TEMPORAL TRENDS OF PCB LEVELS IN SEWAGE SLUGES FROM A WASTEWATER PLANT AT MADRID METROPOLITAN AREA

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Introduction

Particular attention has been focused on the problem of PCBs in the environment and their potential damage to the human health due to their toxic properties [1].

Every year thousands of tons of sewage sludges with organochlorinated contaminants are produced in the wastewater plants, a substantial amount of them are used as fertiliser in soils for agricultural destinations. Although the EU legislation specify the maximum allowed levels of 0.2 mg of total PCBs/ kg of sewage sludge dry matter, at Spain there is not an efficient control for this type of products employed for soils fertilization.

In the wastewater plants and principally at those situated at the urban borough, there are important variations in the input of water along the year, mainly due to the climatic effects. This phenomenon, has a direct occurrence on the organochlorine compounds levels in the sewage sludge, and has not been taken into account in the official regulations. By the other hand, there is a limited information about PCB levels in sewage sludge from Spanish wastewater plants in the literature [2, 3], and to our knowledge no mention exist about any PCB levels progress along the time.

This work presents a study concerning the chronological evolution of total PCBs and the PCB congeners (PCB # 28, 52, 118, 123, 114, 153, 105, 138, 167, 156, 180, 170, 189, 194) [4] in a urban wastewater plant, located in Madrid, from October 1998 to October 1999. The PCB variations are related with the period of time, and climatic conditions.

Material and Methods

Sampling method

The sewage sludges selected for this study were collected every 15 days from a wastewater treatment plant situated in the town of Madrid, Spain (Figure 1). The sewage sludge was mainly of urban origin. Prior to analysis the sewage sludge was dried in a oven at 60º C, manually homogenised, and sieved to a 200 mm size.

Preanalytical treatment

The extraction and clean-up methodology has already been described elsewhere [5]. În brief, a mixture of 1 g of dry weight (d.w.) sewage sludge sample and 0.5 g of cooper powder was extracted with 200 ml of toluene during 20 h by means of a Soxhlet apparatus. Clean-up was carried out using concentrated H_2SO_4 followed by a multilayer open column chromatography. The column contain from the top to bottom layers of Na_2SO_4, silica gel, H_2SO_4-treated silica, silicagel, KOH-treated silica, and

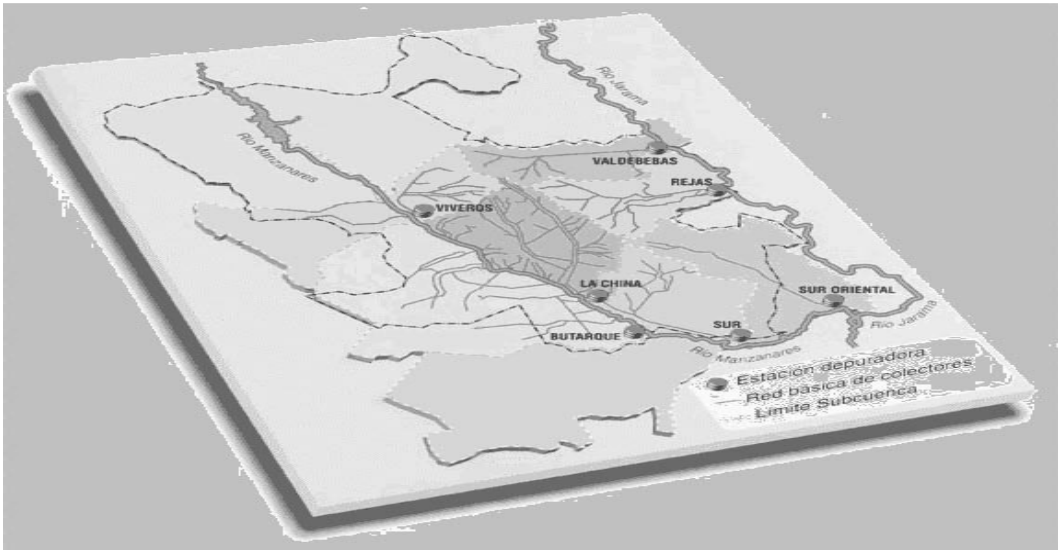

Figure 1. Geographic situation of the wastewater treatment plant studied.

silicagel. The column was eluted with 200 ml of hexane. The final step consist in a column chromatography carried out with activated Florisil eluted sequentially with hexane:CH_2Cl_2(1 %) and CH_2Cl_2. Samples were concentrated to dryness prior to the addition of known amount of an internal standard (1,2,3,4-tetrachlorine naphthalene).

