Supplementary Information for

Species-specific mercury speciation in billfishes and its implications for food safety monitoring and dietary advice

Anaïs Médieu, David Point, Valérie Allain, Nathalie Bodin, Mélanie Lemire, Pierre Ayotte, Zahirah Dhurmeea, Matthieu Waeles, Laure Laffont, Antoine Le Gohalen, François Roupsard, Anne Lorrain

This PDF file includes:

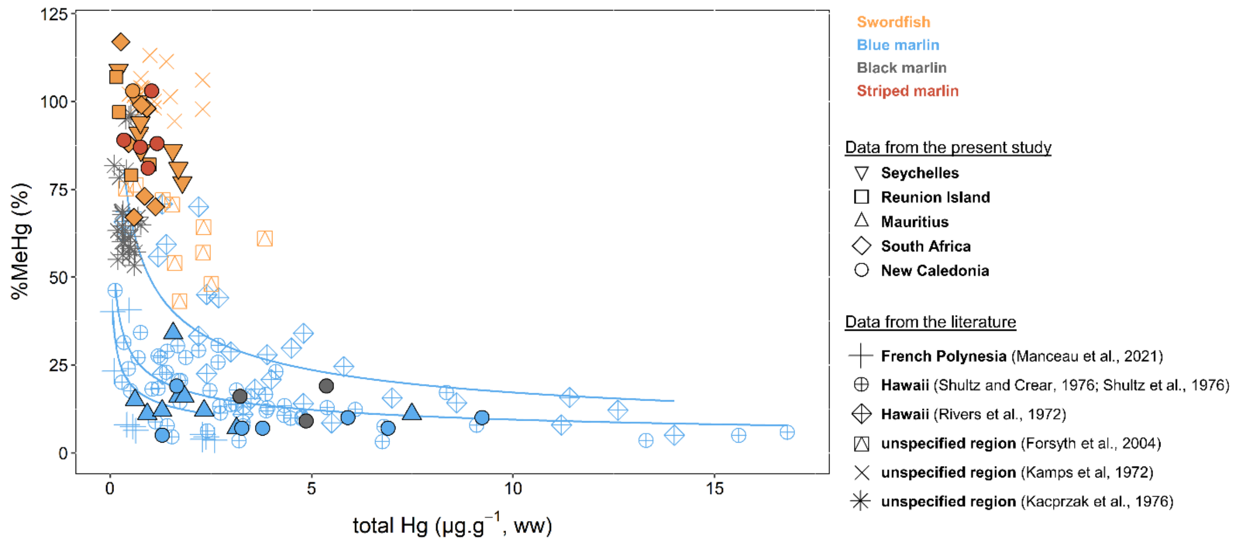

Figure S1. Relationship between the percentage of methylmercury (%MeHg) and total mercury (Hg) concentrations (µg.g^{-1}, ww) in muscle tissue of billfishes. Colours and shapes of the symbols refer to the species and the sample provenance, respectively. Species- and region- specific data from the literature were added when available (Forsyth et al., 2004; Kacprzak and Chvojka, 1976; Kamps et al., 1972; Manceau et al., 2021; Rivers et al., 1972; Shultz et al., 1976; Shultz and Crear, 1976). The two blue lines showed the significant negative power-law relationships evidenced between %MeHg and total Hg concentrations in blue marlin from French Polynesia (Manceau et al., 2021) and Hawaii (Rivers et al., 1972; Shultz et al., 1976; Shultz and Crear, 1976) and likely resulting from *in vivo* MeHg demethylation.

Table S1. Literature review of the studies investigating total mercury (Hg) concentrations and methylmercury percentage (%MeHg) in muscle tissues of four billfish species (i.e., swordfish, striped marlin, blue marlin, and black marlin). *n*: number of billfish individuals; ww: wet weight. When available, the type of fish length is specified: LJFL: lower jaw fork length; TL: total length; FL: fork length; EFL: eye to fork length (i.e., post-orbital of the eye to the fork of the caudal fin); CKL: cleithrum-to-caudal keel length. * indicate that the range of values were estimated visually on figures when exact values were not provided in the manuscript nor the SI. § indicate that Hg concentrations provided in dry weight were converted into ww using a mean water content of 75%, as measured in the present study.

