Indonesia

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1. Introduction

Indonesia is an archipelago and comprises a total of 17,500 islands. Indonesia has a coastline length of about 81,000km and is located on the crossroads between two oceans, the Indian and the Pacific. Indonesia is also a bridge between two continents, Asia and Australia. The total production of Indonesian fish and fish products over the period from 2000 to 2005 has increased steadily from 4,875,649 tonnes (2000) to 5,452,651 tonnes (2005), by volume, with an average increase of 3.51% annually.

Indonesia was involved in the Japanese Trust Fund II Project to participate in the regional survey on chemical contaminants such as heavy metals (Mercury, Cadmium and Lead) in fish and fish products.

Under the Indonesia Food Law No. 7/1996 and Fisheries Law No. 31/204 as well as Government Regulation No. 28/2004 pertaining to Food Quality, Safety and Nutrition; it was clearly stipulated that all food products including fish and fish products put in the market place intended for human consumption shall comply with the prevailing laws and regulations, to ensure that the products are safe and shall not pose any threats to human health.

With the above laws and regulations, it is imperative to formulate the Ministry of Marine Affairs and Fisheries Decree, and clearly define the important requirements to guarantee quality and safety of fish products derived from fishing, collecting vessel, landing sites, auction centers, processing unit and distribution facilities. Three latest Indonesian Regulations and Decrees of Ministry of Marine Affairs and Fisheries are effectively implemented from 1st August 2007. These Regulations and Decrees focused on (1) The Control of Quality Assurance and Food Safety System of Fisheries Products; (2) Monitoring of Drug Residues, Chemicals, Biological Substances and Contaminants in Aquaculture; and (3) Requirements for Quality Assurance and Safety of Fishery Products During Production, Processing and Distribution. In addition, one guideline on the Inspection and Monitoring Program for Fisheries Products is described in the Decree of Director General of Fisheries Products Processing and Marketing.

These Regulations and Decrees are parallel with the activities under the Japanese Trust Fund II Project such as regional surveys on chemical contaminants. These activities are useful and valuable to implement in Indonesia in order to support our national residues monitoring program to produce good and safe Indonesian fish products.

In order to ensure that Indonesian fish and fish products are free of chemical contaminants such as Mercury (Hg), Cadmium (Cd) and Lead (Pb), it is mandatory to survey and monitor the fish and fish product. If chemical contaminants of heavy metal obtained higher than the maximum residue limit (MRL) or minimum required performance limit (MRPL), the corrective actions would be taken according to the procedure stipulated in the regulation.

2. Objectives and Goals

Through participation of the research and analysis of Hg, Cd and Pb in fish and fish products in Indonesia, we expect to be able to:

- Obtain an understanding on the level of heavy metals contamination in fish and fish products in Indonesia;
- Set up and implement the monitoring program on heavy metals contamination in fish and fish products;
- Strengthen the fish inspection and quality control system, including the improvement of laboratory personal skill in conducting fish inspection and quality analysis;
- Improve and facilitate the analysis of chemical contamination in fish and fish products in Provincial Laboratories for Fish Inspection and Quality Control; and

- Supply fish and fish products that comply with international market standard and food safety requirements.

3. Survey Methodologies

a. Sampling Method, Location, Species, Number of Samples and Sampling Size

Sampling method was conducted according to the National Sampling Plan and the monitoring program of each Provincial Laboratory for Fish Inspection and Quality Control (PL-FIQC). During 2005 to 2008, sampling of raw material for heavy metal analysis was carried out in 6 provinces which are representatives for producing fish and fish products, namely:

(1) Jakarta
(2) East Java
(3) South Sulawesi
(4) North Sulawesi
(5) Bali, and
(6) Maluku

All the raw material collected as samples were marine fish products especially *Scombridae* and deep sea fish species such as tuna, skipjack tuna, swordfish, marlin, red snapper, grouper, etc. In most cases, raw materials were taken from the fish landing places and some fish processing plants. After the sample collection, fish and fish products were frozen at -18ºC prior laboratory analysis.

