

MALAYSIA

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1. Introduction

This study was divided into two components of the Japanese Trust Fund (JTF) IV and JTF II. JTF IV was carried out from the year 2005 to 2006, under Component I Activity CI-1: Regional survey of heavy metals in fish and fish product and in the environment. The survey was divided into two areas namely species identification of marine, freshwater and brackish aquacultured fish and marine and freshwater captured fish. Marine, freshwater and brackish aquacultured fish samples comprised of seabass (barramundi), tilapia, catfish, cockles, green mussel and black tiger prawn. Marine and freshwater captured fish samples were Spanish mackerel, grouper, red snapper, prawns and squid.

However, in 2007, the program previously conducted under JTF IV was moved to JTF II, which excluded aquaculture products. The emphasis was on Component I, Activity CI-1: Regional survey of heavy metals in fish and fish products. The survey focused on fish samples collected from processing establishments.

The survey provided information on the level of heavy metals concentration in seafood consumed by people whether it is for domestic use and/or for export. The survey carried out complemented with our on-going Sanitary and Phytosanitary Monitoring Program (SPS), which has the overall objective to ensure safe fish and fish products for human consumption.

Presently, fish and fish products from Malaysia exported to Europe constitute about 30% of the fish production. The Department of Fisheries (DOF) as one of the Competent Authority (CA) should ensure that fish and fish product exported to EU complies with the requirements of importing country and the European Commission (EC) Regulation 1881/2006 –

setting maximum levels for certain contaminants in foodstuffs.

2. Objective and Goals

The objective of this study is to determine the level of heavy metals namely Cadmium (Cd), Lead (Pb) and total Mercury (Hg). All the data generated will be deposited collected into the Fish and Fish Products Safety Information Network.

3. Survey Methodologies

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

From 10 to 13 May 2005, 160 samples were collected throughout Johor. The samples were collected from east and west Johor especially from Tg. Sedili and Pontian. Spanish mackerel (*Scomberomorus sp.*), grouper (*Epinephelus sp.*), red snapper (*Lutjanus sp.*), shrimp (*Metapenaeus sp.*), cultured white shrimp (*Peneaus vannamei*), squid (*Loligo sp.*) and seabass (*Lates calcarifer*) were collected from the east and west coast of Johor, while catfish (*Clarias batrachus*) and tilapia (*Oreochromis niloticus*) were collected from Kota Tinggi. Green mussel (*Perna viridis*) were harvested only from aquaculture farms in Masai and Pantai Lido, covering an area from the west and east coasts of Johor. The black tiger prawn (*Peneaus monodon*) were sampled from Desaru of east coast of Johor and cockles (*Anadara granosa*) were collected only from Pontian, Johor. The second sampling was carried out from 4 to 8 September 2006, of which 152 samples were collected from the same venues as in the earlier sampling.

Eight samples per species were randomly taken from each location of sampling plan. All the samples were stored at -18°C in a cold room for four days before being transported to the laboratory for analysis.

In the laboratory, the length and weight of the samples were measured.

From 5 to 6 June 2007, 72 samples of fish products were collected from processing establishments in the states of Perak and Penang. The second sampling was carried out on 28 August 2007, of which 32 samples were collected from other processing establishments in Perak.

Samples comprised of fishcakes, fishballs, frozen shrimps (*P.vannamei*), surimi kintokidai A (from big eye snapper), surimi (from threadfin bream), frozen octopus (*Octopus doflein*), frozen squid (*Sepia inermis*), frozen black tiger prawn (*P. monodon*) and frozen cuttlefish.

Eight samples per species were randomly taken from each location of sampling plan. The samples were kept in cooler boxes filled with ice to maintain the temperature before being transported to the laboratory on the same day.

b. Method of Analysis

Sample Preparation

Frozen samples were thawed at room temperature. Each sample was homogenized using the Seward stomacher 80 Biomaster at 300 rpm for 120 seconds. The homogenized sample was formed into a composite pie and 20g sample was stored in a 50 ml plastic bottle and kept in a freezer for further analysis.

Detection of Heavy Metals

i) Detection of Total Mercury (Hg)

Initially, one layer of additive M was applied onto the surface of a sample boat and about 20-40 mg of sample was placed onto the middle of sample boat before being covered by additive M. This was followed by a layer of additive B and covered again with additive M (Method 2: for a solid or powder sample). The sample was applied to the MA 2000 instrument for detection of total mercury content.

The specifications of MA 2000 instrument are presented in Table 1.

Table 1. The specifications of MA 2000 for total mercury analysis.

Item	Description
1. Method	Gold-amalgam collection method with thermal decomposition by a ceramic tube heater
2. Carrier Gas	Purified dry air
3. Detection Method	Non-dispersion double-beam cold atomic absorption spectrometry
4. Detection Limit	0.002 ng (weight of sample)
5. Measuring Range	0 – 1,000 ng
6. Wavelength	253.7 nm

ii) Detection of Cadmium (Cd) and Lead (Pb)

Digestion of samples

About 400 mg of sample was prepared into HF100 teflon liner. 4 ml nitric acid (HNO₃) (Merck, Damstard, Germany, 65%) and 2 ml of hydrogen peroxide (H₂O₂) (Merck, Damstard, Germany, 30%) was added into the liner and digested using the USEPA procedure of 3015, 3051 and 3052 wet digestion method (PAAR001H). The digestion was performed using Anton Paar 3000, 16 rotors HF100 teflon vessels at a frequency of 2.45 GHz at 1500 W under operating pressure at 40 bars (580 psi) and maximum temperature of 240°C for 45 minutes. A p/T-sensor was used to monitor the digestion reaction till completion. The sample was topped up to 25 ml prior analysis.

