Levels of polychlorinated biphenyls (PCB) in Swedish foods

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PCB has been used in industry in Sweden since 1929, from the beginning only in electric transformers and capacitors, later also in paints, lacquers etc. The importation of PCBs to Sweden in 1970 was close to 500 tons. Approximately half of this was exported to other countries in electric capacitors. The use of PCB in dyes was 65 tons in 1968, but was voluntarily diminished by industry to 35 tons in 1970.

The high degree of persistence and lipid solubility of the PCBs have led to their accumulation in many foods of animal origin. In Sweden they now occur in the natural environment roughly in the same amounts as the chlorinated pesticides (Jensen et al. 1969). The special hydrographical conditions of the Baltic favour the accumulation of PCB in certain species and areas. The water exchange with the North Sea is very limited because of the thresholds (8 m and 18 m) and the narrowness of the Danish Sounds. The wide archipelagos at some places will also make possible high concentrations in some localities with high pollution, e.g. outside of Stockholm.

PCB and organochlorine pesticides have been analyzed in food samples from 1967 and later in Sweden. After extraction and routine clean-up, the extract is separated by thin-layer chromatography into two groups, one of which contains PCB and p,p'-DDE, o,p'-DDT, o,p'-DDE. The PCB is determined by gas chromatography of this group before and after oxidation of the organochlorine pesticides. Some of the PCBs can be analyzed by gas chromatography without decomposition of the organochlorine compounds. Recoveries average 96-101 % for PCBs added to purified fish extracts before application to thin-layer plate (Westöö & Norén 1970 a).

There was less than 0.1 mg PCB/kg of the fat in all samples of butter (n = 154), margarine (n = 115) and various vegetable oils (corn, olive, soybean, sunflower, linseed, safflower, sesam and mixed oils, total n = 197) (Westöö, Norén & Andersson 1970).

There was less than 0.1 mg PCB/kg in such food items as chicken (n = 143), lamb meat (n = 26), lamb fat (n = 10), beef (n = 34), whole eggs (2 samples) and egg white (28 samples). Two samples of egg yolk (out of 185) contained PCB in the 0.2-0.5 mg/kg range; the same was true for 1 out of 107 samples of pork.

Cow's milk (n = 11) had less than 0.5 mg PCB/kg fat in all samples. Human milk had definitely higher levels of both PCB and "total DDT" than cow's milk. Thus in human milk (n = 22) p,p'-DDT averaged 1.24 $\pm$ 0.072 mg/kg fat, p,p'-DDE 2.08 $\pm$ 0.13 mg/kg fat and PCB 0.50 $\pm$ 0.039 mg/kg fat. With an average fat content of 3.2 % in the human milk, the PCB in whole milk averaged 16 $\pm$ 2.5 µg/kg (mean $\pm$ standard error).

Recently Westöö et al. (1971) also discovered PCB in some samples of cereal products. The origin was found to be the packaging material. On thin-layer chromatography and on gas chromatography the PCB behaved as PCB of type Clophen A 60. In several samples of one kind of imported children's food the PCB levels exceeded 1 mg/kg. In one sample of this product, which had been stored at room temperature for two years, the level of PCB had increased to 11 mg/kg. The sale of this children's food in Sweden was stopped in July 1971.

Westöö & Norén (1970 b) also analyzed for PCB and organochlorine pesticides in about 1 000 fishes from lakes, rivers, the Baltic Sea and the Atlantic Ocean. The levels depend on the fat content of the fish and on the geographical location. PCB levels higher than 0.5 mg/kg fish flesh were rarely seen in Sweden in lean fish (haddock, Gadus aeglefinus, cod, Gadus morrhua, plaice, Pleuronectes platessa) all of which have less than 2 % fat in the edible flesh.

In 54 samples there was more than 0.5 mg PCB/kg flesh, e.g. in salmon, Salmo salar (10-15 % fat), eel, Anguilla anguilla (25 % fat) and herring (7-15 % fat). The highest PCB levels were found in 2 small samples of herring from the Stockholm archipelago, 2.8 and 2.5 mg/kg, in 4 yellow eels close to Gothenburg, 1.5 mg/kg, and in a char, Salmo salvelinus, in the Vättern lake. - Cod liver is rich in fat (40-70 %). Livers of cod from the Baltic Sea had high levels of PCB, 3.8 mg/kg (2.4-4.9), and of DDT+DDE+DDD, 18 mg/kg (11-22). Because of the high levels of "total DDT", cod livers from the Baltic were declared unfit for human consumption (1971). A few livers of cod from the Swedish West coast also had high PCB levels, 2.5 ppm, but lower levels of DDT+DDE+DDD, 3 mg/kg, than in the Baltic.

Studies by Olsson et al. (1971) show that DDT levels in fish are fairly even over wide areas, whereas PCB levels decrease with the distance from the sources of pollution in the same manner as the methylmercury levels in fish.

The main intake of PCB via the food in Sweden thus occurs by eating fish. The average consumption of fish in Sweden 1961-1969 was 17 kg/person/year - and of crustaceans and molluscs about 1 kg/year. In terms of fish flesh, Westin (1970) calculated an intake for 1965 of 35 g per person and day. Of this, about 2 g represent freshwater fish, 1 g caviar, and 1 g shellfish and molluscs together. The average intake of PCB therefore probably does not exceed 1 µg per day, but may exceed 10 µg/dag in people eating herring from the Baltic 3 times a week.

A suckling baby ingests about 0.15 litre of mother's milk per kg body weight daily in the 2nd and 3rd months of live, with an average PCB level of 16 µg/kg milk. This corresponds to 2.4 µg/kg body weight per day. It is known from Japan that PCB passes the placental barrier (Tsukamoto et al. 1969). Thus we have a situation similar to that with DDT with the suckling baby getting the highest exposure. This will probably be the case with several environmental pollutants with high lipid solubility.

To prevent further pollution with PCB the Swedish riksdag (parliament) has enacted the 1971 PCB Act, authorizing the government to prescribe conditions regarding importation, production, offering for sale or handling of PCB.

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