Frozen fish collected from some processing plants were usually analyzed directly for heavy metals such as Hg, Pb and Cd. The period of sampling was monthly and quarterly in 2005 and 2006 and every two months in 2007 and 2008.

b. Method of Analysis

The Atomic Absorption Spectrometry (AAS) method was used for analyzing heavy metals.

c. Limit of Detection and Limit of Quantification

Latest methods validation results for heavy metals conducted by National Center for Fish Inspection and Quality Control (NCQC) are: Hg (LOD = 0.05 ppm), Pb (LOD = 0.04 ppm) and Cd (LOD = 0.07 ppm).

d. National Regulatory Limits

Indonesia latest National Standard Limits (2007) of Heavy Metal are as:

- Hg = 1.0 ppm for predator fish such as tuna, swordfish marlin, bivalve mollusk and crustacean. For other fish and fish products, the limit was stipulated as 0.5 ppm.
- Pb = 0.4 ppm for predator fish such as tuna, swordfish marlin; 1.5 ppm for bivalve mollusk; 0.5 ppm for crustacean. For other fish and fish products, the limit was stipulated as 0.3 ppm.
- Cd = 0.5 ppm for predator fish such as tuna, swordfish marlin; 1.0 ppm for bivalve mollusk and crustacean. For other fish and fish products, the limit was stipulated as 0.1 ppm.

4. Results and Discussion

a. Participation of Inter-laboratory Proficiency Testing and Results

Inter-laboratory proficiency testing are usually conducted routinely by the NCQC to all the Provincial Laboratory for Fish Inspection and Quality Control (PL-FIQC) in Indonesia. The focus for proficiency testing is usually microbiology (*E-coli, Salmonella* etc.) and chemical testing such as heavy metals.

NCQC also participated in the international proficiency testing program for heavy metals (Hg, Cd and Pb) conducted by Asia Pacific Laboratory Accreditation Cooperation (APLAC) in 2003.

b. Survey Results and Discussion

The older version of Indonesia National Standard was used for Year 2005 and 2006. The maximum limits for all fish and fish products for Hg, Pb and Cd are 0.5, 0.3 and 2.0 ppm respectively.

Survey of heavy metals (Hg, Cd and Pb) during the year of 2005 was focused on 5 locations namely Jakarta, East Java (Surabaya), Bali, South Sulawesi (Makassar) and North Sulawesi (Bitung) on the following fish species were surveyed, tuna, marlin, swordfish, skipjack, grouper, red snapper and canned tuna. The total samples taken were 104 samples.

Survey of Mercury (Hg) was conducted monthly from April to September 2005 and it was found that from 96 samples, 6 samples analyzed such as swordfish, marlin and tuna had Mercury (Hg) higher than standard (Indonesia National Standard), that is 0.5 ppm, and the results were between 0.52 and 0.6 ppm. None of the 96 samples analyzed for Cadmium (Cd) was higher than CAC and EU standards (0.5 ppm) and Indonesia National Standard (2.0 ppm) for tuna, frigate mackerel, grouper, skipjack tuna, swordfish and canned tuna. Lead (Pb) were found in 8 samples with values between 0.32 to 0.42 ppm, they were higher than the Indonesia National Standard of 0.3 ppm.

In 2006, the survey of the heavy metals was conducted quarterly in March, June and September. From the 49 samples analyzed, no sample was found to be higher than the maximum limit stipulated in the Indonesia National Standard and the CAC and EU standards for Hg and Cd. For lead (Pb), 4 samples were found higher than Indonesia National Standard of 0.3ppm.

In 2007, Indonesia continued to participate in the survey on heavy metals and focused on 45 samples in 5 locations namely Jakarta, Bali, South Sulawesi, North Sulawesi and Maluku Provinces for the fish species such as tuna, marlin, swordfish, skipjack tuna, grouper, red snapper, canned tuna, etc. These locations have been chosen as they produce mostly scombroid fish. The sampling was conducted on April, June and August 2007. For Mercury (Hg), none of the 46 samples collected was higher than the Indonesia National Standard of 1.0 ppm. For Cadmium (Cd) and Lead (Pb), no sample was found to be higher than the Indonesia National Standard, CAC and EU standards. Comparing with the survey results of heavy metals in 2005 and 2006, the violation in 2007 has decreased.