Detection of Lead (Pb) and Cadmium (Cd) Using Atomic Absorption Spectrometry method

Lead (Pb) and cadmium (Cd) were measured by Atomic Absorption Spectrometry (AAS) Perkin Elmer model AA800. The diluted samples were analyzed using an in-house furnace method that was developed by Perkin Elmer, PE TS04. The analytical conditions for the AAS are presented in Table 2.

Analysis was performed under room temperature. All the containers and the apparatus were placed in 10% purified acid nitric.

Table 2. Analytical conditions for AA800.

Item	Description
Argon gas	
- Flow rate	0.9 – 1.5 liters/min
- Operating pressure	50 psig
Air compressor	
- Flow rate	10-28 liters/min
- Operating pressure	60 psig
Lamp/current	Cd & Pb – Hollow cathode lamp/12 mA
Wavelength	Cd – 228.8 nm Pb – 283.3 nm

c. Limit of Detection and Limit of Quantification

Element	LOD (mg/kg)	LOQ (mg/kg)
Year 2005 & 2006		
Cd	0.0039	0.039
Pb	0.0018	0.018
Total Hg	0.00002	0.0002
Year 2007		
Cd	0.0048	0.048
Pb	0.0006	0.006
Total Hg	0.00002	0.0002

d. National Regulatory Limits

Country	Element	Regulatory Limits (mg/kg)
Malaysia	Cd	1.0
	Pb	2.0
	Hg	0.5 (1.0 for predator)
EC. Reg. 1881/2006	Cd	0.05 (excluding fish species in 3.2.6 & 3.2.7)*
	Pb	0.3
	Hg	0.5 (excluding fish species in 3.3.2)*

* Refer to Appendix 1

4. Results and Discussion

a. Participation in Inter-laboratory Proficiency Testing and Results

Year of Participation	Program Name	Analyte Tested	Reported Results (ppb)	True Value (ppb)	z-Score	Remarks
2004	ASEAN-SEAFDEC Regional Inter-Laboratory Proficiency Testing	Total As	10.1740	10.20	-0.018	–
		Total Pb	0.5066	0.319	0.197	–
		Total Hg	3.1299	3.37	-0.234	–
		Total Cd	18.6340	19.40	-0.509	–
2007	FAPAS Proficiency Test 0786 Metallic Contaminants in canned Fish	Total As	780.16	1124	-1.900	–
		Cd	55.50	52.4	0.3	–
		Pb	–	–	–	z-score not issued
		Total Hg	597.05	704	-0.9	–

b. Survey Results and Discussion

Physical Parameters of Samples Collected in 2005 & 2006

Table 3. Physical parameters of samples collected from east coast of Johor.

Type of system/fish	Location	Weight (g) Average (range)	Length (cm) Average (range)
Aquaculture			
Catfish	Kota Tinggi/Desaru	380 ± 39.5 (343 – 458)	40.3 ± 1.9 (36.5 – 42.1)
Mussel	Masai/Pasir Gudang	45.3 ± 13.4 (22 – 85.4)	8.9 ± 1.0 (7.2 – 40)
Seabass	Tg. Sedili	450.8 ± 61.0 (319 – 578)	30.5 ± 2.3 (24.1 – 33.5)
Tilapia	Kota Tinggi/Desaru	491.3 ± 19.7 (478 – 536)	22.2 ± 2.0 (20.5 – 26.7)
Tiger prawn	Desaru	27.8 ± 7.6 (17.5 – 38)	N.A*
Shrimp	Desaru	27.5 ± 5.0 (17 – 36)	N.A
Marine captured			
Grouper	Tg. Sedili/Mersing	206.5 ± 206.3 (55 – 706)	21.7 ± 6.0 (15.2 – 35.7)
Red snapper	Tg. Sedili	240.9 ± 276.9 (47 – 903)	20.8 ± 8.7 (13 – 39.5)
Squid	Tg. Sedili/Mersing	97.7 ± 33.5 (57 – 175)	21.5 ± 2.8 (18 – 26)
Spanish Mackerel	Tg. Sedili/Mersing	1131.5 ± 147.2 (1013 – 1407)	49.5 ± 1.7 (48 – 52)
Shrimp	Tg. Sedili	14.6 ± 0.6 (13.6 – 15.4)	4.8 ± 1.2 (3.3 – 6.5)

*N.A – Not Available

Table 4. Physical parameters of samples collected from west coast of Johor.

