Mercury Content in West Coast Troll-caught Albacore Tuna (*Thunnus alalunga*) during the 2003 Season

Tomoko Okada, Rosalee Rasmussen and Michael T. Morrissey (michael.morrissey@oregonstate.edu)

Oregon State University Seafood Laboratory, 2001 Marine Drive, Rm 253, Astoria, OR, 97103

Abstract

Ninety-one albacore tuna (*Thunnus alalunga*) captured during the 2003 commercial fishing season were tested for mercury content in the fish muscle. Additional information such as location, weight, length, lipid and moisture content were also collected. The fish were harvested between 32.72 degrees north (off Southern California) and 48.30 degrees north (off the coast of British Columbia, Canada) from a period of July to November. Fish weight ranged from 3.14 to 11.62 kg and length of 50.8 – 86.36 cm. Mercury content was found to range from a low of 0.027 ug/g (ppm) to a high of 0.26 ug/g in the samples tested. The average mercury content was 0.14 ug/g which is well below the US FDA and Canadian standards (1.0 ug/g and 0.50 ug/g respectively). There was a positive correlation of length and weight of albacore with mercury content. There was no correlation with date of capture. Results indicate that West Coast troll-caught albacore have low levels of mercury in the edible flesh and are well within international safety standards for mercury levels in fish.

Introduction

Albacore tuna (*Thunnus alalunga*) is a migratory fish found in the temperate and tropical oceans of the world. Three to four year-old albacore begin their journey off the coast of Japan and migrate across the Pacific Ocean where they arrive off the coast of California in the spring (Kimura et al 1997). They work their way northward feeding along the West Coast upwelling front. Their offshore range is approximately 20 to more than a hundred nautical miles off the Pacific Coastline. It is this close proximity that allows small-scale troll fishing vessels to harvest albacore during summer months.

The West Coast troll-caught albacore fishery season lasts from June to October each year and the albacore is primarily sold whole, frozen and used as raw material for canned products in foreign and domestic markets. Efforts are currently underway to introduce West Coast albacore into alternative markets as high quality loins and steaks. The albacore industry is a small-scale fishery based out of local West Coast port cities aiding to its marketability as a locally caught seafood product. The stock is sustainable and the fishery contributes to the economic well-being of rural coastal communities (Cox et al. 2002). Albacore has high nutritional value in both its protein content and omega-3 lipid content (Wheeler and Morrissey 2003). Omega-3 fatty acids have recently gained public attention for their numerous health benefits (Nettleton, 1995).

Mercury is a natural element that is found in minute quantities in air, water and all living things. Mercury can find its way into food sources through a number of ways including natural uptake and pollution. Mercury exists in nature in two forms, inorganic mercury and organic methylmercury. Methylmercury binds to tissue was thought to be the most prevalent form found in fish although recent studies indicate that the less toxic methylmercury-cysteine is predominant (Harris et al. 2003). Some fish have more methylmercury than others depending on their aquatic environment and where they stand in the food chain. Fish absorb mercury in their gills from their environment and as they feed on other aquatic organisms. Tuna mercury analysis often lists all tunas together and there is no distinction among the species (albacore, skipjack, bluefin, yellowfin, etc.). The purpose of this study was to undertake a more thorough analysis for mercury in a

West Coast Troll-Caught

Albacore Fishery

- **smaller boats 40-80 ft.**
- **frozen and fresh fish**
- **10,000 to 14,000 mt/yr**
- **5-12 kg average size**
- **higher lipid content (4-16%)**
- **jigboats/targeted fisheries**
- **important for rural coastal communities (North-CA, OR WA)**

Materials and Methods

Sample preparation

Ninety-one albacore tuna from fifteen harvest events were troll caught and tagged for identification during the 2003 season from June to October. This was a subset of a larger lipid testing project undertaking by the Western Fishboat Owners Association. Coordination of the tagging and landing of the albacore was done by Gayle Parker of Ilwaco Fish Company, Inc. Fish were captured in the open Pacific and off the Washington, Oregon, and California coasts. Whole fish were frozen at sea, landed and transferred to the Oregon State University Seafood Laboratory, Astoria, OR, where they were stored at –30C for later analysis. The weight, length and circumference of each albacore tuna were measured right before sample preparation. Albacore steaks including the upper forward loin section were cut in the frozen state using a band-saw, vacuum packed, frozen and stored at -20°C.

Mercury Testing

Steaks were thawed at refrigerated temperatures and a 100 g sample of white muscle was taken from the upper loin section and homogenized in a blender at low speed for 1 minute. Samples aliquots of 25 g were placed into disposable plastic containers and frozen. The samples were transported from the OSU Seafood Laboratory to AM Test Laboratories in Redmond, WA for mercury analysis. Aliquots of 1-2 g of sample digested with 2 ml HNO3, 4 ml H2SO4, 1.5 g KMNO4 (if the puroke color wasn't apparent ~0.5 g additional KMNO4 was added), and 8 ml potassium persulfate. Samples sat 48 hours in reagents and were cooked at 98 degrees C water for 2 hours. After digestion hydroxylamine hydro chloride & stannous chloride were added and run on cold-vapor atomic absorption (CVAA). Digested samples were measured for mercury content on a Perkin Elmer Atomic Absorption instrument using the CVAA EPA (Environmental Protection Agency) method 7471A

Lipid analysis

The lipid analysis was done according to the modified AOAC Official Method 948.15 (Crude Fat in Seafood, Acid Hydrolysis method, 1995).

