

TREND OF HEAVY METAL CONCENTRATION IN COMPOST PRODUCED IN VENETO REGION

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1. ABSTRACT

Since 1994 the Agroenvironmental Centre of Regional Protection Agency is dealing with the control of the chemical composition of composts produced in Veneto Region.

During last years composting plants were required to reduce the risks of heavy metal contamination of compost; the new regulation, stated in march 2000, confirmed this requirement in order to give enough assurance to farmers that are going to use it.

Data obtained from samples collected between 1996 and 1999 were examined to point out if any improvement was achieved in order to reduce concentration of heavy metals, such as cadmium, chromium, copper, mercury, nichel, lead and zinc, in composts; results, grouped by type of composted materials, showed a significant reduction in many cases, confirming the efforts made by compost producers of Veneto Region.

Not always a positive trend take place, highlighting that there is still a need of increase the knowledge about the carachteristics of compostable materials and the process control.

2. INTRODUCTION

The Regional Administration of Veneto Region (Italy) established in 1991 for the first time the rules for authorization of composting plants for treatment of pre-selected organic wastes, including limits about the chemical composition of compost; these limits were confirmed with compost regulation approved in 1995 and were successively restricted with last compost directive published in march 2000 (table 1).

Parameter	Unit	Limit 1991	Limit 2000
pH	-	5.5-8.0	6.0-8.5
Moisture	%	<50	<50
Ashes	% dm	<40	-
Salinity	meq/100 g dm	<60	to declare
Organic carbon	% dm	>25	>20
Total nitrogen	% dm	>1.5	to declare
Arsenic	mg/kg dm	<5	-
Cadmium	mg/kg dm	<3	<1.5
Cromium	mg/kg dm	<150	<100
Copper	mg/kg dm	<300	<150
Lead	mg/kg dm	<200	<140
Mercury	mg/kg dm	<3	<1.5
Nichel	mg/kg dm	<150	<50
Zinc	mg/kg dm	<1250	<500

Table 1. Limits of main parameters for composting product stated by Veneto Region (years 1991 and 2000).

Few composting plants started working in 1994, followed during successive years by several others; at the moment twelve firms are dealing with more than 20.000 tons/year each, with a total treatment capacity of more than 400.000 t/y of organic residues (figure 1).

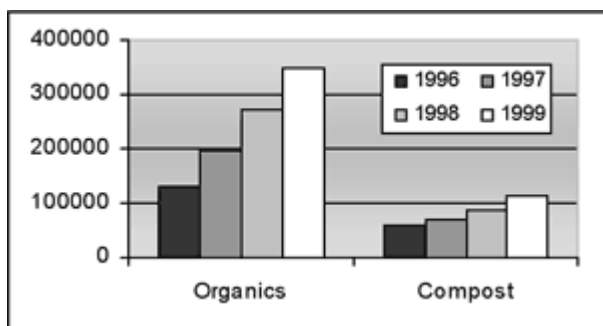


Figure 1. Organic residues composted and compost produced by composting plants of Veneto Region from 1996 to 1999

Main types of organic residues composted are manure, urban and agroindustrial sludges, green residues from public and private gardens and food residues coming from separated collection of households organic wastes.

Rates of different types of organic residues composted in Veneto Region varied significantly during last years, with an increased importance of food residues and a reduction of urban and agroindustrial sludges in last year (figure 2)

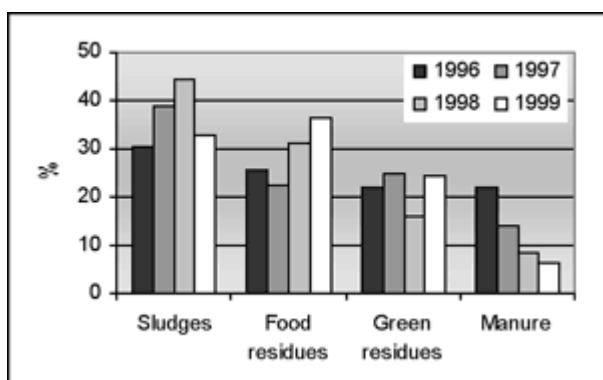


Figure 2. Rates of different types of organic residues composted in Veneto Region from 1996 to 1999

