

Results of a Monitoring Study: Contamination of Pork from the Western States of the Federal Republic of Germany with Harmful Substances from the Environment

R. SCHEUER and H. HECHT

Federal Centre for Meat Research, D-8650 Kulmbach, Germany

SUMMARY

The occurrence of 16 organochlorine compounds, of the heavy metals lead and cadmium, and of the radionuclid ¹³⁷-Caesium in pork has been investigated. All samples were collected in butcher shops in the western states of the Federal Republic of Germany. Residues of the 16 investigated organochlorine compounds were commonly detected in liver and fat of pigs, generally at levels that are one to two orders of magnitude below the legal threshold values. The concentration of radiocaesium in muscle did never exceed 100 Bq/kg. Whereas the contamination of liver with lead and cadmium rarely exceeded the recommended values and also the contamination of kidneys with lead remained low, the cadmium concentrations in kidneys often exceeded the recommended values.

INTRODUCTION

Organochlorine pesticides (OCP) and polychlorinated biphenyls (PCB), as well as heavy metals and - after the nuclear accident at Chernobyl - the radionuclid ¹³⁷-Caesium are in food of particular concern for the consumers in Germany (HAPKE, H.-J., 1988; ROTTKA, H., 1988). OCP, PCB and heavy metals are well known as persistent contaminants which accumulate in the upper trophic levels of food chains. Therefore the German authorities decided to introduce recommended values (Richtwerte) for heavy metals and threshold values (Grenzwerte) for OCP and PCB. These are listed for pork in table 1 and table 2 below. No legal regulation exists at present for radiocaesium in foods and feeds produced within the EEC.

The general population is exposed to these compounds principally through food and drinking water. Pork is often suspected to make a major contribution to the overall uptake of these substances in our food. This report presents the results of investigations about the contamination of pork with organochlorine compounds, heavy metals and radiocaesium.

Table 1: Legal threshold values for organochlorine pesticides (OCP) and polychlorinated biphenyls (PCB) in pork*

agents	threshold value in µg/kg extracted fat fat content > 10%	threshold value in µg/kg sample material fat content < 10%
α - HCH	200	20
β - HCH	100	10
γ - HCH	1000	100
DDT and derivatives	1000	100
HCB	200	20
Heptachlore and Heptachlorepoxyde	200	20
Aldrine and dieldrine	200	20
PCB 28	80	8
PCB 52	80	8
PCB 101	80	8
PCB 138	100	10
PCB 153	100	10
PCB 180	80	8

*) Verordnung über Höchstmengen an Schadstoffen in Lebensmitteln vom 23.03.1988;
Neufassung der Pflanzenschutzmittel-Höchstmengen-Verordnung vom 16.10.1989.

MATERIALS and METHODS

All samples were chosen at random in butcher shops of a big supermarket chain. We thank the HL-company, Bad Homburg, for their help with the samples and their financial support. Samples of muscle were analyzed for radiocaesium, samples of muscle, liver and kidneys for lead and cadmium, and samples of fat and liver for OCP and PCB. The organochlorine pollutants were analyzed using method in ref.: BECK and MATHAR (1985) and quantified by on-column-injection into a Perkin-Elmer Model 8420 capillary gas chromatograph with electron-capture detector.

For lead and cadmium analysis, each 3 g portion of the freeze dried samples were placed overnight in a muffle furnace, at 450°C. The ash was cooled, dissolved in approximately 2 ml of hydrochloric acid, filtered in a propylene tube, and diluted with deionized water. The filter paper was ashed in the muffle furnace and then extracted again. This was repeated three times. At the end of extraction the concentration of hydrochloric acid in the tube was about 0.1 molar. The residues were determined on a Perkin-Elmer Model 3030 atomic absorption spectrometer.

The gamma-ray emission rate of the homogenized pure muscle tissue was measured by the aid of an ultra pure Ge-detector (Canberra) in connection with a 4096-multi-channel analyzer (Canberra Type 35 P). The specific radiocaesium activity was estimated by an calibrated automatic PC-calculator system to the multichannel analyzer.

