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Cadmium Concentrations in Plants and Goats Tissues from Various Areas of Chalkidiki, Greece

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Cadmium (Cd) is a relatively new element to be included in the world list of toxic metals such as lead and mercury. The use of cadmium by industry has resulted in the contamination of the environment, food chain, animals and man (Mortved and Osborn 1982, Underwood 1977, Tsalev and Zaprianov 1983, Von Bruwaene et al 1984).

Animals and man absorb cadmium by the direct consumption of contaminated animal kidneys and liver, shellfish, lettuce, spinach, as well as other vegetables. Usual Cd concentrations, considered as normal, range between 0.01-1 ppm in plants, up to 0.1 mg/kg w/w in meat (muscle), up to 0.5 mg/kg w/w in liver and up to 1 mg/kg w/w in kidney.

Massive Pb, Zn sulphide deposit is mainly composed by the opaque mineral assemblage of sphalerite, pyrite and galena. Cadmium is mainly contained in the sphalerite (~1.6 wt%) (Kalogeropoulos and Arvanitidis 1989), while the normal level of cadmium in soil range between 0.2-0.6 ppm (Tsalev and Zaprianov 1983).

In the present paper, cadmium concentrations in grazing plants and goat tissues from various areas of Chalkidiki, Greece were measured. These areas were chosen, because of underground mining located there.

MATERIALS AND METHODS.

Thirty samples of grass (Cynodon dactylon), twenty of trifolium (Trifolium pratense) and thirty-six samples of goat kidney and liver (36 liver and 36 kidney samples) were collected for analysis. The goats were between 3 and 8 years old. Samples were grouped according the area they were obtained.
A: Arnea, Chalkidiki.
B: Olympias-Ierissos, Chalkidiki.

Plant samples (Cynodon dactylon and Trifolium pratense) were dried to constant weight in an oven at 110^0 C and 3 g of each

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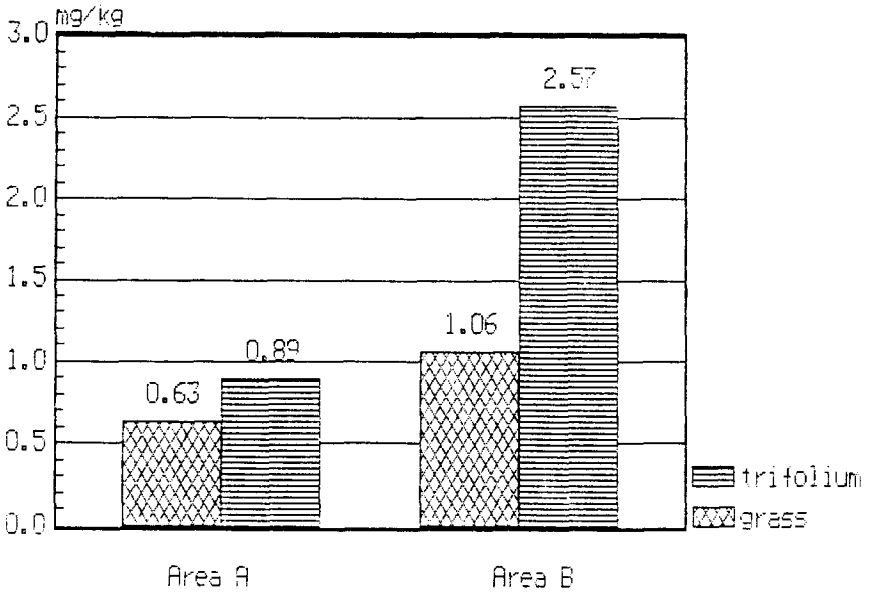

Figure 1. Mean Cd concentrations (mg/kg dry weight) in grass and trifolium

Table 1. Mean Cd concentrations (mg/kg dry weight) in plant (grass and trifolium) in relation with area they grow.

