Research Note

Mercury and Omega-3 Fatty Acids in Retail Fish Sandwiches

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ABSTRACT

Mercury and fatty acids were measured in fish sandwiches from six retail restaurant chains. Average mercury concentrations ranged from 5 to 132 ppb and were well below the Food and Drug Administration action level (1,000 ppb). The average concentrations of eicosapentaenoic acid plus docosahexaenoic acid ranged from 91 to 620 mg per sandwich. Consuming one or two fish sandwiches per week could result in the consumption of 2 to 40% of the reference dose for mercury for a 60-kg individual and would provide 18 to 126% of the adequate intake for eicosapentaenoic acid plus docosahexaenoic acid as recommended for a pregnant or lactating woman.

Omega-3 fatty acids such as EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) are found predominantly in fish oil, fish, and other seafood (4, 19). These fatty acids are vital for fetal and infant brain and retina development (13, 30). Several research groups have studied the associations between these fatty acids and several parameters, i.e., preterm delivery, low birth weight (20, 21), and fetal growth (2, 12, 19, 20, 22).

However, fish also may contain contaminants, such as mercury (Hg), which are well known neurotoxicants (8, 16, 26, 31). Mercury is especially important because it can move across the placenta and can enter breast milk (1, 17, 24, 27, 29). Fetal and infant exposure to excessive mercury has been associated with developmental delays and learning disabilities (5, 7, 15). The U.S. Environmental Protection Agency estimated that each year 630,000 newborns in the United States are exposed to unsafe levels of mercury in utero (14, 23). The Agency has established a reference dose (RfD) of 0.1 μg methylmercury per kg body weight per day (26). Because of these concerns, the Environmental Protection Agency and the Food and Drug Administration (FDA) have issued advisories to women who may become pregnant; they should consume no more than 12 oz (two average meals) of a variety of fish and shellfish per week (9, 10, 28).

Because the vast majority of the U.S. population consumes fast food, it is important to evaluate fish sandwiches in terms of nutrition and safety. These products may provide the benefits from fish consumption but also pose potential risks from exposure to contaminants such as mercury. The objective of this study was to measure the levels of mercury and omega-3 fatty acids in fish sandwiches from retail restaurant chains to determine the safety of these popular items.

MATERIALS AND METHODS

Breaded and deep-fried fish sandwiches or tuna salad sandwiches were purchased from six fast-food restaurant chains throughout northern Indiana in 2003. Five fish sandwiches from four stores within each restaurant chain were collected (i.e., six restaurant chains X four stores X five fish sandwiches). The fish sandwiches were purchased without tartar sauce, cheese, lettuce, and tomato, and the fish was removed from the bun before sample preparation. Tuna salad, which was tuna mixed with mayonnaise, also was removed from the bun. The fish species included in the products were pollock or cod, pollock or hoki, pollock, cod, and tuna. Fish were homogenized in a food processor with stainless steel cutters (HC 3000, Black & Decker, Towson, Md.) and stored at −40°C in Whirl-Pak bags (Sigma-Aldrich, St. Louis, Mo.).

One gram of each sample was analyzed in duplicate for total mercury by thermal decomposition–amalgamation–atomic absorption spectrophotometry (TDA-AAS) using a DMA-80 analyzer (Mercury Analyzer, Milestone, Inc., Pittsburgh, Pa.). As described in the Environmental Protection Agency Method 7473 (25), standard reference materials (Tort-2 and Dorm-2; Institute for Environmental Chemistry, National Research Council of Canada, Ottawa, Ontario, Canada) were used to calibrate the instrument in two ranges: 0 to 35 and 30 to 470 ng Hg (Tort-2 = 0.270 ppm Hg; Dorm-2 = 4.64 ppm Hg). The equation used to calculate mercury concentration in the samples was absorbance = slope X ng Hg + intercept, and absorbance was measured at 253.7 nm. For the range of 0 to 35 ng Hg, the equation was $Y = 0.0245X + 0.0308 (R^2 = 0.9929)$, and for the range of 30 to 470 ng Hg, the equation was $Y = 0.0014X + 0.048 (R^2 = 0.9958)$. The lower limit of detection for mercury in the fish by TDA-AAS was 0.01 ng Hg.