Type of system/fish	Location	Weight (g)	Length (cm)
Aquaculture		Average (range)	Average (range)
Catfish	Senai	258.6 ± 205.3 (98 – 767)	29.6 ± 6.3 (22 – 44.2)
Mussel	Pantai Lido	37.6 ± 26.5 (14.8 – 124)	7.8 ± 0.8 (5.6 – 9.0)
Seabass	Pendas	409.9 ± 96.7 (191 – 535)	29.2 ± 2.5 (23 – 32.4)
Tilapia	Senai	454.1 ± 42.5 (408 – 526)	21.1 ± 0.6 (20.5 – 22.4)
Cockle	Pontian	7.5 ± 1.3 (5.9 – 9.5)	2.7 ± 0.2 (2.4 – 3.3)
Shrimp	Desaru	11.4 ± 1.6 (8.1 – 13.9)	N.A*
Marine captured			
Grouper	Pontian	696 ± 395.5 (390 – 1509)	35.3 ± 5.9 (30.5 – 46.2)
Red snapper	Pontian	895.6 ± 449.1 (330 – 1608)	40 ± 4.8 (32 – 47.2)
Squid	Pontian	105.9 ± 55.2 (55 – 260)	29.1 ± 12.3 (14 – 54)
Spanish Mackerel	Pontian	1131.5 ± 147.2 (1013 – 1407)	16.5 ± 6.3 (11.4 – 31.2)
Shrimp	Pantai Lido	14.6 ± 0.6 (13.6 – 15.4)	N.A*

* N.A – Not Available

Analytical Results For Heavy Metals for Samples collected in 2005 and 2006

Table 5. Results of Cd, Pb and Hg in marine/freshwater/brackishwater aquacultured fish and marine captured fish from east coast of Johor in 2005 and 2006.

Type of system/fish	Sampling Location	Analyte	Fish sample Analysed		No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
			Common name	Scientific name						
Aquacultured										
Catfish	Kota Tinggi / Desaru	Cd	Ikan keli	<i>Clarias batrachus</i>	16	ND	0.03	0.01	Cd = 97.6 Pb = 102.8 Hg = 99.8	
		Pb				0.04	0.88	0.16		
		Hg				0.005	0.04	0.02		
Green mussel	Masai / Pasir Gudang	Cd	Kupang	<i>Perna viridis</i>	16	0.04	0.12	0.07		
		Pb				0.01	0.32	0.09		
		Hg				0.005	0.02	0.01		
Seabass	Tg. Sedili	Cd	Siakap	<i>Lates calcarifer</i>	16	ND	0.02	0.01		
		Pb				ND	0.52	0.19		
		Hg				0.01	0.18	0.12		
Tilapia	Kota Tinggi / Desaru	Cd	Tilapia	<i>Oreochromis niloticus</i>	16	ND	0.02	0.02		
		Pb				ND	0.18	0.10		
		Hg				0.01	0.02	0.01		

Note : ND – less than LOD.

Table 5. Results of Cd, Pb and Hg in marine/freshwater/brackishwater aquacultured fish and marine captured fish from east coast of Johor in 2005 and 2006 (cont'd).

Type of system/fish	Sampling Location	Analyte	Fish sample Analysed		No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
			Common name	Scientific name						
Aquacultured										
Black tiger prawn	Desaru	Cd	Udang harimau	<i>Penaeus monodon</i>	16	ND	0.07	0.01	Cd = 97.6 Pb = 102.8 Hg = 99.8	
		Pb				ND	0.40	0.16		
		Hg				0.02	0.03	0.02		
White shrimp	Desaru	Cd	Udang putih	<i>Penaeus vannamei</i>	8	0.01	0.10	0.04		
		Pb				ND	0.18	0.09		
		Hg				0.02	0.03	0.02		
Captured Fish										
Grouper	Tg. Sedili/ Mersing	Cd	Kerapu	<i>Epinephelus sp.</i>	16	ND	0.06	0.02		
		Pb				0.01	0.14	0.05		
		Hg				0.05	0.27	0.14		
Red snapper	Tg. Sedili	Cd	Ikan merah	<i>Lutjanus sp.</i>	16	ND	0.01	0.01		
		Pb				ND	0.27	0.08		
		Hg				0.02	0.18	0.07		

Note : ND – less than LOD.

Table 5. Results of Cd, Pb and Hg in marine/freshwater/brackishwater aquacultured fish and marine captured fish from east coast of Johor in 2005 and 2006 (cont'd).

Type of system/fish	Sampling Location	Analyte	Fish sample Analysed		No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks		
			Common name	Scientific name								
Captured Fish Squid	Tg. Sedili/ Mersing	Cd	Sotong	<i>Loligo sp.</i>	16	0.02	0.21	0.10	Cd = 97.6 Pb = 102.8 Hg = 99.8			
		Pb					ND	0.31			0.06	
		Hg					0.01	0.03			0.02	
Spanish mackerel	Tg. Sedili/ Mersing	Cd	Tenggiri	<i>Scomberomorus sp.</i>	16	ND	0.01	0.01				
		Pb				ND	0.15	0.06				
		Hg				0.04	0.22	0.12				
Shrimp	Tg. Sedili	Cd	Udang laut	<i>Metapeneaus sp.</i>	8	ND	0.04	0.02				
		Pb				ND	0.14	0.05				
		Hg				0.02	0.26	0.06				
Total number of samples =					160							

Note : ND – less than LOD.