Ocean (site)	***n***	**Sampling years**	**Fish size (cm)** mean ± sd (range)	**Total fish weight (kg)** mean ± sd (range)	**Total Hg (µg.g-1, ww)** mean ± sd (range)	**%MeHg (%)** mean ± sd (range)	**reference**
Swordfish *(Xiphias gladius)*							
Mediterranean Sea (Catalan Sea)	26	2018	139 ± 31 LJFL	40 ± 33	0.66 ± 0.29	not available	Biton-Porsmoguer et al., 2022
Mediterranean Sea (Algerian coasts)	30	2015	not available	not available	0.56 ± 0.16 (0.27 – 0.88)	not available	Mehouel et al., 2019
Mediterranean Sea	45	2009 - 2011	not available	not available	1.95 (0.05 – 6.24)	73.0	Brambilla et al., 2013
Mediterranean Sea (Ionian Sea)	58	2003	66 ± 4 (55 – 73)	2 ± 1 (1 – 4)	0.07 ± 0.04 (0.02 – 0.15)	not available	Storelli et al., 2005
Mediterranean Sea (Ionian Sea)	162	1998	not available	47 ± 36 (6 – 125)	0.49 ± 0.26 (0.15 – 1.05)	not available	Storelli and Marcotrigiano, 2001
Mediterranean Sea	20	2014 – 2017	not available	not available	0.62 ± 0.07 (0.12 – 1.66)	not available	Esposito et al., 2018
Atlantic (Azores)	29	2004 – 2005	(73 – 221) LJFL	not available	(0.03 – 2.40)	93.0 ± 7.0	Branco et al., 2007
Atlantic (Azores)	132	1987	(80 – 241) LJFL	not available	(0.06 – 4.91)	not available	Monteiro and Lopes, 1990
Atlantic (Equator)	23	2004 – 2005	(95 – 265) LJFL	not available	(0.90 – 2.20)	96.0 ± 3.0	Branco et al., 2007
Atlantic (Brazil)	310	2009 - 2010	not available	not available	0.58 ± 0.01	not available	Rodrigues et al., 2013
Atlantic (north east)	25	2014 – 2017	not available	not available	0.48 ± 0.14 (0.03 – 2.14)	not available	Esposito et al., 2018
Atlantic (central east)	17	2014 – 2017	not available	not available	0.67 ± 0.13 (0.16 – 1.35)	not available	Esposito et al., 2018
Atlantic (south east)	17	2014 – 2017	not available	not available	0.82 ± 0.13 (0.12 – 2.00)	not available	Esposito et al., 2018

Ocean (site)	***n***	**Sampling years**	**Fish size (cm)** mean ± sd (range)	**Total fish weight (kg)** mean ± sd (range)	**Total Hg (µg.g-1, ww)** mean ± sd (range)	**%MeHg (%)** mean ± sd (range)	**reference**
Atlantic (south west)	11	2014 – 2017	not available	not available	0.67 ± 0.13 (0.05 – 1.52)	not available	Esposito et al., 2018
Atlantic (south west)	192	1997 - 1999	not available	(10 – 412)	0.62 ± 0.35 (0.04 – 2.21)	not available	Mendez et al., 2001
Atlantic	35	2004	132 ± 49 FL (63 – 255)	not available	1.20 ± 1.12 (0.06 – 3.97)	80.3 ± 15.4 (53.9 – 100)	Chen et al., 2007
Atlantic	7	not available	not available	70 (68 – 80)	0.47 ± 0.24 (– 0.82)	72.0 ± 8.0	Yamashita et al., 2005
Indian (Seychelles)	33	2014 – 2015	150 ± 31 LJFL	not available	0.99 ± 0.45	not available	Bodin et al., 2017
Indian (Seychelles)	8	2013 – 2014	169 ± 42 LJFL (100 – 230)	not available	1.03 ± 0.58 (0.21 – 1.80)	90.5 ± 10.4 (77.0 – 109.0)	this study
Indian (Mozambique Channel)	37	not available	123 LJFL (75 – 191)	not available	1.61 ± 1.11	not available	Kojadinovic et al., 2006
Indian (Reunion Island)	7	not available	126 LJFL (90 – 187)	not available	3.97 ± 2.67	not available	Kojadinovic et al., 2006
Indian (Reunion Island)	4	2014 – 2015	120 ± 39 LJFL (87 – 171)	not available	0.47 ± 0.38 (0.15 – 0.99)	91.3 ± 13.1 (79.0 – 107.0)	this study
Indian (South Africa)	8	2015	168 ± 35 LJFL (131 – 230)	not available	0.70 ± 0.27 (0.27 – 1.13)	84.9 ± 18.8 (67.0 – 117.0)	this study
Indian (Sri Lanka)	not available	2017	104 (40 – 200)	42 (13 – 93)	0.62 (<0.07 – 4.3)	not available	Jinadasa et al., 2019
Indian (Sri Lanka)	176	2009 - 2010	136 ± 40 TL (45 – 278)	44 ± 23 (11 – 112)	0.90 ± 0.52 (0.18 – 258)	not available	Jinadasa et al., 2013
Indian (west)	21	2014 – 2017	not available	not available	0.96 ± 0.12 (0.24 – 1.88)	not available	Esposito et al., 2018
Indian (east)	19	2014 – 2017	not available	not available	0.60 ± 0.08 (0.09 – 1.40)	not available	Esposito et al., 2018
Indian	21	2004	156 ± 38 FL (98 – 232)	not available	1.47 ± 0.63 (0.26 – 2.54)	76.4 ± 14.1 (44.8 – 95.4)	Chen et al., 2007
Pacific (Hawaii)	6	2007 - 2011	140 ± 36 (81 – 178)	not available	1.15 ± 0.48 (0.27 – 1.59)	not available	Blum et al., 2013

