Cadmium Levels of Soil, Plants and Tobacco in Pest County, Hungary

L. VERMES and P. MARTH

Ministry of Agriculture, Budapest and Station for Plant and Soil Protection, Budapest

Cadmium has an outstanding importance among the toxic elements because it reaches man relatively easily through the food chain and the threshold level harmful to man is rather low. Over the last decades higher and higher amounts of Cd have been discharged into our environment from different origins, and therefore its control is of basic importance.

The objectives of this research were to study

- the environmental cycle of Cd,
- the migration of Cd following the soil-plant-animal-man pathway,
- the Cd concentration values actually present in the environment under Hungarian conditions.

Material and Methods

The investigations were made in Pest county. The soil, plant and other samples obtained from well determined areas of the county were tested in the laboratories of the Station for Plant and Soil Protection, Budapest.

During this study soil and plant samples were collected from 46 sites. In addition to Budapest-Nagytétény, samples were taken in Vác, Ócsa, Alsónémedi and Dömsöd. Soil samples were collected from the root zone of the plants (0-30 cm, or 20-40 cm in the case of grapes). The parts of the plants generally used or consumed were studied.

Having studied the international literature it was decided to use two different solvents (extractants) for soil analysis: for the determination of total Cd content hydrogen fluroide was used, and for available Cd content the Lakaanen-Erviö procedure (solvent 0.5 mol/L ammonium acetate - 0.5 mol/L acetic acid + 0.02 mol/L EDTA) was adopted. The nitric acid peroxide procedure was used for treating the plant samples, and all prepared samples were analyzed by the emission spectrometric (ICP) method.

In this investigation the Cd concentrations of tobacco and of the smoke of seven Hungarian-made cigarettes were studied as well.