Table 6. Results of Cd, Pb and Hg in marine/freshwater/brackishwater aquacultured fish and marine captured fish from west coast of Johor in 2005 and 2006.

Type of system/fish	Sampling Location	Analyte	Fish sample Analysed		No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
			Common name	Scientific name						
Aquacultured Catfish	Senai	Cd	Ikan keli	<i>Clarias batrachus</i>	16	ND	0.06	0.01	Cd = 97.6 Pb = 102.8 Hg = 99.8	
		Pb				ND	0.95	0.24		
		Hg				0.004	0.05	0.02		
Green mussel	Pantai Lido	Cd	Kupang	<i>Perna veridis</i>	16	0.01	0.18	0.03		
		Pb				0.01	0.24	0.09		
		Hg				0.005	0.03	0.02		
Seabass	Pendas	Cd	Siakap	<i>Lates calcarifer</i>	16	ND	0.06	0.02		
		Pb				ND	0.43	0.11		
		Hg				0.04	0.11	0.07		
Tilapia	Senai	Cd	Tilapia	<i>Oreochromis niloticus</i>	8	ND	ND	ND		
		Pb				ND	0.18	0.15		
		Hg				0.005	0.01	0.01		

Note : ND – less than LOD.

Table 6. Results of Cd, Pb and Hg in marine/freshwater/brackishwater aquacultured fish and marine captured fish from west coast of Johor in 2005 and 2006 (cont'd).

Type of system/fish	Sampling Location	Analyte	Fish sample Analysed		No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
			Common name	Scientific name						
Aquacultured										
Cockles	Pontian	Cd	Kerang	<i>Anadara granosa</i>	16	0.06	0.81	0.33	Cd = 97.6 Pb = 102.8 Hg = 99.8	
		Pb				0.09	0.58	0.28		
		Hg				0.01	0.06	0.02		
White shrimp	Pontian	Cd	Udang putih	<i>Penaeus vannamei</i>	8	ND	0.02	0.01		
		Pb				ND	0.09	0.05		
		Hg				0.004	0.03	0.02		
Captured Fish										
Grouper	Pontian	Cd	Kerapu	<i>Epinephelus sp.</i>	8	ND	0.02	0.01		
		Pb				ND	0.07	0.03		
		Hg				0.05	0.28	0.13		
Red snapper	Pontian	Cd	Ikan merah	<i>Lutjanus sp.</i>	16	ND	0.01	0.005		
		Pb				ND	0.12	0.06		
		Hg				0.04	0.32	0.12		

Note : ND – less than LOD.

Table 6. Results of Cd, Pb and Hg in marine/freshwater/brackishwater aquacultured fish and marine captured fish from west coast of Johor in 2005 and 2006 (cont'd).

Type of system/fish	Sampling Location	Analyte	Fish sample Analysed		No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
			Common name	Scientific name						
Captured Fish	Pontian	Cd	Sotong	<i>Loligo sp.</i>	16	0.03	0.30	0.08	Cd = 97.6 Pb = 102.8 Hg = 99.8	
		Pb				ND	0.33	0.07		
		Hg				0.02	0.07	0.05		
Spanish mackerel	Pontian	Cd	Tenggiri	<i>Scomberomorus sp.</i>	16	ND	0.08	0.02		
		Pb				ND	0.74	0.11		
		Hg				0.02	0.14	0.05		
Shrimp	Pontian	Cd	Udang laut	<i>Metapeneus sp.</i>	16	ND	0.03	0.01		
		Pb				ND	0.23	0.08		
		Hg				0.01	0.04	0.02		
					Total number of samples =	152				

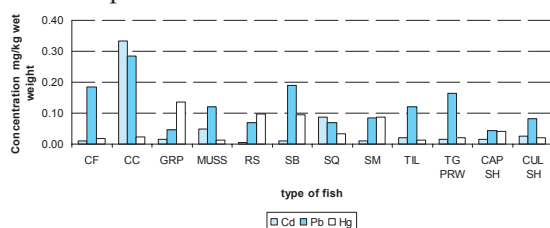
Note : ND – less than LOD.

Discussion

Mean Concentration of Heavy Metals in various fishes in Johor

The mean concentration of Cadmium (Cd), Lead (Pb) and Mercury (Hg) of all the species of fish, green mussel and prawn in Johor was much lower than the standard of Commission Regulation (EC)¹ No. 1881/2006; Food Act of Malaysia² (1983) (amendment, 1993) and Malaysia Food Regulation (1985).

Graph 1. Mean Concentrations of Cd, Pb and Hg in various species of fish in Johor.



