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Research Article

Study on Heavy Metal Contents in Different Fish Samples Available in The Local Market of Dubai by ICP-MS

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Abstract:

Heavy metals contamination in aquatic ecosystems create great problems especially in developing countries through the waste materials coming from rivers, industry, intensive farming pollute the coastal aquatic environment. Especially seafood is of major concern because of the bioaccumulation and bio-magnifications of metal contaminants. The contaminated fish may become a public health concern particularly excessive intake of heavy metals may lead to a decline in mental, cognitive, and physical health. Their detection in fish is an indicator of marine pollution. In order to assess the levels and impact of different trace metals on human health, a study was carried out with more than 2500 fish and seafood samples which were collected from different locations within and outside the UAE during the year 2017-2018 [1]. The edible portions of fish were analyzed for Total Arsenic, Cadmium, Lead and Mercury by ICP-MS after pressure digestion with concentrated nitric acid. The mean contents of heavy metals expressed in ug/kg of wet weight. The average concentrations of heavy metals in this study obtained were below regulations set by the European Union except for cadmium in Frozen seafood cocktail, frozen squid, frozen mussels, dried anchovies, frozen crabs and lobsters were above the maximum limits set up by the European Union. Lead content found to be more in Cephalopods, dried anchovies, dried sardines followed by frozen seafood cocktail and chilled mussels. Highest Hg levels were found in Frozen fish (shark meat) followed by cod fish and some frozen fish fillets. Total Arsenic content was found in all categories of seafood namely, crabs, lobsters, cod fish, dried shrimps, frozen langoustine, frozen octopus. However, Total Arsenic has no regulatory limits set up by the European Union legislation to assess the risk. Further studies are needed to assess the risk associated with different forms of arsenic particularly inorganic arsenic by Arsenic speciation studies using LC-ICP-MS technique [2].

Keywords: Seafood, Arsenic, Cadmium, Mercury, Lead, Microwave digestion, High-resolution ICP-MS, European Union,

Introduction:

Metals and other elements can be naturally present in food or can enter food because of human activities such as industrial and agricultural processes. The metals of particular concern in relation to harmful effects on health are mercury, lead, cadmium, tin and arsenic. Mercury and lead are often referred to as “heavy metals”. The toxicity of these metals is in part because they accumulate in biological tissues, a process known as bioaccumulation. Heavy metals become toxic when the body does not metabolize them.

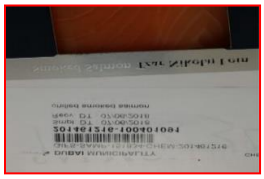


Materials and Methods:

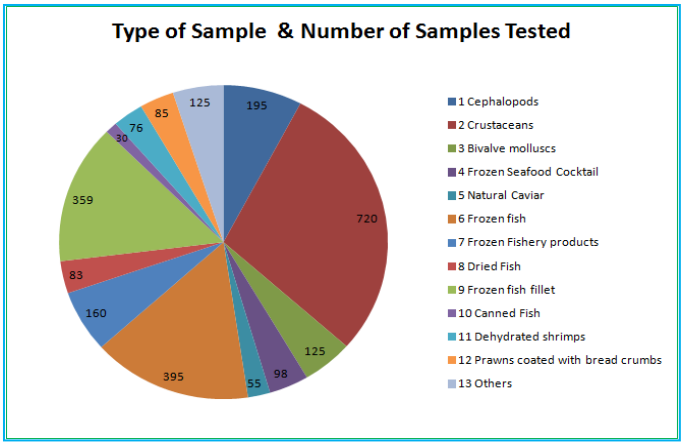
A total of more than 2500 samples of different seafood (Cephalopdos, Bivalve Molluscs, Crustaceans, Frozen fish, Dried fish, Frozen fishery products, Natural caviar, Frozen seafood cocktail, Canned fish and dehydrated fish etc.) were collected from different locations within and outside the UAE during the year 2017-18. Approximately 1-2 Kg of samples was bought from the market and analyzed through the laboratory procedures (BS: EN 15763) [3].

The main objective of this study was to determine selected heavy metals content (Pb, As, Cd, Hg) in tissues of various edible seafood samples and to compare the level of heavy metal concentrations in seafood samples analyzed, with the European Union legislation No 1881/2006 [4,5].

Fish samples were cut, and grinded using laboratory grinder. For the determination of heavy metals in different fruits and vegetables, first the samples were digested by microwave digestion using concentrated Nitric acid. Concentration of different heavy metals in analytical solution measured by using ICP-MS.


