The Use of Polyurethane Foam Plugs for Extraction of Polychlorinated Biphenyls (PCB's) from Natural Waters

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The discovery of polyurethane foam's ability to extract PCB's from water (GESSER et al. 1972) was viewed with great interest by our pesticide laboratory. It was hoped that the method would aid in the measurement of low ppt (parts per trillion) in the Great Lakes and its tributaries in that it increased both the extraction efficiency and the amount of water that could be conveniently analyzed.

In monitoring Michigan's tributaries for PCB's a 5-gallon-30-hour composite sample is collected and a one-gallon aliquot is placed in a bottle equipped with a teflon-lined cap and containing 100 ml of hexane. Since the remaining 4 gallons is discarded it provided a good opportunity to test and compare the polyurethane foam method. It was found that in relatively clear rivers with low levels of PCB's comparable results were found between the two methods of extraction. However, in the more turbid rivers with high concentrations of PCB's much lower levels were found using foam extraction.

In order to examine why this disparity occurred a series of experiments were run using spiked distilled and eutrophic lake water.

METHODS

Two diSPo polyurethane foam plugs (34x44 mm) were placed in glass columns (22x500 mm) and pre-washed with 150 ml of hexane, 50 ml of acetone, and finally 50 ml of distilled water. Water, spiked with PCB's, was passed through the column at a rate of 250-275 ml/min. The PCB's were eluted from the column with 50 ml of acetone followed by 100 ml of hexane. The aqueous portion of the eluate was discarded and the eluate was washed with a 10% sodium chloride solution to remove the acetone. The eluate was dried with anhydrous sodium sulfate and concentrated before analysis by gas chromatography.

A Varian Aerograph Model 1740 gas chromatograph was used for the analyses. It was equipped with a tritium foil electron capture detector and a 6 ft x $\frac{1}{4}$ in (OD) Pyrex glass column pack-

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ed with 4% S. E. 30 and 6% QF-1 on Chromsorb W (HP). The column temperature was 200°C and the detector, 220°C. Quantitations were based on the peak heights of two prominent peaks representing four chlorine isomers. No change in isomer pattern was noted during the experiments.

RESULTS AND DISCUSSION

Ten µg of Aroclor 1254, dissolved in acetone, were spiked in 3-liter quantities of distilled water and lake water. In addition 10 µg were spiked directly on the foam column. The recovery from distilled water was the same as the directly spiked column, while the amount recovered from the lakewater was only one-half as much (Table 1).

TABLE 1

Mean Extraction Efficiency of Polyurethane Foam for Aroclor 1254.

Method Spiked	Column	Distilled Water	Lake Water
Amount Spiked (µg)	10	10	10
Replications	5	5	5
Recovered (µg)	8.9 ± 0.6	8.9 ± 0.4	4.5 ± 0.9

In order to determine why the recovery from lakewater was so low distilled water and lakewater were proportionately mixed before spiking and the column eluate was extracted as well as the foam plugs. Four different 1500-ml water samples were spiked with 10 µg of Aroclor 1254. One contained 1500 ml distilled water, one 1000 ml distilled and 500 ml lakewater, one 500 ml distilled and 1000 ml lakewater and one 1500 ml lakewater.

The amount of Aroclor 1254 recovered from the foam columns was proportional to the amount of distilled water present (Table 2). In this experiment a higher recovery was obtained from the lake water (64 vs 45%) but the recovery from distilled water was also higher (104 vs 89%). The same lakewater was used for both experiments and contained 22 mg/l suspended solids.

The eluates from the columns were extracted with 15% ethyl ether in hexane and hexane as per EPA (1971) recommendations and a considerable quantity of 1254 was found in those eluates con-

taining lakewater (Table 2). When the quantity of Aroclor 1254 in the eluate is added to the amount extracted by the foam column, nearly all of the Aroclor is accounted for. Thus it appears that most of the unrecovered (from the foam) Aroclor 1254 is passing through the column rather than being irreversibly adsorbed onto the foam.

TABLE 2

Extraction Efficiency of Polyurethane Foam for Aroclor 1254 in Mixtures of Lakewater and Distilled Water.

Water Mixture		Spiked (μg)	Recovered (μg)		
Distilled	Lake		Foam	Eluate	Total
1500 ml	0 ml	10	10.4	0.2	10.6
1000	500	10	9.2	0.8	10.0
500	1000	10	7.5	1.5	9.0
0	1500	10	6.4	2.7	9.1

The way the Aroclor passes through the foam column is probably adsorbed onto small particles which can pass through the porous foam. In order to test this hypothesis lakewater (suspended solids=14 mg/l) was filtered thru a 0.45-μ membrane filter. The filtrate, along with unfiltered lakewater and distilled water were spiked with Aroclor 1254 and passed through foam columns. The extraction efficiency of the foam was approximately the same for distilled and filtered lakewater, but much lower for the unfiltered lakewater (Table 3).

An attempt to duplicate the results obtained with lakewater by suspending Montmorillonite clay particles in distilled water failed as the water was extracted equally efficiently (91%) with 0, 10, 20, and 30 mg/l clay. This indicates that either the clay particles did not pass through the foam or that Aroclor 1254 is much more strongly attracted to the foam than the clay.

This study indicates that polyurethane foam cannot be used reliably to extract PCB's from many natural waters unless spiked samples are run from each body of water to be tested. Although this makes the foam method somewhat impractical for enriched and/or turbid waters, it still should be a valuable technique for clear waters containing low quantities of PCB's such as the Great Lakes and open ocean. That is, in very clear waters the extrac-

tion efficiency should remain relatively constant and spiked samples need not be run for each water sample. Also, perhaps correlations can be determined between turbidity and suspended solids and extraction efficiency.

TABLE 3

Extraction Efficiency of Polyurethane Foam for Aroclor 1254 in Filtered versus Unfiltered Lakewater.

Water Type	Spiked (µg)	Recovered (µg)		
		Foam	Eluate	Total
Filtered Lake	10	8.8	0.4	9.2
Unfiltered Lake	10	6.9	1.1	8.0
Distilled	10	9.1	0.2	9.3

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LITERATURE CITED

EPA: Methods for Organic Pesticides in Water and Wastewater. National Environmental Research Center. Cincinnati, Ohio 45268 (1971).

GESSER, H. D., A. CHOW, F. C. DAVIS, J. F. UTHE, and J. REINKE: PCB Newsletter 4, 11-13 (1972).