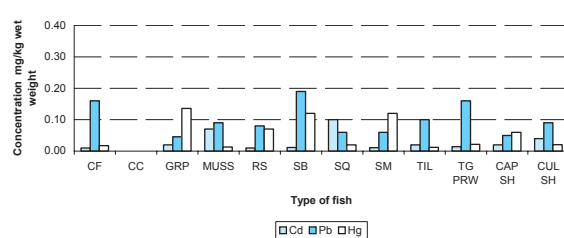
CF - Catfish; CC – Cockles; GRP – Grouper; MUSS – Mussel; RS – Red Snapper; SB – Seabass; SQ – Squid; SM – Spanish Mackerel; TIL – Tilapia; TG PRW – Tiger Prawn; CAP SH – Captured Shrimp; CUL SH – Cultured Shrimp

Graph 1 shows the mean concentration of Cd and Pb were less than 0.20 ppm except for cockles. The highest concentrations of Cd and Pb were found in cockles collected from Pontian, west coast of Johor in 2005, with a concentration of 0.81 ppm for Cd and 0.58 ppm for Pb. The mean concentration of Hg for all samples was less than 0.20 ppm. The highest concentration of Hg was detected in red snapper from Pontian, west coast of Johor in 2005 at a concentration of 0.32 ppm.

Mean Concentration of Heavy Metals in various fishes from east coast of Johor

The mean concentration of Cadmium, Lead and Mercury of all species of fish, green mussel and prawn from east coast of Johor was also lower than the regulatory standards.

Graph 2. Mean Concentrations of Cd, Pb and Hg from east coast of Johor.



CF - Catfish; CC – Cockles; GRP – Grouper; MUSS – Mussel; RS – Red Snapper; SB – Seabass; SQ – Squid; SM – Spanish Mackerel; TIL – Tilapia; TG PRW – Tiger Prawn; CAP SH – Captured Shrimp; CUL SH – Cultured Shrimp

Marine, brackish water and freshwater Aquacultured Fish

Graph 2 shows the mean concentrations of Cd, Pb and Hg in various species of aquacultured fish from east coast of Johor were less than 0.20 ppm. The concentration of Cd was found to be highest in mussel from Masai at 0.12 ppm in 2005. For Pb, it was found that catfish from Kota Tinggi in 2005 had the highest concentration at 0.88 ppm. The highest concentration of Hg was observed in seabass from Tg. Sedili in 2005 at 0.18 ppm. Details are shown in Table 5.

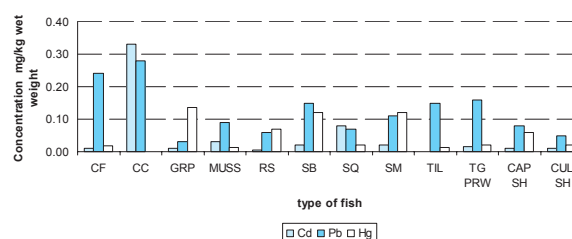
This site is considered to be not suitable for cockles culture due to high water current and soil profile (sandy area), therefore there is no reported data on cockle from this area.

Marine Captured Fish

Graph 2 also shows the mean concentrations of Cd, Pb and Hg in various species of marine captured fish from east coast of Johor were less than 0.20 ppm. The concentration of Cd was found to be highest in squid from Mersing at 0.21 ppm in 2006. In addition, the concentration of Pb was found in squid from Tg. Sedili in 2005 at 0.31 ppm. The highest concentration of Hg was observed in grouper from Pontian in 2005 at 0.27 ppm. Details are shown in Table 5.

Mean concentration of heavy metals in various fishes from west coast of Johor

Graph 3. Mean Concentrations of Cd, Pb and Hg from west coast of Johor.



CF - Catfish; CC – Cockles; GRP – Grouper; MUSS – Mussel; RS – Red Snapper; SB - Seabass; SQ – Squid; SM – Spanish Mackerel; TIL – Tilapia; TG PRW – Tiger Prawn; CAP SH – Captured Shrimp; CUL SH – Cultured Shrimp

Marine, brackish water, freshwater Aquacultured Fish

Graph 3 shows the mean concentrations of Cd, Pb and Hg in various species of aquacultured fish from west coast of Johor were lower than 0.20 ppm except for Cd and Pb in cockles and also for Pb in catfish. The highest concentrations of Cd and Pb in cockles were found from Air Baloi, Pontian at 0.81 ppm and 0.58 ppm respectively. The highest concentration of Cd from cockles collected in Desaru showed lower concentration

at 0.19 ppm as compared to those collected in Pontian. Meanwhile, the concentration of Pb in catfish was found to be highest in Senai at 0.95 ppm. The concentration of Hg was observed at 0.11 ppm. Details are shown in Table 6.

Marine Captured Fish

Graph 3 shows the mean concentrations of Cd, Pb and Hg in various species of marine captured fish

from west coast of Johor were also lower than 0.20 ppm. The highest concentration of Cd was found in squid collected from Pontian in 2005 at 0.30 ppm. The concentration of Pb was found to be highest in Spanish Mackerel from Pontian at 0.74 ppm. In addition, the highest concentration of Hg was found in red snapper collected from Pontian at 0.32 ppm. Details are shown in Table 6.

Analytical Results For Heavy Metals for Samples collected in 2007

Table 7. Mean concentrations of Cd, Pb and Hg in the various fish products.