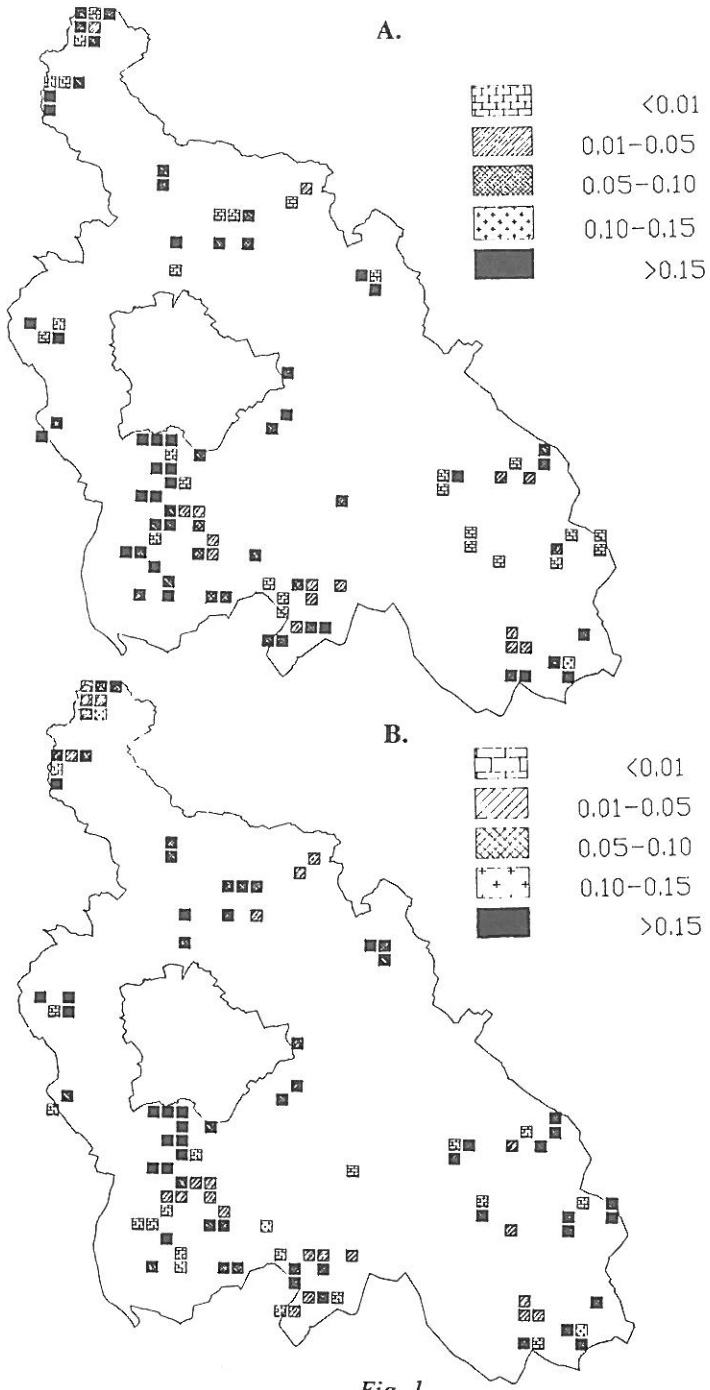

Fig. 1
Cd values of soils in Pest County in the top 0-30 cm layer (A) and in the 30-60 cm layer (B).

Results

The results of a wider analysis of soils in Pest county and in other parts of Hungary show that higher Cd contents occur with greater frequency in the upper soil layers (0-30 cm), though it was found that on some sampling sites equally high Cd levels could be measured in all three soil layers examined (Fig. 1).

Fig. 2 shows the average Cd values of soil samples based on the test sites. It is clear from the figure that the soils of Vác and Nagytétény, "richer" in industrial facilities, have higher Cd levels in the soil than the other, mainly agricultural communities, but the values only exceed the acceptable limits in a few cases.

After the full treatment with hydrogen fluoride the highest total Cd levels were obtained in the samples taken at Nagytétény, particularly in those taken from the area near the Metallokémia chemical works, in the north-west wind direction.

Among the plants examined carrot and sting beans contained the highest concentration of Cd, almost independently of the cadmium content of the soil. The Cd values measured in the different plant species together with the sample numbers can be seen in Table 1 and Fig. 3. The limit value set by the Hungarian Ministry of Agriculture for Cd in the dry matter of fodder materials of plant origin is 0.5 mg/kg.

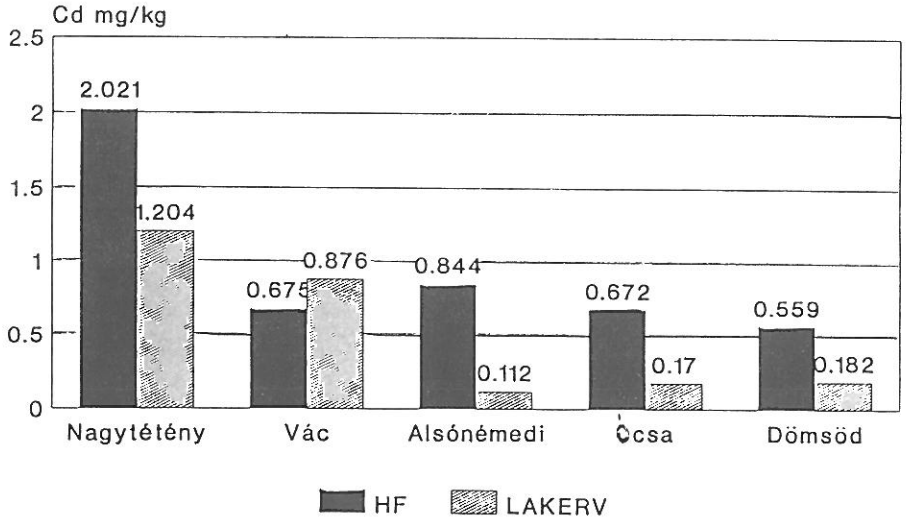

Fig. 2
Average Cd values of soil samples from different settlements.
Solvents: HF = Hydrogen fluoride; LAKERV = Lakaanen-Erviö

