samples. In this study more than 500 compost samples of different origin integrated in a compost database (Huerta, et al., 2003) have been considered, several data had been already published (Soliva et al., 1992; Soliva et al., 2003).

The aim of this study was to compare the heavy metal content values and some agronomical parameters of compost samples from different origin. The analytical methods employed were collected and proposed by Saña et al. (1989) and are commonly used to complete characterisation of different organic fertilisers.

MATERIALS AND METHODS

a. Compost samples. Samples were collected always according to the same procedure from composting plants of different origin. The main samples are compost from municipal solid waste (MSW) and the raw material was selected by mechanical separation (MS) or separate collection (SC): MS was practised before 1997 (MSW-1, 282 samples); SC was done after 1997 in municipalities from Catalunya (MSW-SC, 158 samples), but not in those from the other Spanish communities (MSW-2, 42 samples). The smallest group belongs to sewage sludge compost (SS, 32 samples).

b. Analytical methods. Compost samples were analysed according to the analytical procedures described by Saña et al. (1989). The totals heavy metal content (Fe, Zn, Mn, Cu, Cr, Cr, Ni, Pb, and Cd) was determined by AA after dissolution of ashes (ignition at 470ºC) in 3M HNO_3, result were expressed en mg kg^{-1}. All determinations were conducted with dry samples and analyses were done on duplicate samples and differences between replications were always less than 5%. Several agronomical characteristics had been also determined as: pH; EC, electrical conductivity; H, moisture content; VS, total volatile solids; org-N, organic nitrogen; C/N ratio; ROM, resistant organic matter; SD, stabilisation degree. Analytical procedures are described by Saña et al. (1989) and summarised in Soliva et al. (2004). Statistics were conducted by SAS statistic software.

RESULTS AND DISCUSSION

For all groups of samples studied heavy metal (HM) content decrease according time. In MSW groups it is due to better practices of mechanical separation (MS) in composting plants and to a good citizen participation in a separate collection (SC). From 1997 a drastic HM reduction is done as a consequence of SC organic fraction incorporation in MSW, those could be seen in Figure 1 for Pb and Zn. The lowest HM content appears in MSW-SC (Figure 2).

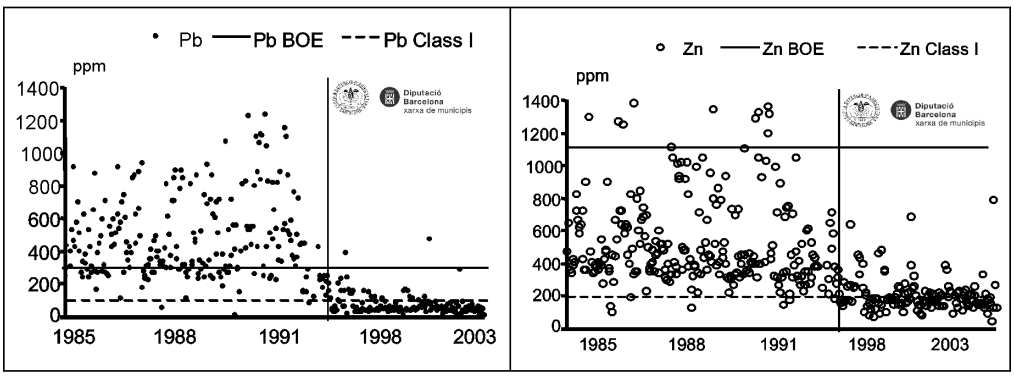

Figure 1. *Pb and Zn content evolution in compost samples from 1985 to 2003 in relation to Spanish legislation (Orden 2/11/1999) and European Proposal (EC, 2001). Vertical line shows the incorporation of SC for organic fraction collection in Catalunya.*

The HM profile for different compost groups is shown in Figure 2, MSW-SC group has a different composition than other groups MSW1 and MSW2. SS profile is also different to the other groups. Genevini et al. (1977) presented similar results for MS compost from MSW.

Ratios of HM content obtained between different groups (Table 1) show that Pb and Cd pre-

sent highest and similar reductions over the time and also it is possible to suggest common source pollution. Similar behaviour shows Zn and Cu but in lower intensity.

