Bull. Environ. Contam. Toxicol. (1989) 42:728–734

Bulletin of Environmental Contamination and Toxicology

Methylmercury Concentrations in Broiler's Meat and Hen's Meat and Eggs

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Even though mercury is a natural element, present since the formation of the earth and known to man since prehistoric times, a great concern over its toxicity has developed during the past 30 years. The epidemic among Japanese fishing families of Minamata and Niigata who had eaten fish polluted with mercury, the death of Swedish wildlife, the case of the Iranians who had eaten wheat treated with mercurial fungicides have caused concern (Haq 1963; D'Itri 1972; Bakir et al. 1973; Clarkson et al. 1976; Harada 1978).

Today mercury poisoning is rare, but the problem remains because the use of mercury fungicides in the treatment of wheat was in practise until recently (Dassani et al. 1975; Englender et al. 1980) and mercurial compounds are widely employed in industry for the production of drugs, electronic products, various chemical substances, etc. Also, considerable amounts of mercury are constantly released in the environment as a consequence of natural geological contamination despite the amounts released because of human pollution.

The concentration of mercury in food has been considered to present the greatest toxicological danger to the average citizen. The presence of mercury in foods has been reported in several studies (Gomez and Markakis 1974; Hugunin and Bradley 1975; Kirkpatrick and Coffin 1975; Maggi et al. 1979). Much of the research has been carried out on total mercury concentration in foods and not on methylmercury concentration and as it is known methylmercury is the most dangerous form of mercury.

Methylmercury, which is highly resistant to biodegradation, can be synthesized from any other form of mercury in the aquatic biosphere, can be bioconcentrated in the aquatic food chain (Magos 1975) and through fish-meals can be transported and concentrated in animals and their products. Such food chains, together with the various terrestrial food chains would represent a serious risk for man.

This study was undertaken to determine the methylmercury levels in broiler's meat, hen's meat and eggs.

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MATERIALS AND METHODS

A total of 180 samples or breast, leg and liver, from 30 hens and 30 boilers were examined. Also, a total of 83 hen's eggs (51 from commercial range and 32 from free range hens) were examined.

The samples were selected from various areas of Northern Greece,not known to be specifically contaminated with mercury.

The methods of Westoo (1967; 1968) and Watts et al (1976) with some modifications were used for the isolation, identification and quantification of methylmercury.

Isolation of methylmercury: a) From meat: 50 g of well homogenized breast of leg meat were transfered to an Erlenmayer flask with a total of 160 ml of distilled water. Then 40 ml of concentrated hydrochloric acid and 30 g of sodium chloride were added and mixed. The mixture was shaked vigorously with 200 ml of benzene for 5 min and separated by centrifugation. 170 ml of the benzene extract were transfered to a separating funnel and shaked vigorously for 2 min with 6 ml of cysteine acetate solution 1%. After the separation of the two phases, 5 ml of the aqueous phase were transfered to a second separating funnel and shaked vigorously for 2 min with 3 ml of 6N hydrochloric acid and 10 ml of benzene (if there was a disturbing precipitate in the aqueous phase it could easily be removed by centrifugation, stirring and recentrifugation until the clearance of this phase). After the separation of the phases, the benzene extract was dried with anydrous sodium sulphate, concentrated to 2 ml and reserved for gas-liquid chromatographic determination (the benzene extract contained methylmercury as methylmercury chloride).

b) From liver: the above procedure was followed, using 30 g of liver and adding 3 g of molybdic acid to the liver suspension (for the precipitation of the proteins at the first extraction for improved results). The mixture was shaked for 30 sec and then treated as for meat.

c) From egg: the procedure as for meat was used with repeated extractions of the first benzene extract with 4+3+3 ml of the cysteine acetate solution (for improved results for eggs) for 2 min every time. 9 ml of the combined aqueous phases were transfered to a separating funnel and shaked with 5.5 ml of 6N hydrochloric acid and 10 ml of benzene. Then treated as for meat.

Gas-Liquid Chromatography: For the identification and quantification of the methylmercury chloride by GLC, a Varian 3700 gas chromatograph with electron capture detector (^{63}Ni) was used. The glass column (200 x 2 mm i.d) was packed with 15% diethylene glycol succinate (DEGS) on 80-100 mesh Chromosorb P.