In 2008, the survey focused on 4 locations namely Jakarta, Bali, South Sulawesi (Makassar) and North Sulawesi (Bitung). The sampling time was only two times on February and April 2008. The results of all sample analysed showed that the heavy metals (Hg, Cd and Pb) were lower than the national and international standards.

Table 1. Data Monitoring Of Heavy Metals Conducted in Jakarta, East Java, Bali, South Sulawesi and North Sulawesi in 2005.

No.	Location	Time of Sampling	Species / Products	Heavy Metals (ppm)		
				Mercury (Hg)	Cadmium (Cd)	Lead (Pb)
1.	Jakarta	April 2005	1. Tuna	0.13	0.01	0.23
			2. Canned tuna	0.27	0.02	0.22
			3. Red snapper	0.08	0.04	0.09
		May 2005	1. Tuna	0.24	0.03	0.18
			2. Skipjack tuna	0.21	0.02	0.35
			3. Red snapper	0.18	0.02	0.16
			4. Grouper	0.17	ND	0.35
		June 2005	1. Tuna	0.42	0.02	0.32
			2. Red snapper	0.16	0.03	0.21
			3. Frigate mackerel	0.20	0.02	0.14
		July 2005	1. Tuna	0.54	0.01	0.18
			2. Red snapper	0.10	0.02	0.14
			3. Frigate mackerel	0.20	0.01	0.12
		August 2005	1. Canned tuna	0.32	0.02	0.16
			2. Skipjack tuna	0.28	0.02	0.20
			3. Grouper	0.14	0.01	0.02
			4. Red snapper	0.12	0.01	0.14
		Sep. 2005	1. Sword fish	0.60	0.02	0.22
			2. Marlin	0.52	0.03	0.30
			3. Baby tuna	0.41	0.02	0.18
2.	East Java	April 2005	1. Tuna	0.35	ND	0.42
			2. Canned tuna	0.05	ND	0.21
			3. Red snapper	0.12	ND	0.10
		May 2005	1. Tuna	0.40	0.04	0.24
			2. Skipjack tuna	0.24	0.02	0.25
			3. Red snapper	0.12	ND	0.10
			4. Grouper	0.12	ND	0.03
		June 2005	1. Tuna	0.38	0.18	0.20
			2. Red snapper	0.12	0.01	0.12
			3. Frigate mackerel	0.08	0.18	0.40
		July 2005	1. Tuna	0.38	0.02	0.18
			2. Red snapper	0.12	0.02	0.14
			3. Frigate mackerel	0.08	0.21	0.26
		August 2005	1. Canned tuna	0.10	0.02	0.24
			2. Skipjack tuna	0.20	0.03	0.22
			3. Grouper	0.08	0.02	0.02
			4. Red snapper	0.12	0.02	0.20
		Sep. 2005	1. Sword fish	0.48	0.03	0.36
			2. Marlin	0.44	0.02	0.28
			3. Baby tuna	0.22	ND	0.10

3.	Bali	April 2005	1. Tuna	0.35	0.01	0.07
			2. Canned tuna	0.48	0.07	0.02
			3. Red snapper	ND	0.01	0.06
		May 2005	1. Tuna	0.38	0.02	0.08
			2. Skipjack tuna	0.24	0.02	0.10
			3. Red snapper	ND	0.08	0.04
			4. Grouper	0.06	0.11	0.05
		June 2005	1. Tuna	0.21	0.01	0.10
			2. Red snapper	0.08	0.01	0.08
			3. Frigate mackerel	0.07	0.24	0.38
		July 2005	1. Tuna	0.24	0.03	0.10
			2. Red snapper	0.14	ND	0.08
			3. Frigate mackerel	0.10	0.01	0.38
		August 2005	1. Canned tuna	0.42	0.12	0.03
			2. Skipjack tuna	0.22	0.02	0.14
			3. Grouper	0.08	0.06	0.02
			4. Red snapper	ND	ND	0.04
4.	South Sulawesi	April 2005	1. Tuna	0.22	0.04	0.03
			2. Canned tuna	0.12	0.02	0.08
			3. Red snapper	0.28	0.02	0.12
		May 2005	1. Tuna	0.42	0.03	0.14
			2. Skipjack tuna	0.15	0.10	0.05
			3. Red snapper	0.14	0.04	0.08
			4. Grouper	0.29	0.02	0.06
		June 2005	1. Tuna	0.52	0.08	0.04
			2. Red snapper	0.12	0.06	0.02
			3. Frigate mackerel	0.05	0.03	0.08
		July 2005	1. Tuna	0.52	0.02	0.10
			2. Red snapper	0.31	0.06	0.06
			3. Frigate mackerel	0.04	0.02	0.06
		August 2005	1. Canned tuna	0.48	0.10	0.02
			2. Skipjack tuna	0.18	0.04	0.01
			3. Grouper	0.19	ND	ND
			4. Red snapper	0.08	0.06	0.04
		Sep. 2005	1. Sword fish	0.58	0.14	0.08
			2. Marlin	0.44	0.08	0.06