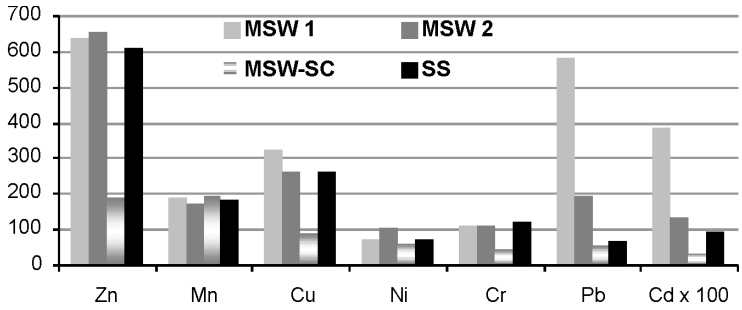

***Figure 2**. Heavy metal content (mg kg^{-1}) of studied compost groups.*

***Table 1**. Heavy metal content ratios between different compost groups.*

	Fe	Zn	Mn	Cu	Ni	Cr	Pb	Cd
MSW1 / MSW2	0.96	0.98	1.09	1.22	0.68	0.96	2.96	2.83
MSW1 / MSW-SC	0.73	3.34	0.96	3.70	1.14	2.52	10.01	11.05
MSW2 / MSW-SC	0.76	3.41	0.88	3.02	1.68	2.61	3.38	3.91
MSW1 / SS	0.66	1.05	1.01	1.22	1.00	0.89	8.55	4.15
MSW2 / SS	0.69	1.07	0.92	1.00	1.47	0.92	2.89	1.47
MSW-SC / SS	0.91	0.31	1.05	0.33	0.88	0.35	0.85	0.38

***Table 2**. Multiple comparisons of several representative parameters (for agronomical characteristics and heavy metal content) for composted waste from different origin. Selected parameters and sample groups are described in previously section, material and methods.*

	pH	EC	H	VS	org-N	C/N	ROM	SD	Fe	Zn	Mn	Cu	Cr	Pb	Cd
MSW-1	c	b	a	ab	c	a	d	d	b	a	a	a	a	a	a
MSW-2	b	a	bc	ab	b	b	c	c	b	a	a	a	a	b	b
MSW-SC	a	c	c	b	a	c	b	b	a	b	a	b	b	b	c
SS	ab	d	b	ab	a	c	a	a	a	a	a	a	a	b	bc

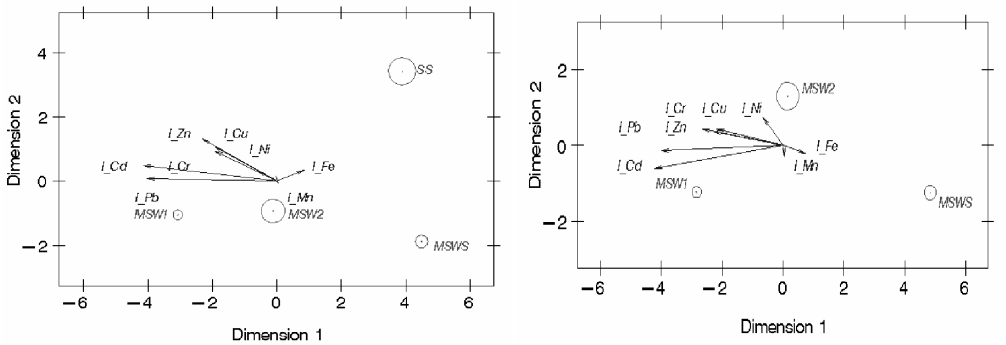

***Figure 3**. Multidimensional scaling between several HM content in compost groups from different origins: (1) all sample groups and (2) only MSW groups.*

From ANOVA and multiple comparison results (Table 2) significant differences can be seen not only for HM content but also for several studied agronomical parameters (pH, EC, H, VS, org-N, C/N, ROM, SD) in most of the cases. Results obtained from MSW-SC group shows the best conditions for soil reuse.

A multidimensional scaling analysis represented in Figure 3 had been done with all groups of compost (1) and only with MSW groups (2). From these analysis most of the previously assertions indicated can also be read.

CONCLUSIONS

HM content has decreased with time due to better mechanical separation systems in treatment plants or/and to SC of organic fraction. The content sequence for HM is: Zn>Cu>Ni>Pb>Cr>Cd. Results suggest a similar origin of contamination source for Pb and Cd, and for Zn Cu.

The raw material quality for compost production is the most important factor to be considered in the production of high quality compost in relation to low HM content.

Raw material quality could affect not only the compost quality but also the operating conditions of composting plants, economical costs and efficiency of process.

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