MERCURY LEVELS IN THE MUSCLES AND KIDNEYS OF HORSES, COWS, AND PIGS

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Determinations of total mercury and methylmercury compounds were carried out by means of flameless atomic absorption spectrophotometry and gas-liquid chromatography in order to compare the concentrations of residues in kidneys and muscles of horses, cows, and pigs.

Industrial and agricultural uses of mercury and its compounds, and the fallout of mercury from the burning of fossil fuels and during the weathering of rocks, have resulted in the widespread occurrence of this metal in the environment. As mercury compounds (and especially its organic forms) are strong poisons for animals and human beings, monitoring of mercury residue levels in the environment, food, and feeds is a matter of concern to toxicologists and food hygienists.

In our previous papers mercury contamination of the environment in Poland on the basis of determinations in horse kidneys (5, 6), tissues of the other animals (11, 12), human milk (7), cow's milk, chicken eggs (14) and some kind of feeds (13) has been presented.

The highest concentrations of mercury in the majority of animals and in human beings were found in the kidneys. For this reason many of investigators choose kidneys as the most convenient tissue for mercury determinations. Nevertheless, for the proper judgement of the quality of the slaughtered animals and the utility of the meat for consumption in particular, knowledge of the mercury concentration in the musles is the most important. For the above reason, in this work studies on concentrations of total mercury and the possibility of occurrence of methylmercury compounds in the muscles and kidneys of horses, cows and pigs butchered for food have being carried out.

Materials and Methods

Samples for investigations were taken from healthy slaughter animals: horses, cows and pigs coming from the Lublin voivodship. The age of the horses was from 8 to 20 years, average weight 460 kg, of the cows from 3.5 to 10 years, average weight 400 kg, and of the pigs below 1 year old, average of weight about 90 kg. The left kidney and a 400-500 g sample of muscles (nape muscles from horses, diaphragm muscles from cows, loin muscles from pigs) were taken from each animal. Samples were packed into marked plastic bags, cooled and stored in a deep freeze (−15°C) till assay (no later than 3 weeks).

For total mercury determination samples of 5 to 10 g of muscles and kidneys were subjected to wet digestion with sulphuric, nitric and perchloric acids under a reflux condenser. The analysis of the total mercury level was thereafter carried out by the method of flameless atomic absorption spectrophotometry using mercury analyser Coleman MAS-50 with a modified reaction bottle. The limit of detectability of the method was 0.001 mg mercury per kilogram fresh tissue (ppm).

In the samples where total mercury levels exceeded 0.02 mg/kg estimations of methylmercury compounds were performed. Extraction according to Westöö

(16) and determination using a gas-liquid chromatograph supplied with an electron capture detector were applied. The limit of detectability of the method was 0.02 mg/kg of methylmercury chloride.

Results and Discussion

All examined samples revealed the presence of mercury in concentrations which ranged in kidneys from 0.011 to 0.407 mg/kg and in muscles from 0.001 to 0.062 mg/kg (Table 1). The highest levels of total mercury were encountered in horse kidneys, mean 0.139 ± 0.118 mg/kg ($\pm$ standard deviation). In pig kidneys, mean concentration was 0.050 ± 0.038 mg/kg, in cow kidneys 0.032 ± 0.013 mg/kg. Also in muscles the highest mercury levels were found in the case of horses, mean 0.026 ± 0.016 mg/kg. In the muscles of the other animals the mercury concentrations appeared to be much lower than those in horses and were as follow: 0.005 ± 0.009 mg/kg in pigs and 0.007 ± 0.002 mg/kg in cows.

Table 1

Total mercury content (mg/kg) in muscles and kidneys of horses, pigs and cows

Animals	No. of samples	Kidneys		Muscles	
		mean±st. dev.	range	mean±st. dev.	range
Horses	28	0.139 ± 0.118	0.033—0.407	0.026 ± 0.016	0.005—0.062
Pigs	30	0.050 ± 0.038	0.011—0.180	0.005 ± 0.009	0.001—0.009
Cows	30	0.032 ±0.013	0.013—0.058	0.007 ± 0.002	0.004—0.014

Because the purpose of this study was to establish the average mercury residue levels in the tissues of the animals, three horses were excluded form the calculations, according to the criterion for extreme values reported by Dixon and Massey (2) as the concentrations found in the kidneys of these animals were much higher than those in kidneys of other horses. The following mercury concentrations were found in the excluded samples of the kidneys: 7.5 mg/kg, 3.54 mg/kg and 0.833 mg/kg compared to those found in the muscles of these same horses: 0.012, 0.016, 0.054 mg/kg. Similar cases of high residues of mercury in kidneys were encountered in previous works on horses coming from various parts of the country (5, 6). These cases were regarded as exceptional mercury intoxications with unknown etiology.