S.NO	Types of seafood	Number of Samples Tested
1	Cephalopods	195
2	Crustaceans	720
3	Bivalve molluscs	125
4	Frozen Seafood Cocktail	98
5	Natural Caviar	55
6	Frozen fish	395
7	Frozen Fishery products	160
8	Dried Fish	83
9	Frozen fish fillet	359
10	Canned Fish	30
11	Dehydrated shrimps	76
12	Prawns coated with bread crumbs	85
13	Others	125
	Total	2506



Maximum levels for Hg, Pb&Cd Commission Regulations No 1881/2006

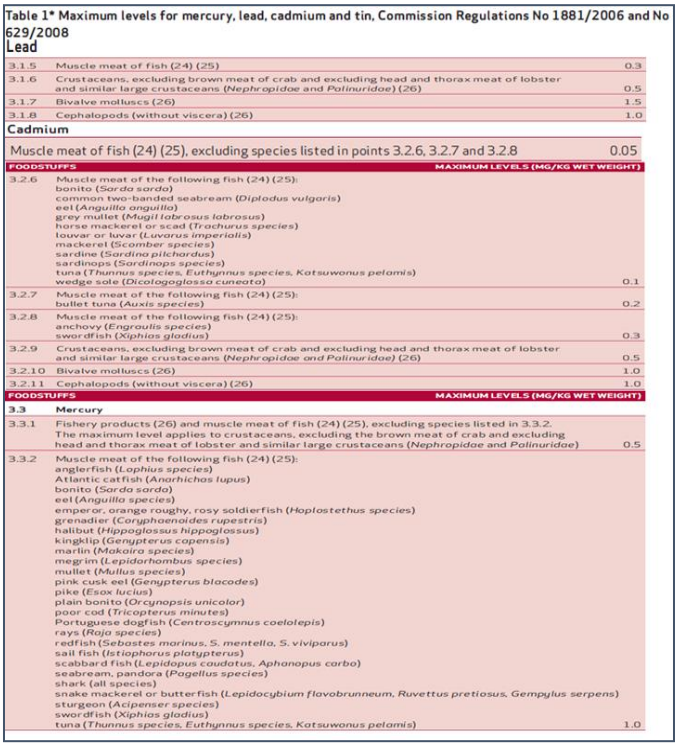


Table 1* Maximum levels for mercury, lead, cadmium and tin, Commission Regulations No 1881/2006 and No 629/2008

Lead

3.1.5	Muscle meat of fish (24) (25)	0.3
3.1.6	Crustaceans, excluding brown meat of crab and excluding head and thorax meat of lobster and similar large crustaceans (*Nephropidae* and *Palinuridae*) (26)	0.5
3.1.7	Bivalve molluscs (26)	1.5
3.1.8	Cephalopods (without viscera) (26)	1.0

Cadmium

Muscle meat of fish (24) (25), excluding species listed in points 3.2.6, 3.2.7 and 3.2.8 — 0.05

FOODSTUFFS		MAXIMUM LEVELS (MG/KG WET WEIGHT)
3.2.6	Muscle meat of the following fish (24) (25): bonito (*Sarda sarda*), common two-banded seabream (*Diplodus vulgaris*), eel (*Anguilla anguilla*), grey mullet (*Mugil labrosus labrosus*), horse mackerel or scad (*Trachurus species*), louvar or luvar (*Luvarus imperialis*), mackerel (*Scomber species*), sardine (*Sardina pilchardus*), sardinops (*Sardinops species*), tuna (*Thunnus species, Euthynnus species, Katsuwonus pelamis*), wedge sole (*Dicologoglossa cuneata*)	0.1
3.2.7	Muscle meat of the following fish (24) (25): bullet tuna (*Auxis species*)	0.2
3.2.8	Muscle meat of the following fish (24) (25): anchovy (*Engraulis species*), swordfish (*Xiphias gladius*)	0.3
3.2.9	Crustaceans, excluding brown meat of crab and excluding head and thorax meat of lobster and similar large crustaceans (*Nephropidae and Palinuridae*) (26)	0.5
3.2.10	Bivalve molluscs (26)	1.0
3.2.11	Cephalopods (without viscera) (26)	1.0

