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Preliminary Study on the Risk of Mercury Exposure to the People Consuming Fish from Camarines Norte, Philippines

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Abstract

The risk of mercury exposure through consumption of fish from Camarines Norte, Philippines was investigated. A total of 34 people were surveyed to know their fish consumption levels. In the study areas, Bugitis, Hipon, Galunggong, Matangbaka, Dilis, Danggit, Pak-an, Bagongon, Alimango, Dalag and Palos are common staples in the residents'diet. Exposure to mercury was calculated on the basis of weekly consumption vis-a-vis body weight. The result for the worst scenario indicated that attention should be paid to several species. Possible safe consumption levels of these fishes were also calculated for the inclusive health management of the local government unit.

Keyword: Artisanal/small-scale gold mining, ASGM, Exposure, Fish, Mercury, Risk, PTWI

Introduction

Mercury contamination arising from the artisanal and small-scale gold mining (ASGM) is one of the important agenda for the Minamata Convention on Mercury. However, the reality of the pollution has not been described in detail, and local communities only have a rare opportunity to learn the situation. Not many reports present the exposure pathways of mercury, particularly the people's diet, habit, and the relation between residential areas and mining sites. This prevents them from knowing potential countermeasures to protect their health.

Exposure to toxic metals such as mercury is one of the universal health problems associated with the consumption of aquatic resources (mainly fish) since the onset of modern civilization (e.g., Nakagawa et al., 1997; Clarkson et al., 2003; Zananski et al., 2011). Data from the Bureau of Fisheries and Aquatic Resources (BFAR) noted that fish and fish products accounted for 11.7% of the total daily food intake of an average Filipino, which is equivalent to 104 g/day or 38 kg/year (BFAR, 2014). Thus in this paper the authors intend to show possible exposure to mercury of fish eaters who live in the vicinity of the ASGM sites.

Fish Consumption in the Study Area

In Camarines Norte, both river and ocean fishes serve as important sources of protein and other nutrients for the local population. Common river fishes are Dalag and Palos. A shellfish locally called Bagongon is caught from local creeks and eaten by some people. Popular ocean fishes are Bugitis, Hipon (shrimp), Galunggong (Mackerel scad), Matangbaka (Big-eyed scad), Dilis, Danggit, Pak-an (Torpedo scad) and Alimango (mud crab). River fishes are accessible to mountainous areas such as the Municipality of Labo while ocean fishes are eaten more in the coastal region.

In December 2015, eleven fish and shellfish samples were collected from three barangays (Filipino administrative unit similar to village) in the Municipality of Jose Panganiban, and one barangay in the municipality of Labo in Camarines Norte. These samples were collected from tributaries possibly contaminated with mine wastes from ASGM operations in the areas. The samples were carefully packed in a shipping cooler and sent to a laboratory in Manila within a day.

The fish consumption habits of the local residents were obtained using questionnaires (Annex), mainly to get data on weekly fish intakes. A face-to-face questionnaire survey was conducted in local language so as to obtain data on fish diet consumption. The interviewer stayed in the study area for three days in 2017 so as to administer the questionnaires. Before the actual interview, the questionnaires were pre-tested to know if the general public understood the questions properly. This has increased the validity of the questionnaires which enabled the researchers to get the information without being deviated.

Mercury Concentration in Fishes

Total mercury concentration for the obtained fishes were determined by the Philippine Institute of Pure and Applied Chemistry (PIPAC) in Manila on commercial basis. The specimens were digested by acid and the resultant solution was set to the Cold Vapor Atomic Absorption Spectrometry (CVAAS). Shells of Bagongon, Bugitis and Alimango were removed before the analysis.

Hipon, Matangbaka, Danggit, Dilis and Galungong were found to have mercury concentrations below the detection limit of 0.02ppm. The other samples showed higher levels of mercury than

Table 1 Mercury concentration of common fishes in Camarines Norte. The result is indicated on wet weight basis except for No. 5 and 6.

No.	Common Name	Place	Date	Hg content*[a], mg/kg
1	"Bugitis", fresh	North Poblacion street vendor Caught from Mambulao bay	12 December 2015	0.23
2	"Hipon" (shrimp), fresh	?	12 December 2015	<0.02
3	"Galunggong" (Mackerel scad), fresh	Jose Panganiban public market Caught from Mambulao bay	12 December 2015	Meat: <0.02 Innards: 0.02
4	"Matangbaka" (Big-eyed scad), fresh	Jose Panganiban public market Caught from Mambulao bay	12 December 2015	Meat: <0.02 Innards: <0.02
5	"Dilis", dry	Larap market Caught from Larap bay	12 December 2015	<0.02
6	"Danggit", dry	Larap market, Caught from Larap bay	12 December 2015	<0.02
7	"Pak-an" (Torpedo scad), fresh	Larap market Caught from Larap bay	12 December 2015	Meat: 0.21 Innards: 0.16
8	"Tabagwang", fresh	Sta. Elena creek	12 December 2015	0.04
9	"Alimango" (crab)	Sta. Elena riverside	12 December 2015	0.05
10	"Dalag" (mudfish), fresh	Brgy. Dalas, Labo, Camarines Norte Caught at the river	13 December 2015	Meat: 0.10 Innards: 0.07
11	"Palos" (eel), fresh	Brgy. Dalas, Labo, Camarines Norte Caught at the river	13 December 2015	Meat: 0.21 Innards: 0.08