For a better evaluation of compost characteristics and according to the commercial destination of products, the composts produced were classified into 4 different classes according to the composition of starting mix:

1. **MANURE**
compost: more than 50% of animal manure in the composting mix;
2. **SLUDGES**
compost: more than 40% of sludges from urban and agroindustry plants, mixed only with green vegetables residues;
3. **FOOD**
compost: more than 50% of food residues, mixed both with sludges and green vegetables;
4. **GREEN**
compost: only green residues coming from public and private gardens.

In 1995 the Agroenvironmental Centre of Regional Protection Agency started a monitoring program to investigate the characteristics of different types of compost produced (Giandon et al., 1999). During the last four years (1996-1999) composts characteristics were expected to improve gradually, both due to an increasing quality of organic residues and to an improvement in process management and technology.

General results of this monitoring activity, together with some study cases, are presented below to discuss if a positive trend took place in composting activities of Veneto Region plants.

3. MATERIALS AND METHODS

Informations about sampling and laboratory analyses of compost were already described in Giandon et al. (1999). Sampling frequency was once every two months for each composting plant during full monitoring activity and at least every six months in other periods.

For a global evaluation of trends results were gathered within the four classes above mentioned; number of samples collected for each type of compost is reported below:

Type	1996	1997	1998	1999	TOTAL
Food residues	9	27	22	32	90
Sludges	4	10	6	14	34
Manure	---	8	9	18	35
Green residues	---	8	15	11	34
TOTAL	13	53	52	75	193

Results achieved by two composting plants, one in Verona Province and the other in Venice Province, are reported separately.

4. RESULTS AND DISCUSSION

From the beginning of organic residues recycling through composting, quality of products was defined on the basis of heavy metal content; many organic residues, especially those coming from industrial processes like sludges, may have high concentration of one or more of these elements that can be accumulate by soil and plants increasing the risk of toxicity and loss of fertility.

Countries of Central and Northern Europe (Germany, Austria, Denmark, The Netherlands, Belgium) went throughout lower limits for heavy metals, reaching concentrations that are near to soil background levels.

Examining results of Veneto composts analysis for heavy metals (figure 3) it could be pointed out a general decrease of heavy metals concentration, with some exceptions especially for compost obtained by high rates of sludges.

Cadmium concentration trend is quite representative of this evidence; food compost went from 1,15 to 0,68 mg/kg dm, with a decrease of 41%, same as green compost (from 0,75 to 0,48) and manure compost (from 1,18 to 0,82). Only sludges compost registered a little increase between 1998 and 99, but from 1996 to 1999 cadmium content decreased from 1,04 to 0,91.

Copper concentration in food compost is quite stable and hard to keep lower than 100-120 mg/kg dm, that could be considered as a natural level of copper in italian food residues; from 1996 to 99 there was a little decrease (from 137 to 119 mg/kg dm), same as sludges (from 148 to 139), which registered an increment in last year, and green compost (from 88 to 57).

Manure compost had the highest copper concentration (more than 190 mg/kg dm) due to the use of copper to integrate feedstock nutrition.