Fish Product	Analyte	No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
Fishcake	Cd	16	ND	0.02	0.008	Cd = 99.5 Pb = 101.1 Hg = 100.4	ND for 14 samples
	Pb		ND	0.24	0.09		
	Hg		0.018	0.022	0.02		
Fishball	Cd	16	ND	ND	ND		
	Pb		ND	0.25	0.05		
	Hg		0.01	0.03	0.02		
Frozen shrimps (<i>Penaeus vannamei</i>)	Cd	8	ND	ND	ND		
	Pb		ND	0.11	0.06		
	Hg		0.01	0.02	0.01		
Surimi Kintokidai A (big eye snapper)	Cd	16	ND	0.08	0.08		
	Pb		ND	0.38*	0.32		
	Hg		0.02	0.05	0.03		
Surimi (threadfin bream)	Cd	8	ND	0.005	0.005		
	Pb		ND	0.06	0.04		
	Hg		0.03	0.04	0.03		
Frozen Octopus (<i>Octopus dofleini</i>)	Cd	8	0.03	0.47	0.18		
	Pb		0.01	0.44	0.18		
	Hg		0.01	0.02	0.02		
Frozen squid (<i>Loligo sp.</i>)	Cd	8	0.12	0.45	0.26		
	Pb		ND	0.64	0.31		
	Hg		0.007	0.02	0.01		
Frozen black tiger prawn (<i>Penaeus monodon</i>)	Cd	8	0.002	0.03	0.01		
	Pb		ND	ND	ND		
	Hg		0.01	0.02	0.02		
Frozen cuttlefish (<i>Sepia inermis</i>)	Cd	8	0.01	0.07	0.04		
	Pb		ND	ND	ND		
	Hg		0.007	0.01	0.01		
Total number of samples =		96					

Note : ND – less than LOD., * reanalyzed

Table 8. Mean concentrations of Cd, Pb and Hg in the various fish products from Hutan Melintang, Perak.

Fish Product	Analyte	No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
Fishcake	Cd	8	0.004	0.01	0.007	Cd = 99.5 Pb = 101.1 Hg = 100.4	
	Pb		ND	0.02	0.07		
	Hg		0.019	0.02	0.02		
Fishball	Cd	8	ND	ND	ND		
	Pb		ND	0.07	0.05		
	Hg		0.017	0.03	0.02		
Surimi (Kintokidai A; big eye snapper)	Cd	8	ND	ND	ND		
	Pb		ND	ND	ND		
	Hg		0.03	0.04	0.03		
Frozen shrimp (<i>Penaeus vannamei</i>)	Cd	8	ND	ND	ND		
	Pb		ND	0.06	0.06		
	Hg		0.01	0.02	0.01		
Frozen Octopus (<i>Octopus dofleini</i>)	Cd	8	0.03	0.47	0.18		
	Pb		0.01	0.44	0.18		
	Hg		0.01	0.02	0.02		
Frozen squid (<i>Loligo sp.</i>)	Cd	8	0.12	0.45	0.26		
	Pb		ND	0.64	0.31		
	Hg		0.007	0.02	0.01		
Frozen black tiger prawn (<i>Penaeus monodon</i>)	Cd	8	0.002	0.03	0.01		
	Pb		ND	ND	ND		
	Hg		0.01	0.02	0.02		
Frozen cuttlefish (<i>Sepia inermis</i>)	Cd	8	0.01	0.07	0.04		
	Pb		ND	ND	ND		
	Hg		0.007	0.01	0.01		
Surimi (threadfin bream)	Cd	8	ND	0.005	0.005		
	Pb		ND	0.06	0.04		
	Hg		0.03	0.04	0.03		
Total number of samples =		72					

Note : ND – less than LOD.

Table 9. Mean concentrations of Cd, Pb and Hg in the various fish products from Bukit Mertajam, Penang.

Fish Product	Analyte	No. of Samples	Min. value of results (ppm) – wet weight basis	Max. value of results (ppm) – wet weight basis	Average value of results (ppm) – wet weight basis	Average Recovery (%)	Remarks
Fishcake	Cd	8	ND	0.02	0.01	Cd = 99.5 Pb = 101.1 Hg = 100.4	
	Pb		0.02	0.24	0.11		
	Hg		0.02	0.022	0.02		
Fishball	Cd	8	ND	ND	ND		
	Pb		0.02	0.25	0.06		
	Hg		0.01	0.02	0.02		
Surimi Kintokidai A (big eye snapper)	Cd	8	ND	0.08	0.08		
	Pb		ND	0.15	0.12		
	Hg		0.02	0.03	0.03		
Total number of samples =		24					

Note : ND – less than LOD.

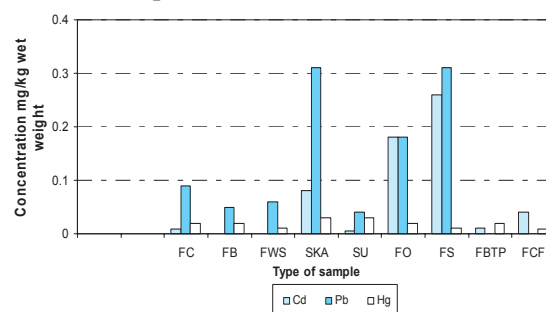
Discussion

Mean Concentrations of Heavy Metals in various Fish Products

All samples of fish products showed the mean concentration of Cadmium, Lead and Mercury were much lower than the standard of Commission Regulation (EC) No. 1881/2006, Food Act of Malaysia, 1983 (amendment 1993) and Food Regulation, 1985.

