CADMIUM RESIDUES IN MARINE SPECIES

Mariona Aznar López June 2021

Universitat Autònoma de Barcelona

OBJECTIVES

1. Deepen the knowledge about concepts related to cadmium (Cd) as a pollutant.
2. Know the importance of Cd pollution in the marine environment (its effects on marine species and humans and their current situation).
3. Highlight possible present and future measures to address Cd pollution in the marine environment.

Cd description and origin

Cd is classified as a heavy metal, one of the most toxic. Its origin can be:

- Natural (4,5 t/year): atmospheric, volcanic depositions or from minerals, soils and sediments.
- Antropogenic (25.000 t/year): from mining, metallurgy, fertilizers and urban pollution (Jaishankar et al., 2014).

Presence in marine species

Through bioaccumulation, organisms assimilate over time more amount of Cd from any source in the marine environment. This metal bioconcentrates in the organisms, which belong to a trophic net. Biomagnification takes place when Cd is increasingly transferred through food chain to successive trophic levels. By biomonitoring sentinel species, Cd contamination and its effects on biota can be assessed.

Cd distribution

Cd has a residence on oceans of 15.000 years and an abundance in the hydrosphere of 0.978 nmol/L. Its concentration increases with depth. Coastal areas have higher Cd presence, and fishing areas are usually the most contaminated (Aparicio-González et al., 2012).

Cd bioavailability

Cd is more bioavailable when sea water has low salinity, pH and diluted oxygen or high temperature and organic matter presence. It is also an energy-dependant process (de Almeida et al., 2021).

Cd levels in marines species

Bioaccumulation shows intra- and interspecific differences and depends on biotic and abiotic factors (Jakimska et al., 2011). Table 1 shows Cd concentration in marine species of commercial interest in our region. Higher Cd levels are associated with lower trophic level animals (due to a major bioconcentration hability), filter feeders (such as molluscs, specially oysters) and bentonic species (like molluscs, crustaceans and cephalopods). Conversely, lower Cd levels are present in higher trophic level species (with minor bioconcentration hability) and demersal or pelagic species able to detoxify or excrete Cd (such as fish). Predators have high amounts of Cd due to its size and the biomagnification phenomenon.

Table 1: Average Cd concentration (in mg/kg, and wet weight or WW) calculated from median and range values taken from diverse studies.

Organism			Cd concentration (mg/kg, WW)	Location	Reference
Bivalve molluscs	Mussel (*Mytilus edulis*)	R=0.170	0.110 (0.020-0.200)	Catalonia	Falcó et al. 2006
			0.290	Galicia	Blanco et al., 2008
			0.170 (0.003-0.500)	Valencia	Yusà et al., 2008
			0.110 (0.079-0.251)	Galicia	Olmedo et al., 2013
	Oyster (*Crassostrea Gigas*)	R=0.573	0.573 (0.326-0.820)	Korea	Mok et al., 2015
	Clam	R=0.062	0.125 (0.030-0.220)	Catalonia	Falcó et al. 2006
			0.070	Galicia	Blanco et al., 2008
			0.010 (0.030-0.070)	Valencia	Yusà et al., 2008
			0.041 (0.028-0.131)	Italy	Olmedo et al., 2013
Crustaceans	Prawn	R=0.260	0.020 (0.010-0.030)	Catalonia	Falcó et al. 2006
			0.029 (0.014-0.063)	Andalusia	Olmedo et al., 2013
			0.730	Bangladesh	Baki et al, 2018
	Crab	0.480	0.48	China	Liu et al., 2019
Cephalopods	Cuttlefish (*Sepia officinalis*)	R=0.065	0.050 (0.010-0.090)	Catalonia	Falcó et al. 2006
			0.140 (0.005-0.900)	Valencia	Yusà et al., 2008
			0.006 (0.000-0.012)	Andalusia	Olmedo et al., 2013
	Octopus	0.210	0.210	Galicia	Blanco et al., 2008
	Squid	R=0.255	0.100 (0.050-0.150)	Catalonia	Falcó et al. 2006
			0.680 (0.250-1.110)	Galicia	Blanco et al., 2008
			0.230 (0.005-0.800)	Valencia	Yusà et al., 2008
			0.010 (0.006-0.021)	Argentina	Olmedo et al., 2013
Fish	Makerel (*Scomber scombrus*)	R=0.008	0.008 (0.005-0.011)	Adriatic, Croatia	Jureša and Blanuša, 2003
			0.007 (0.003-0.010)	Catalonia	Falcó et al. 2006
			0.010 (0.009-0.020)	Valencia	Yusà et al., 2008
			0.007 (0.007-0.008)	Adriatic, Croatia	Jureša and Blanuša, 2003
	Sardine (*Sardina pilchardus*)	R=0.006	0.006 (0.002-0.010)	Catalonia	Falcó et al. 2006
			0.010 (0.003-0.021)	Valencia	Yusà et al., 2008
			0.002 (0.000-0.003)	Andalusia	Olmedo et al., 2013
	Hake (*Merluccius merluccius*)	R=0.003	0.0002	Adriatic, Croatia	Jureša and Blanuša, 2003
			0.007 (0.005-0.010)	Catalonia	Falcó et al. 2006
			0.004 (0.003-0.008)	Valencia	Yusà et al., 2008
			0.001 (0.000-0.005)	Andalusia	Olmedo et al., 2013

Harmful effects

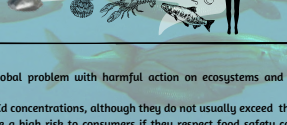
Cd damages biodiversity and ecosystems. It has neurotoxic, genotoxic, nefrotoxic, and carcinogenic (IARC group 1) effects. Also causes bone alterations, as well as endocrine and reproductive disorders (Järup and Åkesson, 2009).

Cd in marine edible species

Cd has low biodisponibility in marine products. According to ACSA, fish and seafood have a contribution of 22 % of Cd in the diet, mainly aported by mollusks, crustaceans and cephalopods (which are species with low consumption). Exceed of Cd limits in edible marine species generated 10 RASFF alerts in Europe on 2020. If the Estimated Weekly Intake (EWI) and Target Hazard Quocient (THQ) is not surpassed, this products can be considered safe for consumers (Storelli and Barone, 2013).

Law and EU reccomendations

Maximum Cd limits on fish and seafood are fixed by the Commission Regulation (EU) No. 420/2011. EFSA established a Cd Tolerable Weekly Intake (TWI) of 2,5 µg/kg of body weight. Kids and high consumers have higher Cd exposition. AESAN also recommends avoiding crustaceans brown meat on the cephalothorax and squid viscera ingestion.



CONCLUSIONS

1. Marine Cd pollution is a current and global problem with harmful action on ecosystems and humans. Must be taken into account and alleviated.
2. Some edible marine species contain high Cd concentrations, although they do not usually exceed the maximum limits set for consumers safety.
3. Cd in marine edible species does not pose a high risk to consumers if they respect food safety competent authorities recommendations and consume seafood responsibly. Certain population sectors with higher risk need specific measures.
4. Contamination of marine species with Cd and the effects on humans of its intake need more study for some regions and species, in order to benefit scientific progress, industries and consumers.

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