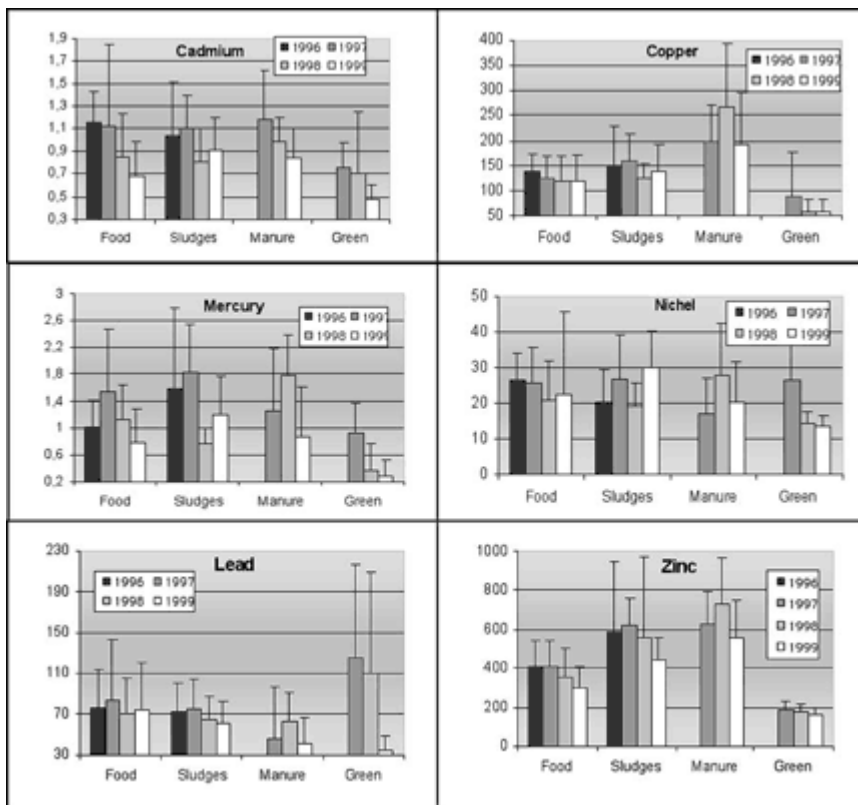


Figure 3. Concentrations of cadmium, copper, mercury, nickel, lead and zinc (mg/kg dm) in the different types of compost produced in Veneto Region from 1996 to 1999: average and standard deviation of a different number of samples per each year from different composting plants.

Mercury concentration is very low in green compost (0,27 mg/kg dm in last year) while in food and in manure composts is about 0,8-0,9 mg/kg dm; sludges compost had, again, a significative increase in last year.

Nickel is quite low in all types of compost, particularly in green compost (13,5 mg/kg in last year); general trend is for little decrease or stability, and all composts had mean values lower than 30 mg/kg dm. Similar situation is for lead, with very big improvement occurred for green compost that came from 126 mg/kg dm in 1997 to 35,2 in 1999; for food and sludges composts mean values ranged between 60 and 80 mg/kg dm, while manure compost had lower concentration.

Regarding zinc concentration food (from 400 to 300 mg/kg dm) and sludges composts (from 580 to 442 mg/kg dm) registered a decrease of mean values; manure compost presented higher concentration, as seen for copper, due to feedstock nutrition, and green compost had a very low zinc level (from 181 to 163 mg/kg dm).

