Health Risk Assessment: Total Mercury in Canned Tuna and in Yellowfin and Frigate Tuna Caught from Leyte Gulf and Philippine Sea

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ABSTRACT

The total mercury (tHg) concentrations in commercially available canned tuna and in yellowfin tuna (*Thunnus albacores*) and frigate tuna (*Auxis thazard*) caught from the waters of Eastern Visayas, Philippines were determined by Inductively Coupled Plasma Optical Emission Spectrometry. The average total mercury concentrations measured from nine frigate tuna, three yellowfin tuna, and four canned tuna were 0.024 ug/g, 0.002 ug/g, and 0.07 ug/g, respectively. Values of estimated daily intake for locally caught tuna for different age groups and sex were calculated. Calculated daily dose for all locally caught tuna in the study were well below the allowed concentration of mercury in fish consumed per day regardless of age and sex, and thus may not pose a health risk to consumers. The same calculations were done for canned tuna with results further explained in the paper.

Keywords: Canned tuna, mercury, *Auxisthazard, Thunnus albacores*

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INTRODUCTION

Over the last few decades, there has been increasing concern about the quality of the food we eat. Heavy metals, such as cadmium, mercury, tin, and arsenic, are among the toxic substances that enter the marine environment, and eventually the human body (Emami Khansari et al. 2005). The most common form of mercury in fish, methylmercury (MeHg), is a potent neurotoxin that is highly dangerous to fetal development (Costa 1988). Methylmercury enters the human body via the gastrointestinal (GI) tract. While the GI tract is the primary route of absorption, methylmercury can be absorbed through the skin and the lungs as well (Rothstein and Hayes 1960). Once absorbed, it goes into the various parts of our body by binding with hemoglobin (Kerper et al. 1992). It eventually enters the brain, where it is demethylated to form the inorganic elemental mercury. Considering the pervasive consumption of tuna in the Philippines, this study was conducted to determine the levels of total mercury in locally caught tuna in Eastern Visayas and in commercially canned tuna.

MATERIALS AND METHODS

Samples of tuna were fished by hook-and-line from three stations in Leyte Gulf (Stations 1-3, Figure 1) and three stations in the Philippine Sea (Stations 4-6, Figure 1). Station 1 was located between the towns of Palo, Tanauan, and Tolosa (N 11°05'02.3" E 125°08'01.3"). Station 2 was located past the municipal waters of Dulag, Leyte (N 10°56'42.6" E 125°08'42.2"), while Station 3 was around the vicinity of MacArthur, Leyte (N 10°47'59.2" E 125°06'30.7"). Station 4 was located 30 km from the shoreline of Guiuan, Eastern Samar (N 10°59'47" E 126°0'19"). Station 5 was located in Hernani, Eastern Samar (N 11°21'21" E 126°5'51"). Lastly, Station 6 was located in Borongan City, Eastern Samar (N 11°37'33" E 125°43'39.5"). Only a few tuna individuals were caught due to weather disturbances and financial constraints. Tuna samples were caught between 25 December 2017 and 22 February 2018. Two brands of canned tuna that are commercially and widely available in Tacloban City were selected. Two cans were tested for Hg per brand. A modified set of criteria by Maqbool et al. (2016) was used to select samples for analysis.

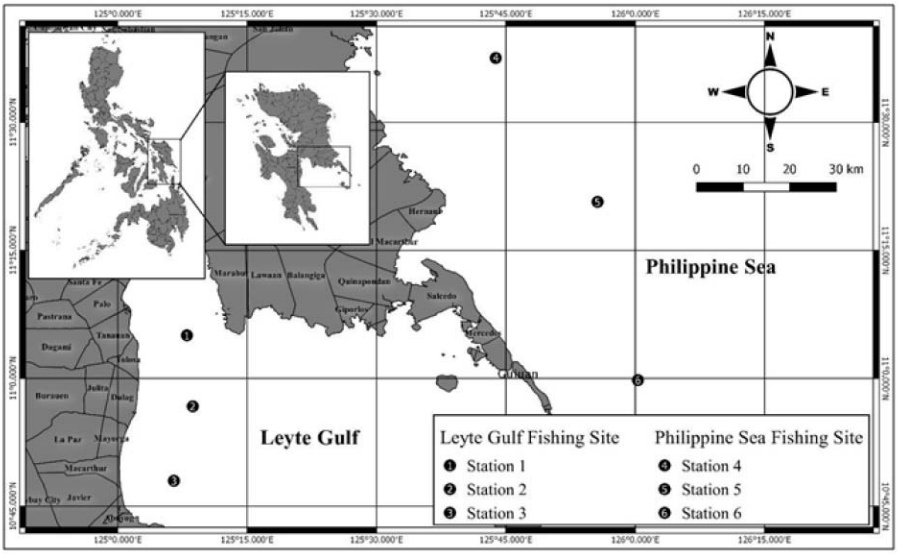

Figure 1. Locations of the six fishing sites in Eastern Visayas

Samples were prepared following the AOAC Standard method 2013.06 (AOAC 2016). These were then digested in closed vessels of 50 mL with 65% nitric acid and analyzed using an Inductively Coupled Plasma Optical Emission Spectrometer. We then compared the concentration measured in the tuna samples to the maximum allowable limits of mercury (tHg) in fish. Estimates of the daily intake of the tuna samples that is safe for human consumption for Filipinos were also calculated.