Moisture content

Moisture contents of samples were determined according to AOAC Official Method 950.46 B (Convection, Gravity method, 1995) by measuring the mass of a sample before and after drying overnight in an oven.

Table 1. Mercury content and other measerments

partial set of data collected (25 of 91 samples)

Sample	Lipid%	Moisture%	Wt (kg)	Length (cm)	Circ (cm)	Hg (ppm)
1	14.1	61.4	5.4	67.3	47.0	0.09
2	5.5	68.3	5.0	66.0	45.7	0.03
3	1.3	72.4	7.6	77.5	50.8	0.15
4	6.4	67.2	5.5	68.6	47.0	0.12
5	7.3	64.6	5.6	66.0	45.7	0.03
6	6.1	65.4	6.3	68.6	49.5	0.12
7	8.2	64.8	6.1	67.3	48.3	0.07
8	3.5	68.6	6.7	71.1	49.5	0.08
9	16.2	60.2	5.8	67.3	48.3	0.12
10	7.3	62.2	5.9	71.1	48.3	0.12
11	11.2	62.1	6.2	71.1	49.5	0.16
12	9.9	61.9	5.8	68.6	48.3	0.14
13	6.2	64.7	6.8	72.4	50.8	0.20
14	8.9	64.1	6.6	71.1	50.8	0.14
15	6.3	66.4	6.4	71.1	49.5	0.08
16	6.9	63.9	4.2	64.8	43.2	0.15
17	9.2	61.3	6.7	72.4	50.8	0.17
18	12.2	60.9	5.5	66.0	48.3	0.14
19	5.2	66.2	10.6	83.8	58.4	0.26
20	9.7	64.4	5.7	66.0	47.0	0.18
21	11.2	62.7	4.2	58.4	43.2	0.16
22	11.1	63.5	4.1	58.4	43.2	0.13
23	3.9	67.6	3.1	50.8	38.1	0.11
24	8.5	65.3	4.9	64.8	44.5	0.14
25	2.0	71.1	5.3	66.0	47.0	0.15

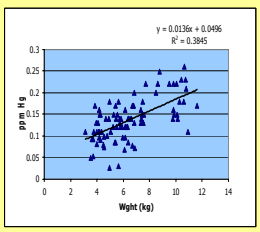

Figure 1. Weight and Hg content correlation

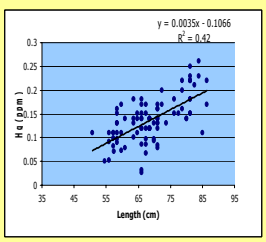

Figure 2. Length and Hg content correlation

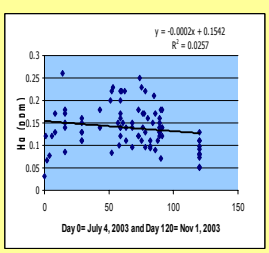

Figure 3. Season and Hg content correlation

Results

Table 1 represents a partial list of the 91 fish analyzed for mercury content as well as other inherent characteristics. As one can see there is a wide range of weight, length and lipid content in the analyzed fish. Previous studies have indicated a strong correlation between lipid and moisture in albacore tuna. Fig.1 shows the correlation between weight and mercury content. There is a general trend showing that larger fish tend to have higher mercury content but the correlation is only moderate (R^2=0.38) and more research needs to be undertaken. There was also a moderate positive correlation between length of albacore and mercury content (R^2=0.42) as shown in Fig 3. We also looked at correlations between time of year captured (seasonality) and mercury and found no correlation.

Discussion

Test results showed mercury levels in West Coast albacore tuna well below mandated regulatory levels for US FDA at 1.0 ppm and Canadian Health Agency regulations at 0.5 ppm. The average mercury content for the albacore was 0.14 ppm. There is a size - Hg content relationship although the correlation is moderate at R^2 = 0.38. In general the trend shows that the larger fish have more Hg content although there is a wide range of values. There was little correlation between mercury content and the time of year they were captured. The West Coast albacore troll fishery is an important fishery for the Pacific Northwest including northern California. Fish are landed in several ports from Eureka, CA to Westport, WA. Boats range in size from 40 - 80 ft and several are family business operated by husband-wife teams. The fish are 3-4 years in age and range from 4-12 kg in size. A recent report showed that the West Coast albacore tend to be higher in lipid content (4-16%) with high levels of omega-3 fatty acids (Wheeler and Morrissey 2003). In the past the majority of the capture were transhipped to large canning operations that produce high quality albacore pack. Recently the West Coast albacore industry has been developing alternative markets and a significant portion of the catch is sent to Europe for small canning operations as well as micro-canners throughout the Pacific Northwest. Mercury is a concern for the industry maintaining a viable albacore fisheries for the Pacific Northwest and developing new markets. This study shows that troll-caught albacore has low mercury levels. Combined with its high level of omega-3 fatty acids, West Coast albacore remains a healthy food choice for the majority of consumers.

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