Instrumental analysis

Purified PCBs extract were analysed by HRGC (ECD) on a Varian 3400 CX using a. DB-5 (J&W Scientific, CA, USA) fused silica capillary column (60 m x 0.25 mm ID, 0.25 mm film thickness). Chromatographic conditions were: Carrier gas was nitrogen. The injector temperature was 280º in splitless mode (60s). The column temperature was programmed as follows: initial temperature 80 ºC (1 min.) until 185 ºC at 30 ºC/min.and then maintained for 3 min, then to 234 ºC at 1.9 ºC/min.and maintained during 65.5 min, and finally to 250 ºC at 2 ºC/min. maintaining this temperature during 45 min. Quantitative analysis was performed using standard solutions of PCBs supplied by Ehrenstorfer, Augsburg, Germany.

Results and Discussion

The Total PCB concentrations in sewage sludge samples (mg/Kg dry matter) refers to the sum of all congeners analysed, differed significantly over the different time intervals tested (Figure 2). The highest PCB values were found at the firsts and last weeks of sampling, from October 1998 to January 1999 and from August to October 1999 respectively. At autumn 1998, the PCBs concentration ranged from 301.9 to 89.3 mg/Kg dry matter, this value decreased along winter and spring seasons (ranged from 29.6 to 6.43 mg/kg dry matter). Summer's 99 showed only slight oscillations in total PCB content. These values increased again at the end of August, reaching in September 99 the highest values of all the period studied (462.8 mg/Kg dry matter).

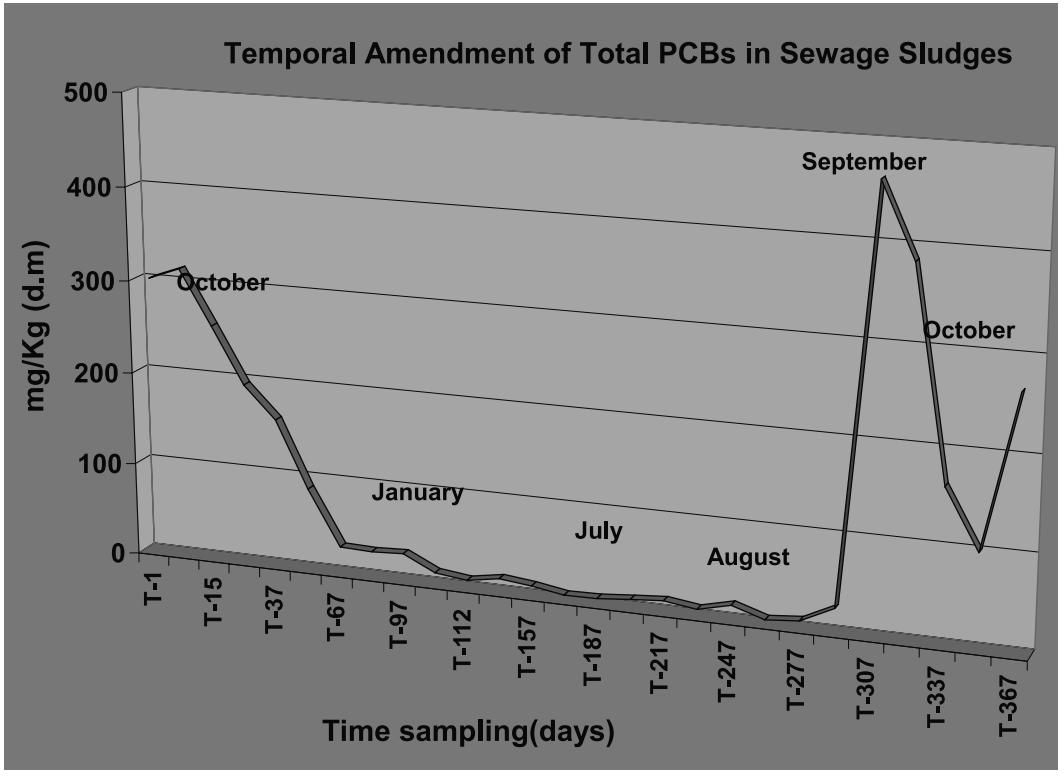

Figure 2. Temporal amendment of total PCBs (in mg/kg d.m.) found in sewage sludge from a Spanish wastewater plant.