5.	North Sulawesi	April 2005	1. Tuna	0.13	0.04	0.12
			2. Canned tuna	0.08	0.02	0.08
			3. Red snapper	0.09	0.01	0.12
		May 2005	1. Tuna	0.16	0.02	0.08
			2. Skipjack tuna	0.08	0.02	0.06
			3. Red snapper	0.14	0.04	0.09
			4. Grouper	0.22	0.07	0.12
		June 2005	1. Tuna	0.28	0.02	0.12
			2. Red snapper	0.08	0.04	0.08
			3. Frigate mackerel	0.20	0.01	0.12
		July 2005	1. Tuna	0.46	0.04	0.08
			2. Red snapper	0.13	0.01	0.04
			3. Frigate mackerel	0.24	0.02	0.14
		August 2005	1. Canned tuna	0.18	0.02	0.01
			2. Skipjack tuna	0.10	0.04	0.10
			3. Grouper	0.20	0.05	0.08
			4. Red snapper	0.18	0.02	0.06
		Sep. 2005	1. Sword fish	0.48	0.02	0.04
			2. Marlin	0.32	0.04	0.08
			3. Baby tuna	0.20	0.08	0.02

Table 2. Data Monitoring Of Heavy Metals Conducted in Jakarta, East Java, Bali, South Sulawesi and North Sulawesi in 2006.

No.	Location	Time of Sampling	Species / Products	Heavy Metals (ppm)		
				Mercury (Hg)	Cadmium (Cd)	Lead (Pb)
1.	Jakarta	March 2006	1. Tuna	0.42	0.02	0.12
			2. Swordfish	0.48	0.04	0.10
			3. Red snapper	0.04	0.02	ND
			4. Frigate mackerel	0.14	0.03	0.10
		June 2006	1. Marlin	0.36	0.28	0.08
			2. Tuna	0.14	0.04	0.02
			3. Red snapper	0.02	ND	ND
		Sep. 2006	1. Swordfish	0.30	0.14	0.20
			2. Red snapper	0.06	ND	ND
			3. Grouper	0.08	0.04	0.06
2.	East- Java	March 2006	1. Tuna	0.28	ND	0.02
			2. Red snapper	0.12	0.10	ND
			3. Barred Spanish	ND	0.06	ND
			4. Grouper	0.12	0.03	ND
		June 2006	1. Tuna	0.22	ND	0.02
			2. Grouper	0.10	ND	0.01
			3. Marlin	0.48	0.04	0.14
		Sep. 2006	1. Tuna	0.08	0.06	0.02
			2. Canned Tuna	0.04	ND	0.01
			3. Swordfish	0.36	0.10	0.28