Area	number	mean	SD	min	max
Area A	26	0.73	0.29	0.2	1.1
Area B	24	1.69	0.99	0.3	3.4
Total	50				

specimens was digested in nitric and sulphuric acid. Kidney and liver samples (20 g) were homogenized and digested with acids too. The pH was adjusted to 3 with ammonium hydroxide and cadmium was extracted in APDC (ammonium pyrrolidine dithiocarbamate)-MIBK (methyl isobutyl ketone). The measurement was performed using a flame atomic absorption spectrometer at 228.8 nm (Friberg et al 1974).

Statistical analysis was performed according to Student-t test (non paired comparison). (Armitage 1971)

RESULTS AND DISCUSSION

The mean concentration of cadmium in plants taken from area B (1.69 mg/kg) was twice the concentration found in plants from area A (0.73 mg/kg). These findings are due to the closer proximity to the

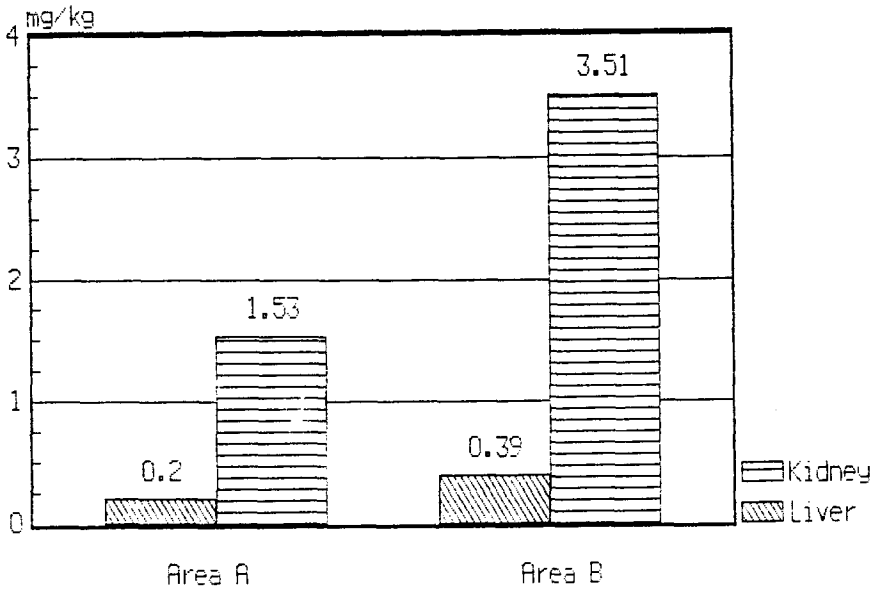

Figure 2. Mean values Cd (mg/kg w/w) in goats liver and kidney in relation with area.

Table 2. Mean Cd concentrations (mg/kg w/w) in goats liver and kidney.

Tissue	number	mean	SD
Liver	36	0.29	0.23
Kidney	36	2.52	2.14
Total	72		

mines of the plants in area B (table 1). In figure 1, studying the kinds of plants, cadmium values in trifolium are higher than those of grass from both areas and particularly from area B (2.57 and 1.06 mg/kg in trifolium and grass respectively). This fact is attributed to phosphorous fertilizers used for trifolium fields which fortified, as it is well known with cadmium (Underwood 1977, De Voogt et al 1980). Plants concentrations, particularly trifolium, from area B are higher that the considered desirable normal value (1 mg/kg), while those from area A are below 1 mg/kg (Bartik and Piskac 1981, Von Bruwaene et al 1984).

In table 2 we observe that cadmium mean concentrations in goats liver (0.29 mg/kg) and kidney (2.52 mg/kg) are lower than the tolerance limits for human consumption that were suggested in Holland (Spierenburg et al 1988) *. In addition, it is obvious that kidney cadmium concentration is higher than liver, as kidney ac

Table 3. Mean Cd concentrations (mg/kg w/w) in goats liver and kidney from area A in relation with age of animals.

Tissue	3-4 years		5-8 years	
	number	mean	number	mean
Liver	10	0.17	8	0.23
Kidney	10	1.05	8	2.14
Total	20		16	

Table 4. Cadmium concentrations (%) in liver and kidney of goats from areas A+B.

