Bull. Environm. Contam. Toxicol. 22,488-493 (1979)

Mercury Contamination of Fish in Guatemala

Alberto Ramos,[1] Marit de Campos[1,2], and A. E. Olszyna-Marzys[1,2]

[1]Unified Food Control Laboratory (LUCA), Guatemala and [2]Food Control and Analysis Division of the Institute of Nutrition of Central América and Panama (INCAP), Guatemala

In Minamata Bay, Japan, 46 people died and 75 more were intoxicated by methyl-mercury between 1953 and 1960. Ever since that catastrophe mercury contamination of food has been a problem of official and public concern. It is now known that bacteria in the sediment are able to convert inorganic mercury in the water into highly toxic organic forms and that the main sources of contamination are industries using mercury in their procedures (KREHL 1972).

Countries like Sweden, Canada and the United States have reported very high residues in fish with values much higher that the maximum allowable level of 0.5 ppm (KOLBYE 1970). The United States Food and Drug Administration adopted this figure as a guideline in 1969 (KOLBYE 1970) and it is also included in the Central American Food Standards (PAHO 1972). It is not clearly indicated on which basis this value is calculated, but it is usual to calculate contaminants on the basis of the edible portion. Most investigators report mercury contamination in muscle (tissue) only, (NEWBERNE 1973, REIMER and REIMER 1975), but results calculated on a whole fish basis are also found in the literature (OLSON *et al.* 1975).

In Guatemala, a country in Central America, the general consumption of fish is low –only 0.17 pounds/person/year (TRABANINO 1976). People on the coast eat fish often, but in the highlands fish consumption is very low.

In Guatemala there is little industry susceptible to contaminate the waters with mercury. However, migrating fish and water currents could be a contamination source, and as no work on the subject has been published in the country, it was decided to undertake a study to establish the degree of mercury contamination in local fish.

MATERIALS AND METHODS

In June and July 1974, 214 specimens of 19 different species of finfish and 89 specimens of 4 classes of shellfish were collected from fresh water sources and on the Pacific and Atlantic coasts. The weights varied from 19 to 700 g. When the specimens were small, composite samples of the same species were made, so that finally 59 finfish samples and 7 shellfish samples were analyzed.

In Guatemala, in areas where fish is eaten at all, it is often consumed almost in its totality; when fried, even the head, the tail, and the small bones are eaten, and soup prepared from fish and shellfish is a popular dish. Because of this it was decided, in this preliminary study, to consider the whole fish as "edible portion" and to grind the specimens completely, crabs being an exception.

0007-4861/79/0022-0488 $01.20

The sample were analyzed on a PERKIN–ELMER atomic absorption instrument, model 305A, supplied with equipment for mercury determination by flameless atomic absorption. The sample preparation and analysis were carried out as published by PERKIN–ELMER (1973), with minor modifications: Depending on the mercury content between 0.1 and 0.5 g was exactly weighed directly into a 300 ml B.O.D. bottle; 1 ml of concentrated HNO_3 and 5 ml of concentrated H_2SO_4 were added from burette and the bottle placed in a 50–60°C shaking water bath until a clear solution was obtained. After cooling the bottles, 15 ml of 6°/o $KMnO_4$–solution were added and, after 1 more hour, a few drops of octanol were added as an antifoam and then 50 ml of reductant solution (100 ml H_2SO_4, 600 ml H_2O, 5 g NaCl, 10 g $(NH_2OH)_2$. H_2SO_4, 20 g $SnSO_4$, diluted to 1000 ml). The bottle was immediately connected to the aerator of the apparatus and the maximum absorption at 254.7 nm was read on the meter. The results were calculated from a standard curve ranging from 0 to 0.1 µg Hg, prepared with standards diluted in 20°/o H_2SO_4. The coefficient of variation of the curve was 10°/o. A standard was carried throughout the entire procedure with each set of samples; the mean recovery was 80°/o. To correct for possible mercury contamination of the reagents, a blank was also run with each set. All determinations were carried out in duplicate; the coefficient of variation between duplicates was 10°/o. A tunafish sample of known mercury content was kept frozen and inclued in each run to assure reproducibility of the method.

RESULTS AND DISCUSSION

As shown in Table I, all the shellfish samples were low in mercury content, the residues varying from 0.00 to 0.10 ppm. The 0.10 ppm value was found in a sample of saltwater shrimp from Puerto Barrios on the Atlantic Coast. Even if the number of samples is low (89 specimens divided into 7 composite samples), the results indicate a low mercury contamination in shellfish in general.

The mercury content in finfish can be observed in Table II. The residues are generally low; one of the saltwater samples, a composite sample of "picuda" taken in Puerto Barrios on the Atlantic Coast exceeds the 0.5 ppm limit, containing 0.61 ppm. As this sample was a composite of 7 specimens, one or more of these must have contained even higher values.

