

PCBs IN SEWAGE SLUDGE FROM WASTEWATER TREATMENT PLANTS

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Abstract

Recycling of sludge from wastewater treatment plants by agricultural land, presents a major interest. It is known that municipal sludge contains toxic organic compounds for human health and for environment. Among these, in the list of European Community Council polychlorinated biphenyls (PCBs) are included. Therefore, their determination in sludge is absolutely necessary. The present work shows the results of a study about the content of PCBs in sewage sludge coming from wastewater treatments plants located in Pitești, Curtea de Argeș, Câmpulung and Mioveni. 24 samples of sludge were collected and the PCBs residues were extracted with organic solvents. Determination was performed by gas chromatography after a preliminary purification of the extract. The determined compounds were PCBs with IUPAC numbers: 28, 52, 101, 138, 153, 180 which are mentioned by the actual legislation. The results show that the total content of PCB compounds are ranged between 0.0031 mg/kg and 0.0610 mg/kg, so values which are 10-100 times smaller than the maximum limit (0.8 mg/kg). So, the sludge samples of this study show contents of PCBs which are permitted in agricultural use according to guidelines of our country.

INTRODUCTION

Most wastewater treatment processes produce a sludge which has to be disposed of. Very rarely do urban sewerage systems transport only domestic sewage to treatment plants; industrial effluents and storm-water runoff from roads and other paved areas are frequently discharged into sewers. Thus, sewage sludge will contain, in addition to organic waste material, traces of many pollutants used in our modern society. Some of these substances can be phytotoxic and some toxic to human and/or animals, so it is necessary to control the concentrations in the soil of potentially toxic elements and their rate of application to the soil [3].

The application of sewage sludge to land in member countries of the European Economic Commission is governed by Council of European Communities 1986. This Directive prohibits the sludge from sewage treatment plants from being used in agriculture unless specified requirements are fulfilled, including the testing of

the sludge and the soil. Parameters subject to the provisions of the Directive include the following: dry matter, organic matter, pH, nitrogen, phosphorus, heavy metals, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), dioxines.

PCBs are types of persistent environmental contaminants with enhanced toxicity and carcinogenic and bioaccumulating properties. Research in this field indicates a high stability of heavily chlorinated PCBs in sludge which suggests a more precautions use of sewage on soil surface [1]. In regard to PCBs, human exposure is primarily attributed to background contamination caused by diffuse contamination of these pollutants through the trophic chain. Of the 209 PCB congeners, European legislation, on which our country is affiliated, requires determination of the following compounds: PCB 28, PCB 52, PCB 101, PCB 138, PCB 153, PCB 180.

MATERIAL AND METHODS

The sludge samples were collected from four different wastewater treatment plants located in Pitești, Curtea de Argeș, Câmpulung and Mioveni. The samples were collected at different moment of time. Thus, from the Pitești wastewater treatment plants, sludge was collected day by day, total 15 samples. From Curtea de Argeș, Câmpulung and Mioveni the sludge was collected three times a week.

The dried samples are extracted with petroleum ether:acetone = 2:1. The extracts are purified on Florisil column and evaporated to a convenient volume. 1 µl of extract are injected in gaz chromatograf. The separation of the PCB compounds takes place in a cappillary column with a non-polar stationary phase (OV 1) and programmed temperature (from 70°C to 330°C with 20°C/minute). The separated compounds are detected with an ECD (electron capture detector) operated at 300°C. The analytical result is a chromatogram were each compound is represented by a peak and a specific retention time. The concentration of each compound is calculated referring on the calibration curve.

RESULTS AND DISCUSSION

The analytical results show that the low chlorinated PCBs (28, 52, 101) are undetectable in all samples of sludge. The high chlorinated congeners (138, 153 and 180) contaminate all the samples (Table 1). Similar results are presented in literature, PCBs residues being found in nearly every sample of selected sewage sludges, with the congeners 138 and 153 the most important among the others [2].