	L i v e r			K i d n e y	
mg/kg	number	%	mg/kg	number	%
0.0-0.5	32	88.9	0-1.0	7	19.5
0.5-1.0	3	8.3	1-3.0	21	58.3
over 1.0	1	2.8	over 3.0	8	22.2
Total	36			36	

cumulate this metal and is the target organ. From figure 2 it is easily derived that kidneys and liver from erea B are more contaminated than those from area A.

Specifically, kidneys cadmium mean concentration from area B (3.51mg/kg), is overdouble that from area A (1.53 mg/kg) and at the same time, this value is higher than tolerance limits. It has to be noted that goats from area B are older than those from A.

In table 3 we observe that Cd concentration increases versus age. Particularly Cd mean concentration of animals aged 3-4 years from area A is 1.05 mg/kg, while those aged 5-8 years is 2.14 mg/kg. This is because Cd has accumulative ability in the body (Underwood 1977, Andersen and Hansen 1982, Frank et al 1989, Antoniou et al 1989) with half-past life 19-38 years (Friberg et al 1974). Finally, on table 4, it is observed that only 2.8% of liver samples are over tolerance limits, while those of kidneys reach 22.2%.

As a conclusion we would suggest kidneys consumption from animals of advanced age, specifically derived from Cd polluted areas, should be avoided.

* Tolerance limits: 1 mg/kg w/w for liver
3 mg/kg w/w for kidney (Spierenburg et al 1988)

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REFERENCES

Andersen A, Hansen H. (1982) Cadmium and zinc in kidneys from Danish cattle. Nord Veterinaermed. 34(40):340-349.

Antoniou V, Tsoukali-Papadopoulou H, Epivatianos P, Nathanael B. (1989) Cadmium concentrations in beef tissues in relation to age of animals and area of their breeding. Bull Environ Contam Toxic 43(6):915-919.

Armitage P. (1971) Statistical methods in medical research. Blackwel, Oxford.

Bartic M. Piskac A. (1981) Veterinary toxicology. Ed. Publ. Company, Amsterdam.

De Voogt P, Van Hattum B, Feenstra J, Copius Peereboom J. (1980) Exposure and health effects of cadmium. Toxicol Environ Chem Rev 3:89-105.

Frank R, Suda P, Luyken H. (1989) Cadmium levels in bovine liver and kidney from agricultural regions on and off the Kanadian field, 1985 - 1988. Bull Environ Toxicol 43:737-741.

Friberg L, Piscator M, Nordberg G, Kjellstrom T. (1974) Cadmium in the environment. 2nd Ed. CRC Press, Cliveland, Ohio. USA.

Kalogeropoulos S, Arvanitidis N. (1989) A comparison of the chemistry of sphalerites between the Pb-Zn (Au, Ag) sulfide deposits of the Eastern Chalkidiki peninsula and the respective mineralizations of the Thermes area, Xanthi. Bull Geol Soc Greece, vol XXIII/2:245-260.

Koh TS, Judson GJ. (1986) Trace elements in sheep grazing near a lead-zinc smelting complex at port Pirie South Australia. Bull Environ Contam Toxic 37:87-95.

Mortvedt J, Osborn G. (1982) The chemical form of cadmium contaminants in phosphate fertilizers. Soil Sci 134(3):185.

Spierenburg JTH, De Graaf JC, Baars JA, Brus DHJ, Tielen MJM, Arts BJ. (1988) Cadmium, zinc, lead and copper in livers and kidneys of cattle in the neighbourhood of zinc refineries. Environ Monit Assess 11:107-114.

Tsalev LD, Zaprianov KZ. (1983) Analytical aspects and health significance. In: Atomic absorption spectrometry in occupational and environmental health practice. Vol. 1, Ed. CRC Press, Florida, pp 105-112.

Underwood JE (1977) Cadmium. In:Trace elements in human and animal nutrition. 4th ed. Academic Press, New York, pp 243-246.

Van Bruwaene R, Kirchmann R, Impens R. (1984) Cadmium contamination in agriculture and zootechnology. Experientia 40:43-50.

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