The mean concentrations of heavy metals in Table 7, was actually the overall result from Tables 8 and 9. However, some of the samples were collected from different states, where frozen shrimp, octopus, squid, black tiger prawn and cuttlefish can only be found in Perak. In Penang, only samples of fishcake, fishball and surimi kintokidai A were collected.

Graph 4. Mean Concentrations of Cd, Pb and Hg in various fish products.



FC - Fishcake; FB – Fishball; FWS – Frozen Shrimp (*P.vannamei*); SKA – Surimi Kintokidai A (big eye snapper); SU – Surimi (threadfin bream); FO – Frozen Octopus; FS – Frozen Squid; FBTP – Frozen Black Tiger Prawn; FCF – Frozen Cuttlefish

Graph 4 shows the mean concentration of Cd in fish products was less than 0.20 ppm except for frozen squid. Meanwhile, the concentration of Pb in surimi kintokidai A (big eye snapper) and frozen squid were higher than 0.30 ppm. For Hg, the concentration was observed to be lower than 0.1 ppm.

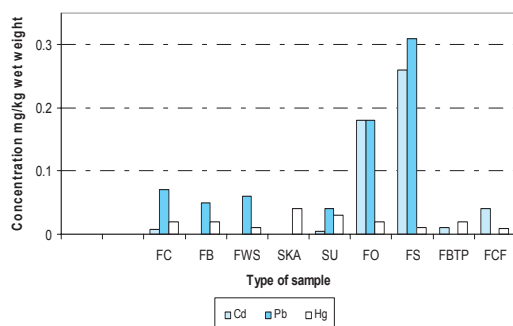
Surimi kintokidai A showed concentrations of Cd and Pb exceeding the standard limits set by EC standard 1881/2006. However, only 1 sample out of 16 samples was analyzed to be more than this standard with their concentration of 0.08 for Cd and 0.37 ppm for Pb. However the rest of the samples had very low levels and not detected. Cd and Pb were not detected in the samples collected from processing establishments from Perak .

Frozen octopus and squids collected from Perak showed a higher concentration but not exceeding the EC standard for Cd, Pb and Hg. The highest concentration of Cd and Pb in frozen octopus was 0.47 and 0.44 ppm respectively. Frozen squid also had the highest concentration of Cd and Pb of 0.45 and 0.64 ppm. It is lower than the EC standard for Cd and Pb with their concentration of 0.5 and 1.0 ppm for crustaceans and cephalopods.

All the samples collected for Hg analysis showed that the concentration did not exceed the EC and National standards.

Mean concentration of heavy metals in various fish products from Perak

Graph 5. Mean Concentrations of Cd, Pb and Hg in various fish products from Perak.

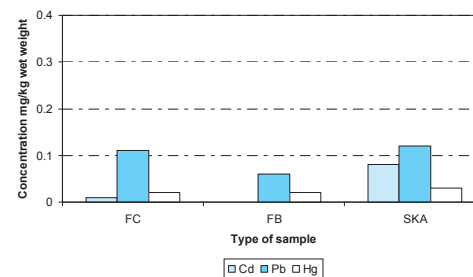


FC - Fishcake; FB – Fishball; FWS – Frozen Shrimp (*P.vannamei*); SKA – Surimi Kintokidai A (big eye snapper); SU – Surimi (threadfin bream); FO – Frozen Octopus; FS – Frozen Squid; FBTP – Frozen Black Tiger Prawn; FCF – Frozen Cuttlefish

Graph 5 shows the mean concentrations of Cd, Pb and Hg in the various fish products in Perak as stated in Table 8. The concentration of heavy metals in these products were less than 0.1 ppm except for frozen octopus and frozen squid.

Mean concentration of heavy metals in various fish products from Penang

Graph 6. Mean Concentrations of Cd, Pb and Hg in various fish products from Penang.



FC - Fishcake; FB – Fishball; SKA – Surimi Kintokidai A (big eye snapper);

Graph 6 also shows the mean concentrations of Cd, Pb and Hg in the various fish products in Penang which were stated in Table 9. The concentration of heavy metals in these products were less than 0.1 ppm for Cd and Hg and 0.2 ppm for Pb respectively.

Findings

The mean concentrations of heavy metals for all samples such as in fish and fish products were found to be not exceeding the food safety standard under the national standards. This implies that fishes from Johor east and west coasts and the fish products collected from Perak and Penang are within food safety limits for heavy metals contaminants. However, a more comprehensive study needs to be carried out to ensure seafood safety in Malaysia for heavy metals and other chemical contaminants.

c. Corrective Actions

Only one of the surimi kintokidai A sample from Perak exceeded the Pb level set by EC standard. The sample extraction and analysis was conducted again. No heavy metals was detected for this sample.

5. Problems and challenges encountered

- Method validation
- Proficiency testing
- Accreditation

6. Recommendations and Suggestions for Future Follow up Action

- The JTF programs should be continued among the ASEAN country to collect data which can support regional trade opportunities and benefits.
- The proficiency testing (PT) should be extended to another scope of analysis such as antibiotics, pesticides and histamine.
- Other elements such as Copper (Cu) and Arsenic (As) should be included in the survey.
- This survey should also cover canned products.
- SEAFDEC should consider the possibility of training for methyl Mercury and inorganic Arsenic for member countries because of the possibility that these analytes might be part of the requirement for food safety for products exported to EU country in the next few years.