As the determinations were made on a whole fish basis, it was considered necessary to make a comparison between results obtained on a whole fish basis and those obtained when only muscle is analyzed. In fourteen samples a piece of muscle was analyzed, then the entire fish was ground and the mercury content determined once more. The results of this study can be seen in Table III. Excluding sample No. 14, the relation $\pm$ standard deviation between muscle values and whole fish values is 2.0 ± 0.6

WINTON and WINTON (1937) give the proportions of waste and edible portion in 44 species of fish and the average edible portion standard deviation can be calculated to 50 ± 10°/o.

This means that our results will have to be multiplied by a factor of two to get an estimate of the residue in muscle. In this case four of the fish samples (7°/o of total) would exceed the 0.5 ppm limit.

TABLE I

Mercury in Shellfish
in ppm

Origin	Scientific name	Common name English	Common name (Spanish)	Composite samples n	Specimens n	MERCURY
Fresh water:						
Lake Amatitlán	*Procambarus mexicanus*	crawfish	(cangrejo)	1	28	0.03
María Linda River	*Carcinus moenas*	river shrimp	(camarón de río)	1	12	0.00
Salt water:						
Iztapa	*Carcinus moenas*	saltwater shrimp	(camarón de mar)	1	11	0.01
Ocós	*Carcinus moenas*	saltwater shrimp	(camarón de mar)	1	19	0.02
Puerto Barrios	*Carcinus moenas*	saltwater shrimp	(camarón de mar)	1	9	0.10
Puerto Barrios	*Callinectes sapidus*	king crab	(jaiba)	1	2	0.00
Ocós	*Callinectes sapidus*	king crab	(jaiba)	1	8	0.01

TABLE II

Mercury in Finfish
in ppm

(whole fish basis)

Origin	Composite samples n	Specimen n	MERCURY mean ± S.D.*	min.	max.
Fresh water:					
Lake Amatitlán	14	38	0.13 ± 0.07	0.01	0.31
Lake Izabal	3	3	0.10 ± 0.11	0.02	0.23
Salt water:					
Iztapa	2	11	0.03 ± 0.04	0.00	0.05
Tilapa	7	25	0.05 ± 0.06	0.00	0.17
Champerico	11	30	0.07 ± 0.08	0.00	0.23
San José	6	18	0.07 ± 0.05	0.01	0.16
Ocós	3	37	0.14 ± 0.22	0.00	0.39
Puerto Barrios	13	52	0.12 ± 0.17	0.00	0.61

* S.D. = Standard deviation.

TABLE III

Relation Between Mercury Content in Muscle and in Whole Fish

Sample No.	Mercury in muscle ppm	Mercury whole fish basis ppm	Relation muscle/whole fish
1	0.39	0.16	2.4
2	0.18	0.11	1.6
3	0.16	0.12	1.3
4	0.38	0.13	2.9
5	0.36	0.17	2.1
6	0.17	0.14	1.2
7	0.31	0.19	1.6
8	0.30	0.17	1.8
9	0.16	0.09	1.8
10	0.93	0.31	3.0
11	0.11	0.06	1.8
12	0.05	0.02	2.5
13	0.35	0.23	1.5
14	0.28	0.01	28*

* Excluded from mean.
Mean $\pm$ S.D.: 20 ± 0.6.

CONCLUSIONS AND RECOMMENDATIONS

The mercury contamination of finfish and shellfish in Guatemala does not seem to constitute any big problem. A few samples, however, had high residue levels, so it is recommended that local fish should be analyzed regularly for mercury contamination. For control purposes each specimen should be analyzed separately in order not to mask a high value included in a lower mean.

Even if the eating habits in Guatemala could call for considering the whole fish as "edible portion", it is recommended to use the fish muscle only for analysis. This would give higher values, giving a better idea of the maximum risk involved.

REFERENCES

KOLBYE, A. C.: Testimony before the Subcommittee on energy, natural resources and the environment of the Senate Committee of Commerce, May 8, 1970, p. 56.

KREHL, W. A.: Nutrition Today *7*, 4 (1972).

NEWBERNE, P. M.: Critical Reviews in Food Technology, *4*, 311 (1973).

OLSON, G. F., D. I. MOUNT, V. M. SNARSKI and T. W. THORSLUND: Bull. Environ. Contam. Toxicol. *14*, 129 (1975).

PAN AMERICAN HEALTH ORGANIZATION: "Normas Sanitarias de Alimentos". Aprobadas por el Consejo de Ministros de Salud Pública de Centro América y Panamá 1964–1966. Guatemala, (1972).

PERKIN–ELMER CORPORATION: Analytical methods for atomic absorption spectrophotometry. Norwalk, Connecticut, (1973), p. FP-4.

REIMER, A. A. and R. D. REIMER: Bull. Environ. Contam. Toxicol. *14*, 105 (1975).

TRABANINO, J. F.: Department of Agriculture, Division of Fauna, Guatemala. Personal communication (1976).

WINTON, A. L. and K. B. WINTON: In The Structure and Composition of Foods. Volume III, New York, John Wiley and Sons, Inc. 1937, p. 435-438.