Table 1

Cd concentrations (mg/kg dry matter) in the plant species examined

Site	Code No.	Plant	HF (solvent hydrogen fluoride)	LAKERV (solvent Lakaanen-Erviö)
Nagytétény	1/1	Alfalfa	3.2475	1.9300
	1/10	Alfalfa	0.8969	0.2475
	1/2	Paprika	3.0516	2.2316
	1/3	Tomato	3.2475	2.6416
	1/4	Grape	3.4434	2.0437
	1/5	String beans	2.7251	2.2580
	1/6	Tomato	-	0.2369
	1/7	Kohlrabi	0.7663	0.7951
	1/8	Maize	.	0.2581
	1/81	Hazelnuts	0.3746	0.2766
	1/9	Red beet	0.4399	0.3242
Vác	2/1	Tomato	0.3093	0.2025
	2/2	Alfalfa	-	0.1443
	2/3	Maize	0.5052	0.1946
	2/4	Weed	0.4399	0.1629
	2/5	Alfalfa	0.7010	3.0586
	2/6	Maize	1.4193	1.4935
Alsónémedi	3/1	Alfalfa	0.3711	0.0703
	3/10	Carrot	0.8969	0.0861
	3/2	Tomato	0.7467	0.1523
	3/3	Carrot	0.8218	0.1655
	3/4	Tomato	1.0472	0.0755
	3/5	Maize	0.5964	0.1046
	3/6	Kohlrabi	1.0472	0.1046
	3/7	Celery	0.7467	0.1338
	3/8	Maize	1.1974	0.1073
	3/9	Weed	0.9720	0.1152
Ócsa	4/1	Kohlrabi	0.4462	0.1364
	4/10	Carrot	0.7467	0.1417
	4/11	Kohlrabi	-	0.5914
	4/2	Tomato	0.3711	0.1496
	4/3	Kohlrabi	0.9720	0.1629
	4/4	Alfalfa	0.6716	0.0808
	4/5	Maize	0.5213	0.0861
	4/6	Maize	-	0.1020

1. táblázat folytatása

Site	Code No.	Plant	HF	LAKERV
Dömsöd	5/1	Maize	0.4462	0.0816
	5/2	Alfalfa	0.6716	0.0931
	5/3	Carrot	-	0.1331
	5/4	Radish	-	0.1445
	5/5	Tomato	-	0.1531
	5/6	Kohlrabi	-	0.1645
	5/7	Alfalfa	-	0.3561
	5/8	Maize	-	0.3332

During the investigations the relationship between the Cd volumes extracted by different soil solvents (HF and LAKERV) was also studied. The correlation coefficient (r = 76) obtained with linear regression showed a probability level better than 0.1% at FG = 33. On the basis of the results and the relationships between the soil solvents and the Cd levels in plants, the Cd results of the treatment with hydrogen fluoride were correlated with the plant Cd contents at the