RESULTS AND DISCUSSION

In this study, all canned and fresh samples of tuna were found to contain traces of mercury. Frigate and yellowfin tuna samples were shown to have an average concentration of 0.024 and 0.002 ug/g mercury, respectively (Table 1). On the other hand, canned tuna samples of both brands had an average concentration of 0.07 ug/g. It was also noted that the mercury concentration in locally caught tuna was lower than the concentration in canned tuna.

Table 1. Total Hg concentrations in locally caught tuna (in wet weight) from Leyte Gulf and the Philippine Sea

Species and Area	No. of Specimens	Wet Weight (kg)	Fork Length (m)	Mercury (ug/g) Range	Mean
Yellowfin Tuna (*Thunnus albacores*):					
Philippine Sea:					
Guiuan, Eastern Samar	1	3	1	0.003	0.003
Philippine Sea:					
Borongan, Eastern Samar	2	1.25-2	0.5-0.75	0.002-0.01	0.006
Frigate Tuna (*Auxis thazard*):					
Leyte Gulf:					
Palo Leyte	2	0.062-0.067	0.021-0.03	0.031-0.034	0.0325
Leyte Gulf:					
Dulag, Leyte	2	0.070-0.080	0.027-0.032	0.026-0.031	0.0285
Leyte Gulf:					
Tanauan, Leyte	2	0.068-0.073	0.028-0.033	0.029-0.031	0.03
Philippine Sea:					
Hernani, Eastern Samar	2	0.078-0.081	0.029-0.04	0.026-0.027	0.0265
Philippine Sea:					
Guiuan, Eastern Samar	1	1	1	0.01	0.01

The allowed concentration of mercury in fish is calculated from the daily reference dose (Rf_D) and the daily consumption of fish.The Rf_D for mercury is the daily dose that is considered safe or the dose that does not entail an appreciable risk of adverse effects of mercury (IRIS 2001). The USEPA calculated an RfD of 0.1 ug/kg bodyweight per day for mercury based on the risk to an adult woman, the population sector most vulnerable to the adverse effects of mercury **(**IRIS 2001**)**.

The per capita fish consumption of the Filipino adult as reported by FAO (2016) was 81.09 g per day in 2016. However, the published average weight is 61.3 kg for adult males, 54.3 kg for adult females (FNRI 2013), 29.1 kg for male children and 28.0 kg for female children (Florentino et al. 1987). The health risk assessment was done on adult females and children as they are more at risk from mercury intoxication.

Based on the 2016 data for fish consumption and average weights,a daily dose of 0.0388 to 0.0015 ug/kg bodyweight per day for adult women, 0.0725 to 0.0028 ug/kg bodyweight per day for male children, and 0.0753 to 0.0029 ug/ kg bodyweight per day for female children was estimated for locally caught tuna with the maximum mercury contamination of 0.024 to 0.002 ug/g. Whereas for canned tuna, with the maximum mercury contamination of 0.07 ug/g, the estimated daily dose for adult women is at 0.1 ug/kg bodyweight per day, and 0.20 ug/kg bodyweight per day for male and female children.

The calculated daily dose or the estimated daily exposure due to the consumption of locally caught tuna is less than the (reference dose) Rf_D of 0.1 ug/kg bodyweight per day as set by the WHO and, therefore, does not entail any risk. The risk assessment for canned tuna indicates otherwise. Both the organic and inorganics states of Hg are considered threats to public health due to high toxicity when absorbed by organisms. The risk of toxicity is determined by the concentration of Hg in the edible tissues and the amount of tuna consumed (Araújo & Cedeño-Macias 2016). It greatly affects vulnerable segments of the population, such as pregnant women and children. Chronic exposure to Hg by ingestion of contaminated food—in this case, the canned tuna—can cause neurological and psychological problems commonly associated with Minamata disease. Other effects include nephrotoxicity, pulmonary and gastrointestinal damage, genetic damage, cardiovascular diseases, diabetes, abnormalities in fetal development, and cancer (Araújo & Cedeño-Macias 2016). With the calculated high EDI for adult women and male and female children, it is suggested that they consume less than total daily fish consumption of 81.09 g per day (FAO 2016).

In brief, adult Filipino men and women may consume more than the daily fish consumption of 81.09 grams without the risk of mercury poisoning for locally caught tuna. Whereas, for the canned tuna, it has exceeded the reference dose set by the WHO, except in the adult male group, and thus pose a significant neurological threat to vulnerable sectors of society, such as pregnant women and children.

The presence of elevated mercury in food increases probable health risks and may have profound impacts on the body. Consuming food high in mercury as described does not mean that life is in immediate peril.Transitory excursion beyond the estimated daily intake limit would have no health risk if the mean consumption over an extended period is not surpassed, as the emphasis of EDI is lifetime exposure. Nevertheless, since only the total mercury content was analyzed for tuna, both locally caught and canned, supplementary research is essential to evaluate the specific methylmercury level and to establish the health threat of this seafood.

AKNOWLEDGEMENTS

This study is funded through the Small Budget In – House Research Grant (SBIRG) of the UP Visayas Office of the Vice Chancellor for Research and Extension (OVCRE). The authors wish to acknowledge their friends and family for happiness in times of distress, for food in times of hunger, for sharing the pain of sleepless nights in the laboratories, and for their unconditional love and untiring support in every aspect of this research.The authors also thank Mr. Eugene Abria for his help in analyzing the results; Mr. Zosimo Yakit and his son for accompanying the researchers during the sampling of locally caught tuna in the Philippine Sea sites; and the family of Mrs. Erlinda Martija for the sampling of locally caught tuna in the Leyte Gulf sites.

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