The PCB 138 concentrations ranged between 0.0006 mg/kg and 0.0145 mg/kg, PCB 153 concentrations have values in the interval 0.0008 mg/kg - 0.0153 mg/kg and PCB 180 concentrations ranged between 0.0013 mg/kg - 0.0610 mg/kg. Regarding the total PCBs content it can be observed that the interval of variation is

0.0031 mg/kg - 0.0225 mg/kg. The highest value of concentration is obtained in sample collected from the wastewater treatment plant located in Mioveni, 0.0610 mg/kg, but even in this case the concentration value is about 10 times smaller than the maximum limit (0.8 mg/kg).

Table 1

Polychlorinated biphenyls in sewage sludge (mg/kg)

Location	Time of sampling	PCB 138	PCB 153	PCB 180	Total PCB
P I T E Ş T I	1	0.0049	0.0076	0.0084	0.0209
	2	0.0006	0.0010	0.0015	0.0031
	3	0.0030	0.0042	0.0036	0.0108
	4	0.0025	0.0041	0.0039	0.0105
	5	0.0020	0.0037	0.0029	0.0086
	6	0.0024	0.0035	0.0024	0.0083
	7	0.0025	0.0041	0.0034	0.0100
	8	0.0035	0.0057	0.0044	0.0136
	9	0.0016	0.0028	0.0021	0.0065
	10	0.0015	0.0022	0.0020	0.0057
	11	0.0016	0.0029	0.0022	0.0067
	12	0.0024	0.0031	0.0027	0.0082
	13	0.0024	0.0037	0.0024	0.0085
	14	0.0022	0.0039	0.0030	0.0091
	15	0.0012	0.0022	0.0012	0.0046
CURTEA DE ARGEŞ	1	0.0020	0.0008	0.0022	0.0050
	2	0.0013	0.0045	0.0048	0.0106
	3	0.0016	0.0024	0.0025	0.0065
CÂMPULUNG	1	0.0014	0.0020	0.0017	0.0051
	2	0.0011	0.0016	0.0015	0.0042
	3	0.0011	0.0019	0.0013	0.0043
MIOVENI	1	0.0042	0.0095	0.0116	0.0253
	2	0.0145	0.0153	0.0179	0.0477
	3	0.0068	0.0076	0.0081	0.0225
<i>Maximum limit</i>					0.8

The variation in time of the total concentrations of PCB compounds in the sludge samples collected from Pitești indicate that there is no correlation between the two parameters (Figure 1). In Curtea de Argeș and Mioveni, the total concentration of PCBs increase at the second sampling, while in Câmpulung the level of concentration is, practic, unchanged. So, it can not be determined a time value corresponding to a minimum of PCBs concentration value. For this reason, monitoring the concentration of PCBs in sewage sludge coming from wastewater plants is absolutely necessary.

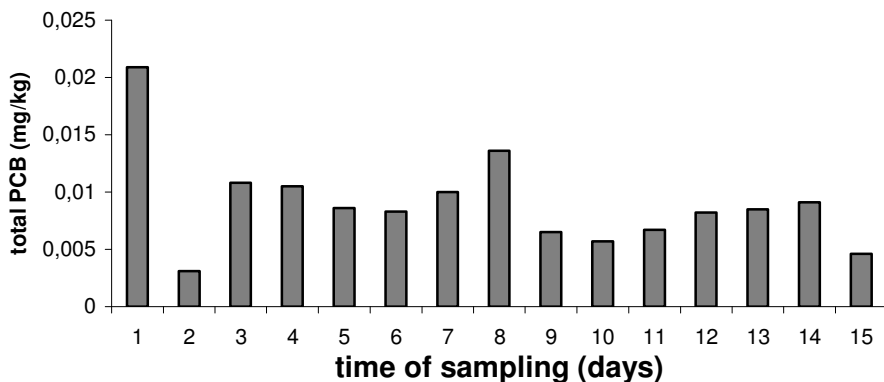


Fig. 1. Variation in time of total PCB content in sewage sludge samples collected from Pitești

CONCLUSIONS

1. The sludge samples of this study show contents of PCBs which are permitted in agricultural use according to guidelines of our country.
2. It is absolutely necessary to monitor the content of the polychlorinated biphenyls compounds in sewage sludge.

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