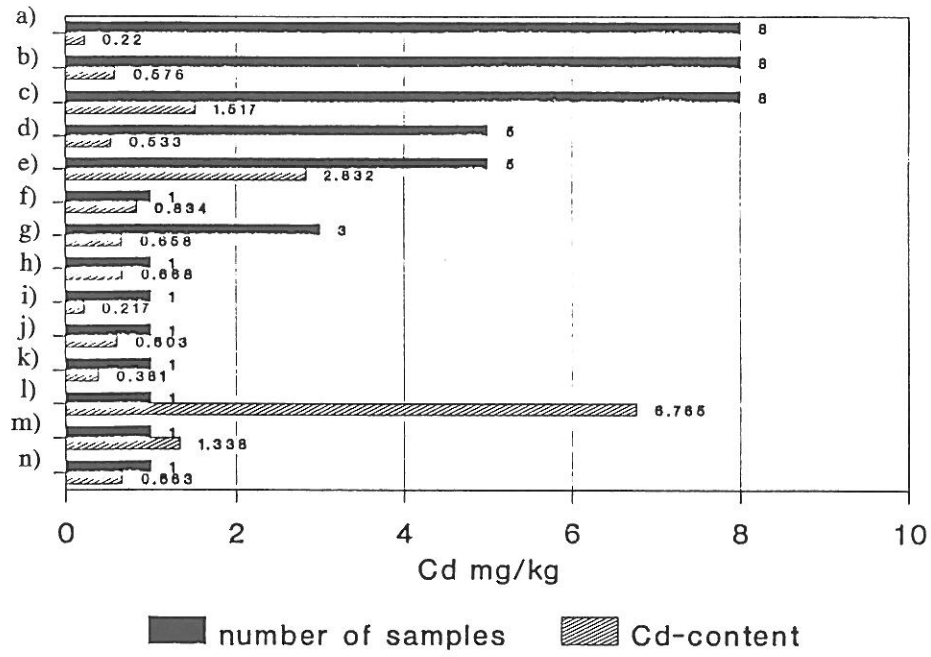

Fig.3

Average Cd values measured in different plant species (Solvent: Nitric acid oxide): a) maize; b) alfalfa; c) tomato d) kohlrabi; e) carrot f) celery; g) weeds; h) hazelnut; i) grape; j) savoy; k) red beet; l) string beans; m) radish; n) paprika

5% probability level (with a correlation coefficient r = 0.35) (n = 34). The Cd contents determined in the soil were correlated with those measured in the plants with the Lakaanen-Erviö method at the 1% probability level for 44 plants at r = 0.35.

The data of cigarette analysis show that the Cd concentration of "Románc" is higher than that of the other brands, but the smoke of "Fecske" is the worst (Table 2).

Table 2

Cd concentration of Hungarian-made cigarettes and of cigarette smoke

Name of cigarette	Cd (mg/kg) in cigarette*	Cd (mg/L) in the smoke of**		
		5 cigarettes	1 cigarette	1 cm smoked cigarette
1. Fecske	1.410	3.7×10^{-3}	0.74×10^{-3}	1.26×10^{-3}
2. Kossuth	1.680	5.7×10^{-3}	1.14×10^{-3}	0.30×10^{-3}
3. Sopiane	1.524	2.8×10^{-3}	0.56×10^{-3}	0.22×10^{-3}
4. Marlboro	1.084	2.7×10^{-3}	0.54×10^{-3}	0.11×10^{-3}
5. Románc	2.246	2.5×10^{-3}	0.50×10^{-3}	0.12×10^{-3}
6. Symphonia	1.372	1.7×10^{-3}	0.34×10^{-3}	0.09×10^{-3}
7. Munkás	1.690	1.5×10^{-3}	0.30×10^{-3}	0.08×10^{-3}

* values are given in terms of 100% dry matter; ** smoke of 5 cigarettes was absorbed into 50 ml 1 *M* HNO_3

Summary

Within the framework of a complex, long-term investigation on the environmental occurrence and circulation of cadmium, soil, plant and tobacco samples were taken from differently polluted areas of Pest county. The main aim of the investigations conducted in 1989-1990 was to determine the present status of Cd concentrations in the environment and to obtain basic data for the determination of further loading levels.

Soil analyses (n = 60) show the highest Cd values in the surface layer of soils situated in industrial areas, but even these values only exceed the permissible limit in a few cases.

Among different plants (n = 46) the highest Cd level was found in carrot, but high Cd values were also measured in green beans and other vegetables.

Some Hungarian cigarettes (tobacco and smoke, n = 14) were analysed as well, but more and wider investigations are necessary for the determination of further details of the Cd cycle, and of the Cd transfer factors between different elements of the environment in Hungary.