Table 2: Recommended values for lead and cadmium in fresh pork*)

tissue	lead (µg/kg)	cadmium (µg/kg)
muscle	250	100
liver	500	300
kidney	500	500

*)Richtwerte für Schadstoffe in Lebensmitteln, Bundesgesundhbl. 5, 224 (1990)

RESULTS and DISCUSSION

Minimum (Min), maximum (Max) and median (\bar{x}) of the contents of radiocaesium, lead, cadmium and organochlorine compounds in pork are given in table 3. Even if PCB's are no longer manufactured in Germany and the use of the most of OCP's is forbidden or restricted, their manufacture, use and disposal during the past 50 years, have resulted in their widespread presence in the environment. Major source of contamination with PCB was the accidental contamination of feed either with transformer oil containing PCB or PCB-containing paints and sealants used in silos or impregnated binding yarns (LORENZ and CLAUS, 1983). The OCP contamination seems to be mainly caused by residues in agricultural soils and by imported feeds from countries in which the use of OCP is allowed (HEESCHEN and BLÜTHGEN, 1987). In our investigation the contamination of pork with OCP and PCB was one to two orders of magnitude below the legal threshold values (tab. 1 and 3).

Emissions of lead result primarily from fuels, to which tetraethyl-lead was added to improve the fuel's quality; emissions of cadmium are caused in the first place by smelting works, incinerators and firing equipments. According to our results, the contamination of kidneys with cadmium often exceed the recommended values, but we did never find elevated values in the muscle. This is caused by specific metal-binding proteins (metallothioneins) in the kidneys (ALTMANN, 1978).

In contrast to venison, where we can observe in some cases a high contamination with radiocaesium and a widespread distribution related to the animal's feeding habits and living space (KREUZER and HECHT, 1988), the 137-Cs activity in pork was very low and we found nearly the same values in all parts of Germany. This is a consequence of the strong control of the feed of farm animals and of the fact, that agriculturally used soils have normally a high "immobilization capacity" for radiocaesium due to its clay mineral content and type, pH and potassium status. Because of this human influence on the feeds farm animals on the other hand are no good monitoring organisms to control the radiocaesium contamination in different areas.

Table 3: Amounts of plant-protective agents, harmful substances, heavy metals and radiocaesium in fresh material of pork (µg/kg pork tissue)

OCP and PCB in fat/liver	N	min	max	\bar{x}
	µg/kg extracted meat fat;	µg/kg fresh liver tissue;		
α - HCH	68/40	0.1/0.04	4.3/0.79	1.1/0.12
β - HCH	68/40	0.3/0.03	13.2/2.94	1.1/0.58
γ - HCH	68/40	0.9/0.02	49.4/4.37	5.1/0.73
pp' DDT	68/40	0.3/0.05	22.2/1.19	3.4/0.05
pp' DDE	68/40	0.7/0.08	23.4/1.52	5.9/0.31
pp' DDD	68/40	0.3/0.05	37.9/3.44	4.7/0.39
HCB	68/40	0.2/0.02	7.4/0.94	1.7/0.13
Heptachlore	68/40	0.2/0.02	37.6/1.49	4.5/0.04
cis Heptachlorepoxyde	68/40	0.5/0.06	22.6/2.31	0.5/0.08
trans Heptachlorepoxyde	68/40	0.3/0.04	15.5/1.37	0.3/0.19
Dieldrine	68/40	0.2/0.06	11.7/0.65	1.9/0.18
Aldrine	68/40	0.1/0.02	5.5/0.82	0.2/0.10
PCB 101	68/40	0.5/0.08	8.9/0.93	0.5/0.08
PCB 138	68/40	0.2/0.03	15.1/1.02	1.6/0.12
PCB 153	68/40	0.3/0.02	11.5/0.50	0.5/0.02
PCB 180	68/40	0.2/0.15	26.6/3.05	4.1/0.43
lead/cadmium in pork-tissue	µg/kg fresh tissue			
muscle	31/31	0.500/0.000	27.00/5.000	4.000/0.900
liver	31/31	12.00/20.00	3880/1120	38.00/45.00
kidney	28/28	2.000/61.00	49.00/3290	12.00/333.0
¹³⁷ Cs	Bq/kg fresh tissue			
muscle	171	1.0	67	2.0

CONCLUSIONS

Pork is the most important meat source in Germany. More than 50% of total meat consumption including fish and poultry is pork*. Therefore a possible contamination of pork with harmful substances from the environment would contribute to a high degree to the contamination of the German population. In our investigations we found, however, that the content of residues in pork is very low. Residues of organochlorine compounds are one to two orders of magnitude below the legal threshold values; the concentration of radiocaesium did never exceed 100 Bq/kg; and because there are no metal-binding proteins in the muscle, we did never find high values of lead and cadmium in the muscle of pork.

*) Calculated according to: Statistisches Jahrbuch über Ernährung, Landwirtschaft und Forsten der Bundesrepublik Deutschland 1989; Landwirtschaftsverlag GmbH., Münster-Hiltrup.

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