The column, injector and detector temperatures were 160, 250 and 200°C

Cysteine acetate solution 1%: Dissolved 1.00 g of cysteine hydrochloride, 0.775 g of sodium acetate and 12.5 g of anydrous sodium sulphate in water and make up to 100 ml.

respectively. A gas mixture (90% argon and 10% methane) was used as carrier gas at a flow rate 25 ml/min.

Methylmercury chloride was identified by comparing the retention time with that of standard, chromatographed separately or added to the samples (fig. 1). Periodically "blank" analyses were performed to check on contamination of the solvents. The recovery of the method was 69-93% and the detection limit 0.1 ppb.

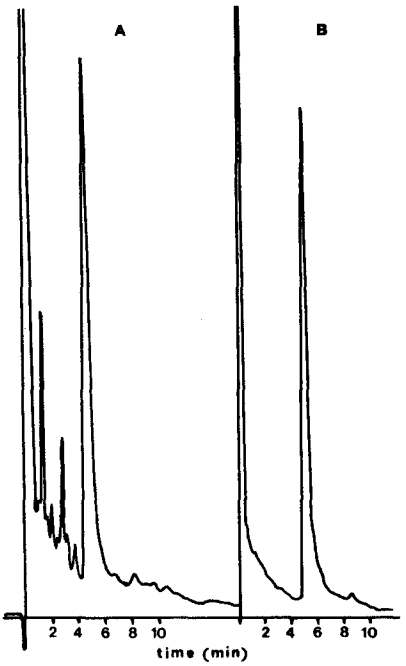

Figure 1. Gas chromatogram of methylmercury chloride. A: sample (liver); B: standard solution.

RESULTS AND DISCUSSION

Table 1 lists values of methylmercury (as methylmercury chloride) found in broiler's and hen's meat and liver and table 2 lists values of methylmercury found in eggs.

Table 1. Methylmercury chloride in broilers and hens (ppb wet wt)

	Breast		Leg		Liver	
	Range	Mean	Range	Mean	Range	Mean
Broilers	0.1-3.0	0.9(100)[a]	traces-2.7	0.7(100)	0.5- 7.1	2.6(100)
Hens	0.5-3.1	1.8(100)	0.4-2.9	1.4(100)	1.7-16.5	6.1(100)

a. Positiveness per cent

The partitioning of methylmercury in each step of the analytical method is not quantitative and this must be taken into account to calculate the concentration of methylmercury originally present in the sample.

Table 2. Methylmercury chloride in eggs
(ppb wet wt.)

	Range	Mean
Commercial range hen's eggs	0.1- 6.0	1.4 (100)[a]
Free range hen's eggs	0.4-28.9	4.3 (100)

a. Positiveness per cent

The quantities of methylmercury found in hens were larger than those in broilers. Also, larger quantities were found in liver than in meat and in breast meat than in leg meat, either in hens or in broilers, as it is shown in fig. 2.