Most abundant PCB congeners were PCB 101, 118, 138, 153, 170, 180 and 194, and less abundant were PCB 28, 52, 156 and 189. PCBs 105, 114, 157 and 167 were only detected in a few samples. The PCB congeners showed similar variations as the total PCBs amount at the time interval tested. The most abundant PCB congeners suffered the highest variations (Figure 3).

The PCB levels along the time in the sewage sludges reveals a relationship with the period of sampling, which are related with the input of water in the wastewater treatment plant and the sampling season. Although PCB levels found were above the maxima recommended by the EU legislation in all cases, it is important to note that the concentrations detected were highly dependent on the season sampling. Following the implications of these results, it can be recommended that future regulations take in consideration the possibility of deviations in PCB levels in sewage sludge in dependence with the sampling season.

Aknowledgment

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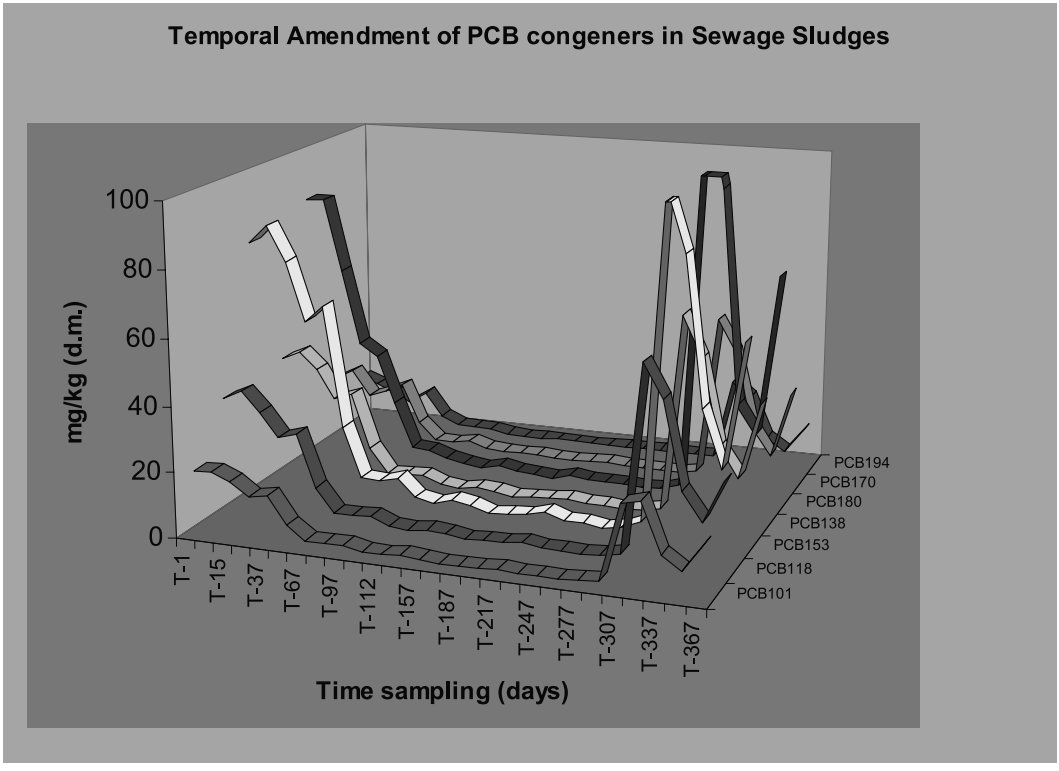

Figure 3. Temporal amendment of PCB congeners (in mg/kg d.m.) found in sewage sludge from a Spanish wastewater plant.

References

1. van der Berg M., Birnbaum L., Bosveld A.T.C. (1998) Environ. Health Perspec. 106, 775.
2. Eljarrat E. (1999) PhD Thesis. Department of Analytical Chenistry, University of Barcelona, Spain.
3. Rodríguez M.C. (1996) Ph.D. Thesis. Department of Analytical Chemistry. Chemical Institute of Sarriá. University Ramon Llull, Barcelona, Spain.
4. Ballschmiter K., Zell M. (1980) Fresenius Z. Anal. Chem.320, 20.
5. Jiménez B., Eljarrat E., Hernández L.M., Rivera J., González M.J. (1993) Chemosphere 32, 1327.