3.	Bali	March 2006	1. Swordfish	0.10	0.02	ND
			2. Marlin	0.21	0.05	0.09
			3. Yellowfin Tuna	0.06	0.05	0.06
			4. Striped Marlin	0.18	0.07	0.12
		June 2006	1. Butterfish	0.02	0.02	0.10
			2. Marlin	0.12	0.03	0.18
			3. Bluefin Tuna	0.04	0.03	0.35
		Sep. 2006	1. Striped Marlin	0.02	0.02	0.50
			2. Black Marlin	0.02	0.02	0.46
			3. Bluefin Tuna	0.02	0.03	0.36
4.	South Sulawesi	March 2006	1. Tuna	0.06	0.02	ND
			2. Red Snapper	0.02	0.03	0.15
			3. Grouper	0.01	ND	0.09
			4. Baramundi	0.02	0.02	ND
		June 2006	1. Tuna	0.04	0.01	0.08
			2. Leather Jacket	0.02	0.01	ND
			3. Baramundi	0.02	0.02	ND
		September 2006	1. Tuna	0.04	0.08	0.04
			2. Grouper	0.06	0.09	0.09
			3. Red Snapper	0.02	ND	0.01
5	North Sulawesi	March 2006	1. Fresh Tuna	0.24	0.04	0.16
			2. Canned Tuna	0.02	0.04	0.05
			3. Skipjack	0.06	0.10	0.02
			4. Marlin	0.34	0.06	0.14
		June 2006	1. Marlin	0.46	0.08	0.12
			2. Fresh Tuna	0.30	0.10	0.08
			3. Skipjack	0.08	0.06	0.02
		Sep. 2006	1. Fresh Tuna	0.10	0.04	0.12
			2. Skipjack	0.10	0.02	0.01
			3. Canned Tuna	-	-	-

Table 3. Data Monitoring Of Heavy Metals Conducted in Jakarta, Bali, South Sulawesi, North Sulawesi and Maluku in 2007.

No.	Location	Time of Sampling	Species / Products	Heavy Metals (ppm)		
				Mercury (Hg)	Cadmium (Cd)	Lead (Pb)
1.	Jakarta	April 2007	1. Marlin	0.30	0.04	0.12
			2. Tuna	0.28	0.03	0.14
			3. Spanish- mackerel	0.11	0.02	0.13
		June 2007	1. Red snapper	0.11	0.03	0.11
			2. Spanish-mackerel	0.20	0.02	0.18
			3. Tuna	0.26	0.02	0.21
		August 2007	1. Marlin	0.31	0.03	0.13
			2. Red snapper	0.22	0.03	0.12
			3. Oil-fish	0.35	0.03	0.12
2.	Bali	April 2007	1. Marlin	0.82	0.03	0.07
			2. Yellow-fin tuna	0.12	0.02	0.12
			3. Blue-fin tuna	0.46	0.01	0.04
		June 2007	1. Sailfish	0.16	0.02	0.13
			2. Blue-fin tuna	0.45	0.01	0.07
			3. Marlin	0.82	0.03	0.08
			4. Yellow-fin tuna	0.25	0.07	0.04
		August 2007	1. Striped marlin	0.17	0.06	0.17
			2. King fish	0.21	0.03	0.08
			3. Yellow-fin tuna	0.26	0.04	0.05
3.	South Sulawesi	April 2007	1. Yellow-fin tuna	0.25	0.01	0.07
			2. Baramundi	0.18	0.04	0.02
			3. Red snapper	0.20	0.02	0.04
		June 2007	1. Yellow-fin tuna	0.28	0.02	0.06
			2. Grouper	0.24	0.02	0.14
			3. Red snapper	0.16	0.08	0.04
		August 2007	1. Yellow-fin tuna	0.22	0.02	0.10
			2. Red snapper	0.18	0.02	0.08
			3. Leather Jacket	0.07	0.24	0.18
4.	North Sulawesi	April 2007	1. Yellow-fin tuna	0.38	0.02	0.04
			2. Canned tuna	0.14	0.02	0.08
			3. Red snapper	0.22	0.03	0.04
		June 2007	1. Yellow-fin tuna	0.32	0.03	0.11
			2. canned tuna	0.14	0.08	0.06
			3. Swordfish	0.44	0.04	0.10
			4. Skipjack tuna	-	-	-
		August 2007	1. Yellow-fin tuna	0.22	0.06	0.06
			2. Red snapper	0.18	0.04	0.04
			3. Marlin	0.34	0.03	0.06

5.	Maluku	April 2007	1. Skipjack tuna	0.13	0.04	0.12
			2. Marlin	0.38	0.02	0.08
			3. Skipjack tuna	0.19	0.04	0.06
		June 2007	1. Skipjack tuna	0.16	0.06	0.04
			2. Yellow-fin tuna	0.28	0.02	0.06
			3. Marlin	0.34	0.06	0.08
		August 2007	1. Skipjack tuna	0.18	0.02	0.12
			2. Marlin	0.28	0.04	0.08
			3. Yellow-fin tuna	0.20	0.01	0.12

Table 4. Data Monitoring Of Heavy Metals Conducted in Jakarta, Bali, South Sulawesi and North Sulawesi in 2008.