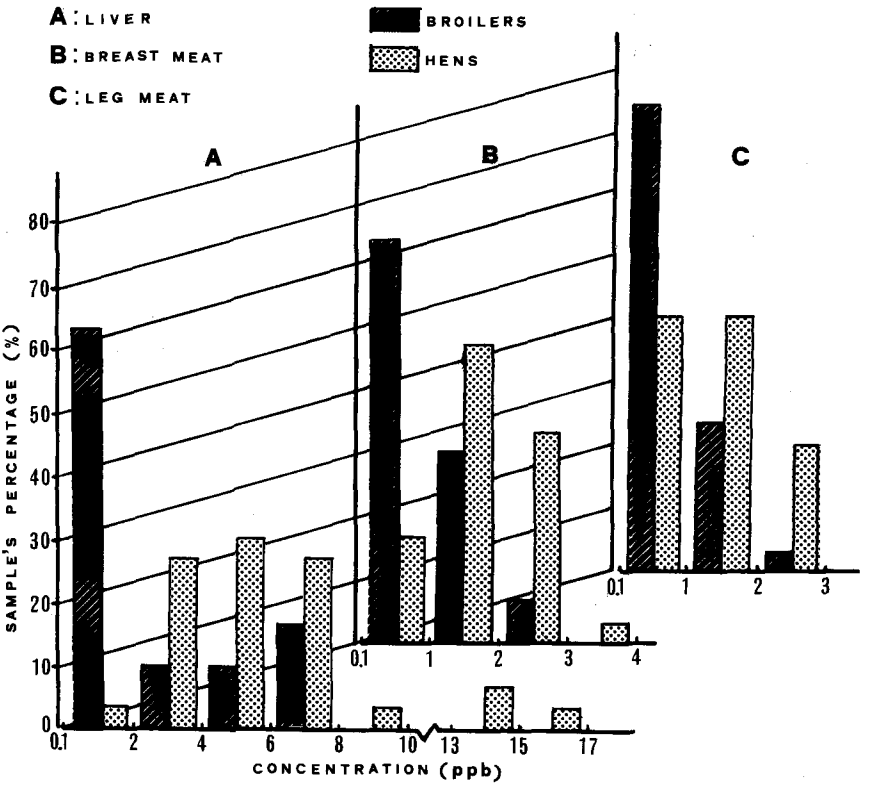

Figure 2. Distribution of methylmercury concentration in broilers and hens.

Finally, larger quantities of methylmercury were found in free range hen's eggs than in commercial range hen's eggs (Fig. 3).

The above results indicate that samples were found to be contaminated with methylmercury. This is not surprising in view of the fact that fish-meals are used in the nutrition of poultries and mercury in fish exists predominantly as methylmercury. Through this food chain methylmercury is transported in poultries and their products.

Also, environmental pollution takes part in the contamination of animals and animal products.

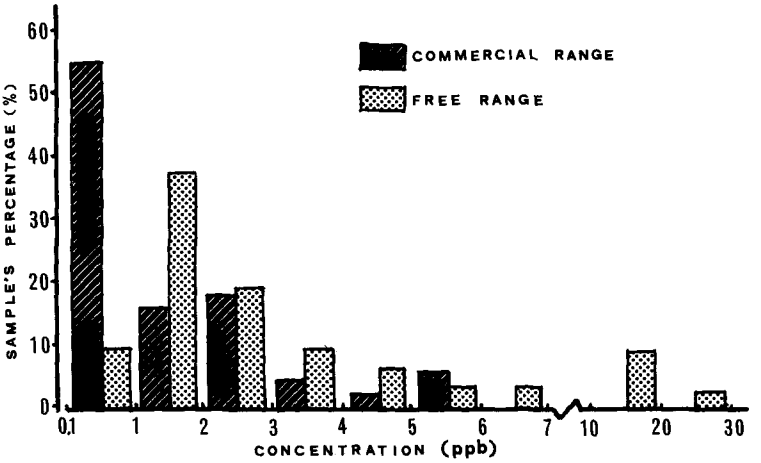

Figure 3. Distribution of methylmercury concentration in eggs

Larger quantities of methylmercury were found in hens than in broilers. This difference may be due to the different age and lenght of life between hens and broilers. Larger quantities of methylmercury were also found in liver than in meat and in breast meat than in leg meat. This is reasonable because, according to the findings of other researches (Gardiner et al. 1971; Wright et al. 1973, 1974, 1978), the administration of methylmercury in chickens gave residues of mercury higher in the liver than in muscle and higher in breast muscle than in leg muscle.

The quantities of methylmercury in free range hen's eggs were larger than those in commercial range hen's eggs. This may be due to the different nutrition and rate of egg production of hens (March et al. 1974).

Unfortunately, it is difficult to compare our findings with those of other researches, owing to lack of sufficient data on levels of methylmercury in food, in contrast to sufficient data on levels of total mercury in foods. Schafer et al. (1976) found methylmercury in eggs of U.S.A. up to 40 ppb (concentrations higher than others previous, according to the researches) and Westoo (1969) found methylmercury in eggs of Sweden 6-22 ppb in egg white and 1-2 ppb in egg yolk, also, in hen's meat 17-37 ppb (of course those determinations became a few years after the prohibition of the use of methylmercury in agriculture, in Sweden). The other data are reported to total mercury. Weight (1978) found <1-141 ppb of total mercury in broiler's meat in Germany. Maggi et al. (1979) found 3-15 ppb of total mercury in chicken's meat and <1-15 ppb of total mercury in eggs in Italy. In Canada, Kirkpatrick and Coffin (1975) found 1-23 ppb of total mercury in eggs and in U.S.A. Gomez and Markakis (1974) found 20-40 ppb of total mercury in eggs, 15-30 ppb in chicken's

meat and 15-30 ppb in chicken's liver.

The concentrations of methylmercury found in our samples are lower than the FAO/WHO acceptable tolerance limit (0.05 ppm Hg for foods other than fish). Of course this limit is for total mercury and not for methylmercury.

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Received May 2, 1988; accepted June 10, 1988