FOODSTUFFS		MAXIMUM LEVELS (MG/KG WET WEIGHT)
3.3	**Mercury**	
3.3.1	Fishery products (26) and muscle meat of fish (24) (25), excluding species listed in 3.3.2. The maximum level applies to crustaceans, excluding the brown meat of crab and excluding head and thorax meat of lobster and similar large crustaceans (*Nephropidae* and *Palinuridae*)	0.5
3.3.2	Muscle meat of the following fish (24) (25): anglerfish (*Lophius species*), Atlantic catfish (*Anarhichas lupus*), bonito (*Sarda sarda*), eel (*Anguilla species*), emperor, orange roughy, rosy soldierfish (*Hoplostethus species*), grenadier (*Coryphaenoides rupestris*), halibut (*Hippoglossus hippoglossus*), kingklip (*Genypterus capensis*), marlin (*Makaira species*), megrim (*Lepidorhombus species*), mullet (*Mullus species*), pink cusk eel (*Genypterus blacodes*), pike (*Esox lucius*), plain bonito (*Orcynopsis unicolor*), poor cod (*Tricopterus minutes*), Portuguese dogfish (*Centroscymnus coelolepis*), rays (*Raja species*), redfish (*Sebastes marinus, S. mentella, S. viviparus*), sail fish (*Istiophorus platypterus*), scabbard fish (*Lepidopus caudatus, Aphanopus carbo*), seabream, pandora (*Pagellus species*), shark (all species), snake mackerel or butterfish (*Lepidocybium flavobrunneum, Ruvettus pretiosus, Gempylus serpens*), sturgeon (*Acipenser species*), swordfish (*Xiphias gladius*), tuna (*Thunnus species, Euthynnus species, Katsuwonus pelamis*)	1.0

Analytical Methodology:

The concentration of toxic metals arsenic, cadmium, lead and mercury in different fish sample was determined by using Inductively Coupled Plasma- Mass Spectroscopy (ICP-MS) after Microwave Digestion with Nitric acid and Hydrogen peroxide.

Fish tissues were cut and homogenized using laboratory grinder and appropriate homogenized test portion was weighed (apprx 2g) and is heated at 200˚C with Nitric Acid, and Hydrogen peroxide in a closed-vessel microwave digestion system (MDC), and after completing the heating process the sample was then allowed to cool to room temperature. The content of the vessel was transferred into a 50 ml volumetric flask and diluted to the mark with ultra-pure water. All the steps were performed in the fume hood.

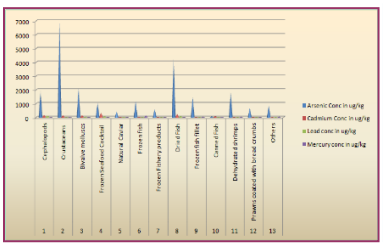
Inductively Coupled Plasma- Mass Spectroscopy (ICP-MS)

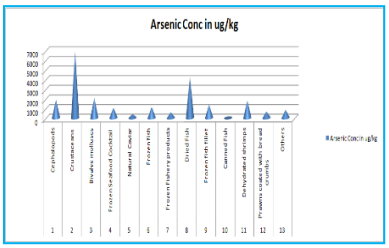
Results and Discussions

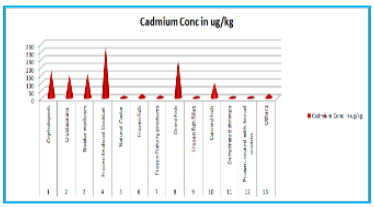
Average Concentration of heavy metals in different seafood in µg/kg

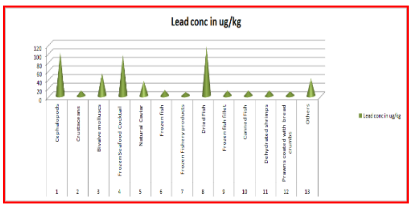
S.NO	Different types of seafood	Arsenic Conc ug/kg	Cadmium Conc ug/kg	Lead conc ug/kg	Mercury conc ug/kg
1	Cephalopods	1910	175	135	38
2	Crustaceans	6885	149	12.15	46.5
3	Bivalve molluscs	2061	156	53	10.7
4	Frozen Seafood Cocktail	1070	340	95	8.6
5	Natural Caviar	416	12.7	34.9	10.2
6	Frozen fish	1174	26.4	13.8	150
7	Frozen Fishery products	605	15.6	8.6	10.8
8	Dried Fish	4271	249	105	20
9	Frozen fish fillet	1421	10.8	12.4	52.3
10	Canned Fish	67	98.7	12.4	36.2
11	Dehydrated shrimps	1820	10.8	12.4	52.3
12	Prawns coated with bread crumbs	680	10	10.2	8.8
13	Others	860	26	40	56

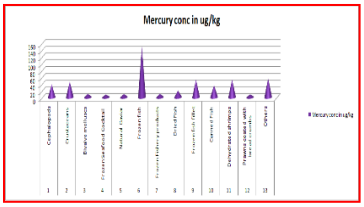
Concentration of Individual heavy metals in different seafood in µg/kg.