*: Analysis by the Philippine Institute for Pure and Applied Chemistry (PIPAC)

[a]: Through cold vapor- atomic absorption spectrometry (CVAAS)

Table 2 Weekly intake of mercury and safe level of consumption for each fish.

No.	Local name	Maximum consumption (kg/week)	Minimum body weight above 20 years old (kg) for each fish	Weekly intake per body weight (μg/kg)	Safe level of consumption (kg/week)
1	"Bugitis"	0.5	40	2.9	0.86
7	"Pak-an"	0.75	35	4.5	0.83
9	"Alimango"	1	30	1.7	3
10	"Dalag"	1.5	38	3.9	1.9
11	"Palos"	0.5	38	2.8	0.9

detection limit (Table 1).

As shown in the formula below, people's exposure to total mercury due to fish consumption can be estimated by taking their dietary habits and the total mercury levels in the fish consumed into account. The authors estimated the total mercury exposure based on the data in Table 1, on the basis of weekly consumption vis-à-vis the body weight. A worst scenario, i.e. maximum consumption by the smallest adult above 20 years old for each fish, was employed in the estimation.

$$\frac{\text{amount of fish ingested per week } (\frac{\text{kg}}{\text{week}}) \times \text{mercury concentrations in the fish ingested } (\frac{\mu\text{g}}{\text{kg}})}{\text{kg body weight}}$$

The result for each fish and shellfish sample was compared to the Provisional Tolerable Weekly Intake (PTWI) set by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The PTWI is the amount of a substance that can be consumed weekly over an entire lifetime without appreciable risk to health, and is an end-point used for food contaminants. If the PTWI is exceeded, risk management interventions can be considered.

Result and Conclusion

JECFA, which evaluates chemical contaminants in the food supply, has established PTWIs for total mercury at 5 μg/kg body weight (UNEP DTIE Chemicals Branch and WHO Department of Food Safety, Zoonoses and Foodborne Diseases, 2008).

The investigation revealed that Hg intake per kg body weight depends on the species of fish being consumed: Pak-an shows a value 4.5μg/kg which is close to the PTWI. Dalag also has a closer value than the other species in this study. Although

all of the results are still in the safe range, attention should be paid to the amount of consumption. The authors calculated the possible safe volume of each fish as a test (Table 2).

A previous study proved that Hg is bound to proteins such as muscle, which is the main edible part of fishes, and its levels cannot be reduced or removed by cooking (Burger et al., 2003). The municipalities in this region could conduct regular fish monitoring and downstream the result to the local communities for the inclusive health management. Since the fishes used in this study were caught in December, another result may be obtained for another season. For the monitoring, attention should be paid to seasonal change.

Cultural dimension may be another factor influencing the people. It is known that sometimes people are compelled to choose chemical risk rather than giving up the consumption of contaminated fish due to their cultural and religious beliefs (Harper et al., 2008). Multi-disciplinary approach should be taken as well as fish monitoring when the municipalities formulate countermeasure programs.

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Annex

Questionnaire used in this study (example for Bugitis)

ASSESSMENT OF DIETARY MERCURY CONSUMPTION IN CAMARINES NORTE, PHILIPPINES

Respondent No.

Age

Sex

Occupation

Barangay

Municipality

A Household Information

1 How many people currently reside in your household?

2 Please enumerate their sex, age, body weight.

3 Do you regularly eat meals together?

4 What is your total household income per month?

B Fish Consumption

1 Where do you regularly buy fish/ shellfish for your consumption?

2 How often do you buy fish/ shellfish in a weekly basis?

3 Where do you buy Bugitis?

4 How often do you buy Bugitis?

5 How much *bugitis* do you usually buy?

6 Whole, gutted, fillet, dried?

7 What other fish/ shellfish do you usually buy?

8 How much of each do you buy?

9 How do you cook/ prepare each *bugitis* for consumption?

10 Do you eat the guts?

11 What are the factors that affect your purchase of fish/shellfish?

Freshness and quality

Affordability

Health

Taste

12 Remarks