No.	Location	Time of Sampling	Species / Products	Heavy Metals (ppm)		
				Mercury (Hg)	Cadmium (Cd)	Lead (Pb)
1.	Jakarta	February	1. Frozen tuna*	0.20	0.01	0.20
			2. Fresh loin tuna*	0.30	0.01	0.12
		April	1. Frozen tuna*	0.18	0.02	0.10
			2. Frozen loin tuna*	0.26	0.02	0.12
			3. Red snapper*	0.10	0.01	0.10
2.	Bali	February	1. Tuna *(BE)*	0.50	0.01	0.14
			2. Tuna *(YF)*	0.16	0.01	0.04
			3. Skipjack	0.08	0.04	0.18
		April	1. Tuna *(YF)*	0.43	0.03	0.11
			2. Skipjack	0.20	0.05	0.14
			3. Tuna *(BE)*	0.18	0.03	0.10
3.	South Sulawesi	February	1. *Lutjanus* sp.	0.12	0.05	0.11
			2. Canned tuna	0.25	0.04	0.09
			3. *P. monodon*	0.04	0.02	0.03
		April	1. Tuna (BE)	0.21	0.04	0.10
			2. *P. vannamei*	0.22	0.10	ND
			3. *P. monodon*	0.10	0.01	ND
4.	North Sulawesi	February	1. Fresh Tuna loin*	0.20	0.10	0.08
			2. Fresh Tuna	0.26	0.04	0.12
			3. Canned Tuna*	0.10	0.01	0.04
		April	1. Frozen Tuna*	0.30	0.04	0.02
			2. Canned Tuna*	0.12	0.06	0.08
			3. Skipjack tuna	0.10	0.01	0.02

Note
ND = Not Detected
Method of Analysis: Atomic Absorption Spectrometer (AAS)
Limit of Detection (LOD): Hg = 0.52ppb**;** Cd = 0.11ppb; Pb = 0.19ppb
* Sample taken from fish processing plant

c. Corrective Actions

Corrective actions will be taken when the results of monitoring does not comply with the standard or higher than the standard. The corrective action process for non-compliant results is as follows:

1) Carry out the investigation such as traceability to the fishing ground areas.
2) Verification of sampling and analytical methods.
3) Perform repeat sampling.
4) Exclusion of products with higher than the maximum residue limit allowed from establishment or continue processing as products not for human consumption.
5) Intensively control chemical contaminants (Hg, Cd and Pb) in fish and fish products during processing or during fishing.

Moreover, in order to ensure the safety of fish and fish products, Indonesia Government undertakes continuous actions such as: (1) Surveillance of stakeholders to ensure their compliance with the rules and regulations in the standards/procedures and (2) Obtain data and information periodically on the level of chemical contaminants such as heavy metal in fish and fish products.

5. Problems and Challenges Encountered

Problem faced during the heavy metals monitoring and surveys are as follow:

1) Analysts are not properly qualified to perform the heavy metals (Hg, Cd and Lead) analysis using Atomic Absorption Spectrometer (AAS).
2) Lack of networking system to harmonize the standard and methods of analysis for heavy metals among ASEAN countries.
3) Lack of knowledge and skill of fishermen regarding the presence of heavy metals in fish and fish products.
4) Stringent requirements set by importing countries for monitoring program such as heavy metal in fish and fish products.

6. Recommendations and Suggestions for Future Follow up Action

1) Need training program for methods validation and verification especially in the determination of the limit of detection and minimum residue performance limit for heavy metals (Hg, Cd and Pb).
2) Need training to improve the methods of analysis for heavy metals.
3) Need to establish networking system to develop the methods of analysis for heavy metals among ASEAN countries.
4) Need to establish harmonizing standard especially for maximum level of each content of heavy metals in order to fulfill the requirements of importing countries such as EU.
5) Need to improve the accuracy of testing results by participating in proficiency testing program especially for heavy metals among ASEAN countries