No methylmercury above the limit of detectability (0.02 mg/kg) in all the examined samples was detected. This seems to be a very profitable observation, as methylmercury is the most dangerous mercury compound and its presence has been encountered in fish and tissues of other animals in some countries (8, 17, 18).

Table 2
Total mercury content (mg/kg) in muscles and kidneys of pigs and cows in different countries

Country	Samples	No. of samples	Mean concentr.	Range	Year of publ.	References
Denmark	pig, muscle	6	0.003	0.002—0.007	1965	18
West Germany	„	80	0.042	0.000—0.118	1973	4
Sweden	„	30	0.008	0.001—0.016	1968	17
USA	„	12	0.005	0.000—0.005	1974	3
G. Britain	„	4	<0.005	<0.005—0.005	1971	9
G. Britain	pig, kidney	11	0.04	0.01 —0.07	1971	9
G. Britain	„	8	0.05	0.02 —0.18	1973	10
Sweden	„	21	0.042	0.014—0.105	1968	17
Denmark	cow, muscle	6	0.003	0.002—0.004	1965	18
West Germany	„	25	0.004	—	1973	4
Sweden	„	23	0.012	0.002—0.074	1965	18
USA	„	—	0.004	0.000—0.019	1972	1
USA	„	23	0.003	<0.002—0.007	1972	15
USA	„	6	0.01	0.000—0.02	1974	3

These results of total mercury determinations in the muscles and kidneys of pigs and cows are close to the results found in other countries (Table 2). They also do not exceed (with the exception of horse kidneys) the value 0.05 mg/kg which is the practical residue limit for mercury in food according to FAO/WHO recommendations.

REFERENCES

1. *Deitz F. D.*: J. Anim. Sci. 30, 1090, 1972. — 2. *Dixon W. J., Massey F. J.*: Introduction to statistical analysis. McGraw-Hill, New York 1957. — 3. *Gonez M. J., Markakis P.*: J. Food Sci. 39, 673, 1974. — 4. *Hamm R.*: Medycyna Wet. 29, 709, 1973. — 5. *Juszkiewicz T., Szprengier T.*: Medycyna Wet. 29, 87, 1973. — 6. *Juszkiewicz T., Szprengier T.*: Pol. Arch. Wet. 17, 71, 1974. — 7. *Juszkiewicz T., Szprengier T., Radomański T.*: Pol. Tyg. Lek. 30, 365, 1975. — 8. Methyl mercury in fish, Report from an expert group, Nordisk Hygienisk Tidskrift, suppl. 4, 1971. — 9. Survey of mercury in food — First Report, Working Party on the Monitoring of Foodstuffs for Heavy Metals, Min. Agr. Fish. Food, London 1971. — 10. Survey of mercury in food — Third Report, Working Party on the Monitoring of Foodstuffs for Heavy Metals, Min. Agr. Fish. Food, London 1973. — 11. *Szprengier T.*: Bull. vet. Inst. Puławy 17, 110, 1973. — 12. *Szprengier T.*: Bromat. Chem. Toksykol. 7. 371, 1974. — 13. *Szprengier T.*: Medycyna Wet. 31, 155, 1975. — 14. *Szprengier T.*: Bull. vet. Inst. Puławy 19, 99, 1975. — 15. *Tanner J. T., Friedmann M. H., Lincoln D. N., Ford L. A., Jaffee M.*: Science 177, 1102, 1972. — 16. *Westöö G.*: Acta Chem. Scand. 21, 1790, 1967. — 17. *Westöö G.*: Var föda 7, 137, 1969. — 18. *Westöö G.*: Methylmercury compounds in animal foods, Chemical Fallout — Current Research in Perisistent Pesticides, Springfield, 1969.