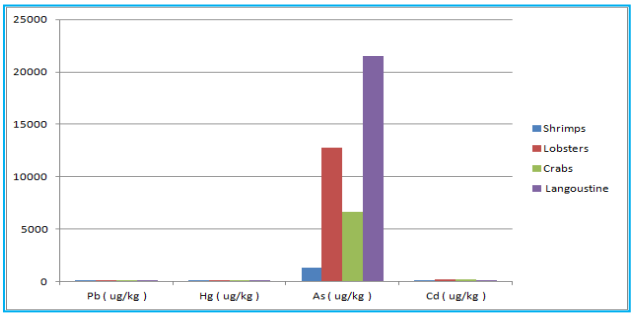


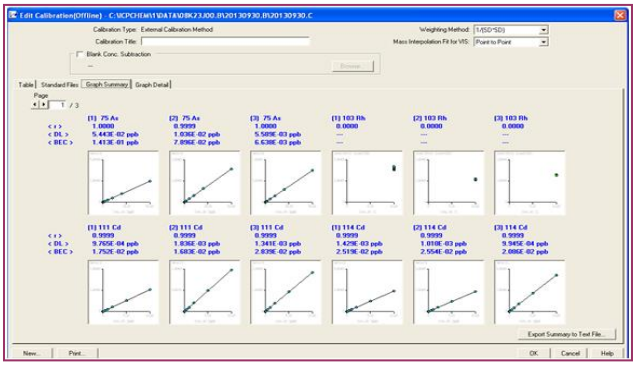
1. Highest average concentration of cadmium were found in Frozen seafood cocktail (340 ug/kg) followed by dried fish (249 ug/kg), Cephalopods (175 ug/kg), Bivalve mollusks (156 ug/kg), and Crustaceans (149 ug/kg), and all were above the maximum limits set up by the European Union.

2. Average Lead content were found to be more in Cephalopods (135 ug/kg), followed by Dried fish (105 ug/kg), and Frozen seafood cocktail (95 ug/kg), and were below the maximum limits set up by the European Union. Among dried fish the content of lead content varies with highest content was found in dried anchovies followed by dried sardines dried shrimps and dried mackerel.

3. Highest Hg levels were found in Frozen fish (shark meat), followed by cod fish and some frozen fish fillets and all were below the maximum limits set up by the European Union

4. Total Arsenic content was found in all categories of seafood with highest levels were found in crustaceans (6885 ug/kg), followed by dried fish (4271 ug/kg), Bivalve mollusks, Cephalopods and dried shrimps etc. However, total Arsenic has no regulatory limits set up by the European Union legislation to assess the risk.





Conclusions:

1. In order to ensure that these MLs are not exceeded, routine surveillance of food must be carried out, involving the taking of samples of potentially contaminated produce, followed by laboratory analysis to determine the levels of the toxic metals in the product.

2.The concentrations of toxic metals (Pb, Hg, Cd) found in this study were below the regulations set up by the European union except for cadmium in Frozen Seafood cocktail, Dried fish, Squid, Frozen mussels, frozen crabs and lobsters were above the maximum limits

set up by the European Union. Lead content found to be more in Cephalopods followed by dried anchovies, dried sardines and frozen seafood cocktail.

3. Highest Hg levels were found in frozen fish (shark meat), codfish and frozen fish fillets. Total Arsenic content was found in all categories of seafood namely, crabs, lobsters, cod fish, dried shrimps, frozen langoustine, frozen octopus with highest levels were found in crustaceans (6885 ug/kg), followed by dried fish (4271 ug/kg), Bivalve mollusks, Cephalopods and dried shrimps etc.

4. However total Arsenic has no regulatory limit set up by the European Union legislation to assess the risk. Further studies are needed to assess the risk associated with different forms of arsenic particularly inorganic arsenic by Arsenic speciation studies using LC-ICPMS technique.

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