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Volatile Pollutants in the Environment and Human Tissues

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More and more attention have lately been paid to the occurrence of volatile pollutants in the environment (Rook 1974, Eklund et al. 1978, Kroneld & Reunanen 1980, Johnson et al. 1982) and in human tissues (Dowty et al. 1975, Kroneld & Reunanen 1980, Pfaffenberger & Peoples 1980, Bauer et al. 1981, Kroneld & Reunanen 1985).

These substances are lipophilic to their nature and they accumulate in body tissues (Vogt et al. 1980, Kroneld & Reunanen 1985). Especially patients receiving haemodialysis therapy could be exposed more than other categories of patients (Kroneld & Reunanen 1985).

These substances are toxic, even though our knowledge of especially long-term exposure is limited (Davidson et al. 1982). Carcinogenic activity of these substances and an increased cancer mortality of the urinary organs have been discussed (Williamson 1981, Davidson et al. 1982).

This work is dealing with the concentrations found in healthy individuals tissues and the results are compared to findings in Central Europa (Bauer et al. 1981).

MATERIALS AND METHODS

Air samples were collected from the suburbs of the city of Turku, food from food shops in the city and tissue from hospital and medical centers. The air samples (n=35) were collected during 1987 by using an adsorption apparatus (3M, K-electronics, Finland). The samples were taken during clear days and monthly, at the middle of the day.

Food samples, 10 gr samples (dry weight) of milk, juice, coffee, fish and meat (n=22) were analysed.

The tissue samples were collected at hospitals and medical centers during surgery and pathological-anatomical analyses. Samples of 10 gr of kidney tissue, lung tissue and muscle tissue were used.

Each sample was then homogenized and 0,5 ml n-pentane, containing a known amount of 1-chlorohexane as an internal standard, was used for the extraction of the volatile hydrocarbons. After centrifugation, the pentane phase was analysed by gas chromatography-mass spectrometry (GC-MS) in a selected ion monitoring mode (SIM), Recovery tests (n=12) of the eluation were made (Table 1).

Student's t-tests were used in this study. $P < 0.01$ (*) was considered statistically almost significant, $P < 0.05$ (**) statistically significant and $P < 0.001$ (***) statistically highly significant.

Table 1. Recovery (per cent) of volatile hydrocarbons from the tissue samples used in the study (waterbath 85 °C, 40 ml N_2/min pass., 45 min. of duration) (n=12).

Substance	Kidney	Lungs	Muscle
$CHCl_3$	91± 8	72±15	88±11
CH_3CCl_3	94± 9	79±14	90± 9
CCl_4	89±12	73±18	92± 9
Br_2ClCH	77±13	81± 6	87±10
$ClCH=CCl_2$	88±11	87± 9	94± 8
$Cl_2C=CCl_2$	79± 9	83±13	89±11

RESULTS AND DISCUSSION

The results of the analyses are shown in Table 2.

Small concentrations of volatile pollutants could be found in most of the samples taken. The concentrations of trichloromethane were highest of the six substances analysed. The highest concentrations were found in food samples. The concentrations were higher in juice compared to coffee ($p < 0.1$, *) and fish samples ($p < 0.001$, ***). 1,1,1-trichloroethene could be found only in air and tissue samples, but not in food samples. Tetrachloromethane concentrations were found in all samples, as traces only in milk and coffee. The highest concentrations were found in fish and meat. The concentrations in meat samples were significantly higher compared to fish samples ($p < 0.05$, **). Dibromochloro-

Table 2. The results of the analyses of suburban air (mg/m³), food and human tissues (ug/kg) in the city of Turku at the south-west coast of Finland in 1987.

Substances	Air	Food					Tissue		
		milk	juice	coffee	fish	meat	kidney	lung	muscle
	(n=35)	(n=22)	(n=22)	(n=22)	(n=22)	(n=22)	(n=9)	(n=13)	(n=16)
$CHCl_3$	0.06 ±0.001	0.8±0.1	7.3 ±0.8	5.4±0.7	2.6±0.8	3.3±0.5	1.1±0.09	1.3 ±0.1	1.2 ±0.1
CH_3CCl_3	0.002±0.001	N.D	N.D	N.D	N.D	N.D	0.1±0.08	0.1 ±0.09	0.4 ±0.08
CCl_4	0.009±0.003	+	0.3 ±0.08	+	0.6±0.08	0.9±0.1	0.3±0.07	0.08±0.01	0.05±0.01
Br_2ClCH	0.31 ±0.07	N.D	+	2.2±0.6	+	+	0.6±0.02	0.06±0.01	+
$ClCH=CCl_2$	0.06 ±0.01	0.1±0.06	N.D	1.2±0.09	0.1±0.06	0.5±0.01	0.7±0.1	0.02±0.01	0.2 ±0.09
$Cl_2C=CCl_2$	0.08 ±0.01	0.2±0.08	0.01±0.005	0.3±0.1	0.3±0.02	1.1±0.3	0.5±0.1	0.09±0.01	0.6 ±0.2

N.D = not detectable, + = traces

methane concentrations were not detected in milk and only as traces in juice, fish, meat and muscle tissue samples. Trichloroethylene concentrations were detected in all categories of samples except for juice samples. Tetrachloroethylene concentrations were detected in all sample categories analysed.

Studies of human tissues have also been undertaken elsewhere in Europe. Bauer et al. (1981) have described a similar trend that could be studied in the human tissue samples from the suburban area of the city of Turku. The concentrations (ug/l, n=15) in the study of Bauer (1981) were for trichloromethane 2.6 in kidneys, 2.7 in lung and 1.9 in muscle tissue samples. The concentrations for 1,1,1-trichloroethene were 1.8 in kidney, 1.9 in lung and 3.8 in muscle tissue samples; for tetrachloroethene 1.8 in kidney, 1.9 in lung and 1.3 in muscle tissue samples; for trichloroethylene 7.8 in kidney, 2.2 in lung and 2.4 in muscle tissue samples; for dibromochloromethane 0.9 in kidney, 0.7 in lung and 1.3 in muscle tissue samples and for tetrachloroethylene 13.4 in kidney, 5.5 in lung and 6.8 in muscle tissue samples. The values were higher than those found in our study and the differences were highly significant.

The spreading of volatile pollutants in the biosphere is well-documented (Häsänen et al. 1981, Singh et al. 1981). Values of 10 mg/m^3 of trichloromethane in suburban air samples have been reported (Edwards et al. 1982). The production and the spreading of volatile pollutants is obviously increasing all the time. In one of our studies (Kroneld & Reunanen 1988) we have suggested a method to partly solve the problem with contamination of volatile pollutants in water. We think that there are good reasons to develop treshold values for volatile pollutants, as well as new methods concerned with elimination of volatile pollutants also from the air.

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