Total fat was extracted by a modified Folch method (6, 11). The fish tissue was thawed, the bags were massaged, and 5.0000 g of sample was combined with 100 ml of chloroform-methanol (2:1 vol/vol) (high-pressure liquid chromatography–grade chlo-

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TABLE 1. Mercury residues and omega-3 fatty acid concentrations in fish sandwiches*

<table>
<thead>
<tr>
<th>Restaurant chain</th>
<th>Sandwich weight (g)</th>
<th>Mercury ppb, range (mean)</th>
<th>µg per sandwich</th>
<th>Total fat (%)</th>
<th>Fatty acids (mg/sandwich)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ALA</td>
</tr>
<tr>
<td>1</td>
<td>96.96 ± 2.1</td>
<td>5.1–68.4 (33.1)</td>
<td>3.2</td>
<td>11.3 ± 2.1</td>
<td>68.8</td>
</tr>
<tr>
<td>2</td>
<td>63.84 ± 4.8</td>
<td>37.6–194.0 (132.3)</td>
<td>8.4</td>
<td>11.6 ± 7.2</td>
<td>391.0</td>
</tr>
<tr>
<td>3</td>
<td>75.56 ± 4.3</td>
<td>1.9–27.9 (16.4)</td>
<td>1.2</td>
<td>9.7 ± 3.6</td>
<td>40.5</td>
</tr>
<tr>
<td>4</td>
<td>37.61 ± 3.5</td>
<td>4.0–58.4 (20.7)</td>
<td>0.8</td>
<td>10.6 ± 2.2</td>
<td>316.9</td>
</tr>
<tr>
<td>5</td>
<td>77.32 ± 4.1</td>
<td>2.9–7.3 (5.7)</td>
<td>0.4</td>
<td>12.3 ± 7.8</td>
<td>46.3</td>
</tr>
<tr>
<td>6</td>
<td>82.48 ± 3.7</td>
<td>55.3–169.0 (101.6)</td>
<td>8.4</td>
<td>9.1 ± 3.4</td>
<td>2,636.4</td>
</tr>
</tbody>
</table>

* Analyses were conducted on the fish patty removed from the bun (restaurant chains 1 through 5) or on tuna salad containing mayonnaise and other ingredients (restaurant chain 6).

b n = 5. Values with different letters are significantly different at α = 0.05.

ALA, α-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5n-3); DHA, docosahexaenoic acid (22:6n-3).

RESULTS AND DISCUSSION

The mean total mercury in the fish sandwiches from five retail restaurant chains (1 through 5) ranged from 5.7 to 132.3 ppb, and the mean total mercury in tuna sandwiches was 101.6 ppb (chain 6) (Table 1). The concentrations of mercury in fish sandwiches were well below the FDA action level of 1,000 ppb for fish. There was a significant difference in mercury concentrations in the fish sandwiches among the different restaurant chains and among stores within the same restaurant chain (P < 0.05). The intake of mercury from the fish sandwiches was between 0.4 and 8.4 µg per sandwich. Two restaurants had sandwiches that if consumed by a 60-kg individual would provide 140% of the RfD for mercury per day.

Total fat in the fish and tuna salad ranged from 9.1 to 12.3% (Table 1). Total omega-3 fatty acids in the fish and tuna salad ranged from 160.2 to 3256.4 mg per sandwich. Tuna sandwiches generally contained higher concentrations of omega-3 fatty acids compared with the other fish sandwiches. The concentrations of ALA and DHA in fish ranged from 40.5 to 316.9 mg per sandwich and 59 to 323 mg per sandwich, respectively. However, the ALA and DHA concentrations were significantly higher in tuna at 2636.4 and 537.2 mg per sandwich, respectively. Differences in EPA content between the fish and tuna salad were not observed; concentrations ranged from 32.4 to 197.3 mg per sandwich. EPA plus DHA in all sandwiches ranged from 91.4 to 620 mg per sandwich. Consumption of these sandwiches would provide EPA plus DHA at 65 to 442% of the adequate intake of 0.14 and 0.13 g/day for EPA plus DHA set by the National Academy of Sciences Institute of Medicine.

There is little information on the intake of fish sandwiches by pregnant and lactating women. In a cohort study in Denmark, consumption of fish sandwiches was more frequent than consumption of other types of meals containing fish (20); 36.6% of pregnant women consumed one to three fish sandwiches per month, and 30.9% of pregnant women consumed one or two fish sandwiches per week. If a 60-kg woman consumed a fish sandwich from one of these restaurant chains, the intake of mercury from the fish sandwiches would be between 2.1 and 40% of the RfD for mercury (RfD = 0.1 µg/kg of body weight per day). None of the fish sandwiches from these restaurants would exceed the RfD for mercury, but they would provide 18 to 126% of the adequate intake for EPA plus DHA. Olsen et al. (21) suggested that consumption of fish sandwiches may protect against the risk for low birth weight and preterm delivery compared with zero intake of fish during pregnancy because of the presence of omega-3 fatty acids. More studies on consumption of fish sandwiches by pregnant and lactat-
ing women are needed to weigh the associated benefits and risks.

The total mercury concentrations in fish sandwiches from various restaurant chains were well below the FDA action level of 1,000 ppb. Based upon consumption of two fish sandwiches per week, mercury intakes from fish sandwiches would not exceed the RfD for a 60-kg individual but would provide 18 to 126% of the adequate intake for EPA plus DHA needed by a pregnant or lactating woman.

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REFERENCES