Appendix 1

COM.REG. 1881/2006 – setting maximum levels for certain contaminants in foodstuff

	Foodstuff	Maximum level (mg/kg wet weight)	Performance criteria for sampling and for methods of analysis
3.1 LEAD (Pb)	3.1.5. Muscle meat of fish ⁽¹⁾ (²)	0,30	Reg 333/2007
	3.1.6. Crustacean, excluding brown meat of crab and excluding head and thorax meat of lobster and similar large crustaceans (Nephropidae and Palinuridae) ⁽³⁾	0,50	
	3.1.7. Bivalve molluscs ⁽³⁾	1,50	
	3.1.8. Cephalopods (without viscera) ⁽³⁾	1,00	
3.2 CADMIUM (Cd)	3.2.5. muscle meat of fish ⁽¹⁾ (²), excluding fish species in 3.2.6 and 3.2.7	0,05	Reg 333/2007
	3.2.6. Muscle meat of the following fish ⁽¹⁾ ⁽²⁾ : [1] anchovy (<i>Engraulis</i> species) [2] bonito (<i>Sarda sarda</i>) [3] common two-banded seabream (<i>Diplodus vulgaris</i>) [4] eel (<i>Anguilla anguilla</i>) [5] grey mullet (<i>Mugil labrosus labrosus</i>) [6] horse mackerel or scad (<i>Trachurus trachurus</i>) [7] louvar or luvar (<i>Luvarus imperialis</i>) [8] sardine (<i>Sardina pilchardus</i>) [9] sardinops (<i>Sardinops</i> species) [10] tuna (<i>Thunnus</i> , <i>Euthynnys</i> species, <i>Katsuwonus pelamis</i>) [11] wedge sole (<i>Dicologlossa cuneata</i>)	0,10	
	3.2.7. Muscle meat of swordfish (<i>Xiphias gladius</i>) ⁽¹⁾ ⁽²⁾	0,30	
	3.2.8. Crustaceans, excluding brown meat crab and excluding head and thorax meat of lobster and similar large crustaceans (Nephropidae and Palinuridae) ⁽³⁾	0,50	
	3.2.9. Bivalve molluscs ⁽³⁾	1,00	
	3.2.10. Cephalopods (without viscera) ⁽³⁾	1,00	

3.3 MERCURY (Hg)	3.3.1. <u>Fishery products</u> ⁽³⁾ and <u>muscle meat of fish</u> ⁽¹⁾ ⁽²⁾ , excluding species listed in 3.3.2. The maximum level applies to <u>crustaceans</u> , excluding the brown meat of crab and excluding head and thorax meat of lobster and similar large crustaceans (<i>Nephropidae</i> and <i>Palinuridae</i>)	0,50	Reg 333/2007
	3.3.2. Muscle meat of the following fish ⁽¹⁾ ⁽²⁾ [1] anglerfish (<i>Lophius</i> spp.) / Baudroie [2] atlantic catfish (<i>Anarhichas lupus</i>) / Loup [3] bonito (<i>Sarda sarda</i>) [4] eel (<i>Anguilla</i> spp.) /anguille [5] emperor, orange roughly, rosy soldierfish (<i>Hoplostethus atlanticus</i>) [6] grenadier (<i>Coryphaenoides rupestris</i>) [7] halibut (Hippoglossus hippoglossus) /flétan [8] marlin (<i>Makaira</i> spp.) [9] megrin (<i>Lepidorhombus species</i>) [10] mullet (<i>Mullus species</i>) [11] pike (<i>Esox lucius</i>)/ Brochet [12] plain bonito (<i>Orcynopsis unicolor</i>) / palomète [13] poor cod (<i>Tricopterus minutes</i>) [14] Portuguese dogfish (<i>Centroscymnes coelolepis</i>) [15] rays (<i>Raja</i> spp.) [16] redfish (<i>Sebastes marinus, S. mentella, S. viviparus</i>) [17] sail fish (<i>Istiophorus platypterus</i>) [18] scabbard fish (<i>Lepidopus caudatus, Aphanopus carbo</i>) [19] sea bream, Pandora (<i>Pagellus species</i>) [20] shark (all species) [21] snake mackerel or butterfish (<i>Lepidocybium flavobrunneum, Ruvettus pretiosus, Gempylus serpens</i>) [22] sturgeon (<i>Acipenser</i> spp.) / esturgeon [23] swordfish (<i>Xiphias gladius</i>) / espadon [24] tuna (<i>Thunnus</i> spp., <i>Euthynnus</i> species, <i>Katsuwonus pelamis</i>)	1,00	
3.4 TIN (inorganic) (Sn)	Canned foods other than beverages	200	Reg 333/2007 LOD<5 mg/kg LOQ<10 mg/kg

Reg 333/2007: for HM, Detection limit (LOD): 1/10 maximum level
Quantification limit (LOQ): 1/5 maximum level