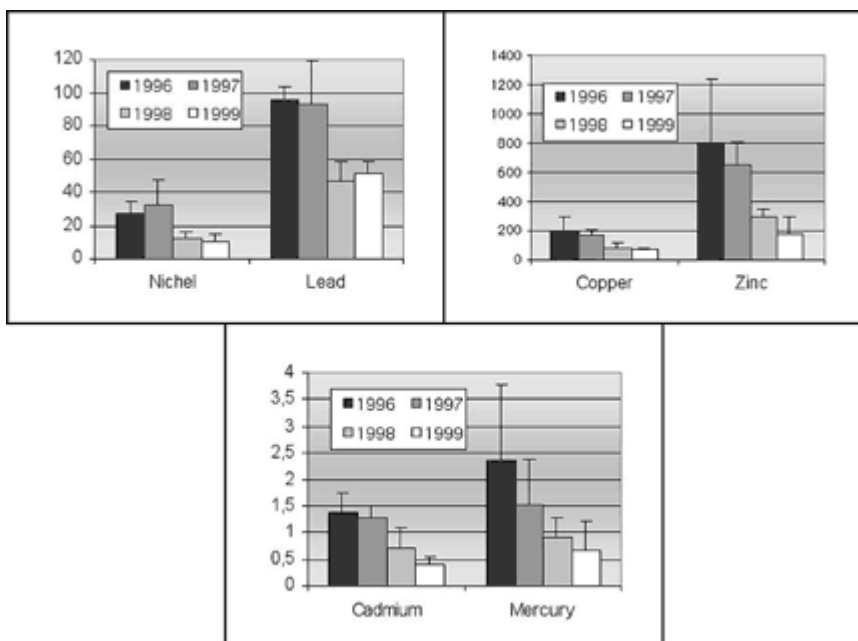


Figure 4. Concentrations of cadmium, copper, mercury, nichel, lead and zinc (mg/kg dm) in the compost produced in a plant of Verona province, Veneto Region, from 1996 to 1999: average and standard deviation of a different number of samples per each year.

Results of compost produced in a plant of Verona province (figure 4), show a very good improvement in last four years mainly due to the substitution of sludges with food residues between 1997 and 1998; copper and nichel are the elements that had minor changes during considered time, while for mercury and zinc a reduction of three and four times respectively occurred. Lead had a two times reduction and cadmium 2,5 times.

All heavy metals reached in 1999 very low levels, confirming that composting of high quality, i.e. well selected, organic residues allows to respect also very severe limits for heavy metals.

A different situation occurred in a plant of Venice province (figure 5), where sludges were only partially substituted by food residues; a reduction of heavy metals concentration was detected but the improvement was quite low, coming from 28% for zinc, to 26% for mercury, 24% for lead, 16 for copper and cadmium while no change occurred for nichel. In other plants not always a gradual improvement was detected; often an improvement took place in the long period but with alternation between improvements and worsenings.

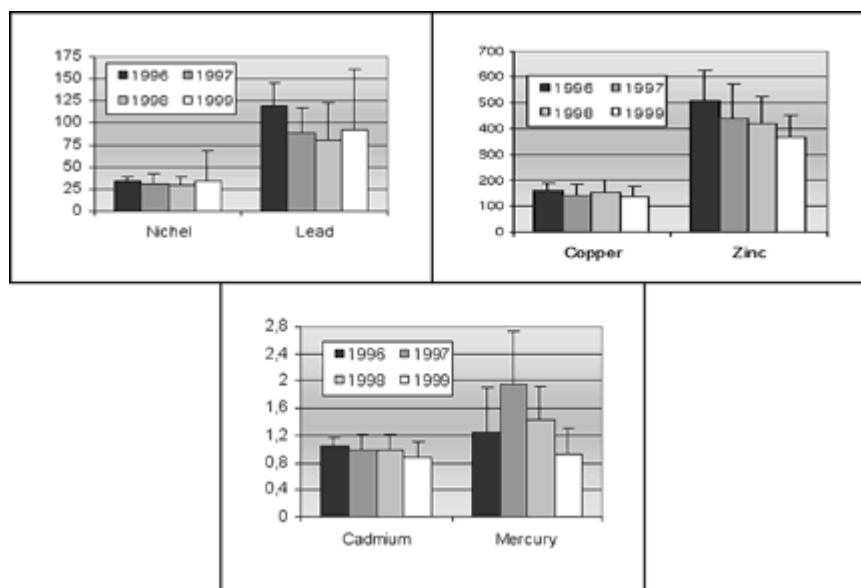


Figure 5. Concentrations of cadmium, copper, mercury, nichel, lead and zinc (mg/kg dm) in the compost produced in a plant of Venice province, Veneto Region, from 1996 to 1999: average and standard deviation of a different number of samples per each year.

5. CONCLUSIONS

Results of monitoring activity of compost produced in Veneto Region pointed out that a good improvement was achieved in concentration of heavy metals, such as cadmium, chromium, copper, mercury, nichel, lead and zinc; infact they showed a significant reduction in many cases, confirming the efforts made by compost producers of Veneto Region to find out and remove negative factors for product quality.

Not always a positive trend take place, highlighting that there is still a need of increase the knowledge about the characteristics of compostable materials and the process control.

6. LIST OF REFERENCES

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