Ocean (site)	***n***	**Sampling years**	**Fish size (cm)** mean ± sd (range)	**Total fish weight (kg)** mean ± sd (range)	**Total Hg (µg.g-1, ww)** mean ± sd (range)	**%MeHg (%)** mean ± sd (range)	**reference**
Pacific (Hawaii)	24	not available	not available	(25 – 180)*	(0.70 – 2.80)*	not available	Choy et al., 2009
Pacific (Hawaii)	50	2006	not available	78 ± 56 (10 – 199)	1.07 ± 0.60	not available	Kaneko and Ralston, 2007
Pacific (north east)	3	not available	not available	(2 – 227)	(0.04 – 2.10)	not available	Shomura and Craig, 1972
Pacific (Fiji)	5	not available	not available	not available	1.81 ± 0.82 (0.99 – 2.81)	not available	Kumar et al., 2004
Pacific (central east)	4	2014 – 2017	not available	not available	0.71 ± 0.05 (0.34 – 1.10)	not available	Esposito et al., 2018
Pacific (central west)	20	2014 – 2017	not available	not available	0.65 ± 0.07 (0.17 – 1.65)	not available	Esposito et al., 2018
Pacific (south east)	29	2014 – 2017	not available	not available	0.71 ± 0.05 (0.12 – 2.93)	not available	Esposito et al., 2018
Pacific (south west)	5	2014 – 2017	not available	not available	0.79 ± 0.01 (0.25 – 2.13)	not available	Esposito et al., 2018
Pacific (New Caledonia)	1	2021	102 FLJ	not available	0.56	103	this study
Pacific	82	2013 - 2014	(90 – 153)* CKL	not available	(0.23 – 2.09)	not available	Cladis et al., 2015
not available	32	2014 – 2017	not available	not available	0.81 (0.04 – 3.70)	not available	Esposito et al., 2018
not available	27	2005	not available	not available	0.96 ± 0.47 (0.41 – 2.11)	not available	Torres-Escribano et al., 2010
not available	10	2002	not available	not available	1.82 (0.40 – 3.84)	not available	Dabeka et al., 2004
not available	10	not available	not available	not available	1.82 ± 0.99 (0.40 – 3.85)	62.1 ± 11.5 (43.1 – 76.2)	Forsyth et al., 2004
not available	20	not available	not available	not available	1.05 ± 0.52 (0.48 – 2.30)	101.7 ± 5.0 (93.4 – 113.1)	Kamps et al., 1972
Striped marlin *(Kajikia audax)*							
Atlantic	7	not available	not available	71 (70 – 75)	0.51 ± 0.08 (– 0.64)	76.0 ± 6.0	Yamashita et al., 2005

Ocean (site)	***n***	**Sampling years**	**Fish size (cm)** mean ± sd (range)	**Total fish weight (kg)** mean ± sd (range)	**Total Hg (µg.g-1, ww)** mean ± sd (range)	**%MeHg (%)** mean ± sd (range)	**reference**
Indian (Seychelles)	3	2018	182 ± 3 LJFL	not available	0.13 ± 0.03	not available	Sardenne et al., 2020
Pacific (Gulf of California)	17	2015	167 ± 21 EFL (142 – 214)	not available	0.90 ± 0.53[§] (0.12 – 3.10)	not available	Ordiano-Flores et al., 2021
Pacific (Gulf of California)	13	2006 – 2007	186 ± 28 LJFL (159 – 254)	79 ± 43 (45 – 188)	1.70 ± 0.48 (0.81 – 3.12)	not available	Soto-Jiménez et al., 2010
Pacific (New Caledonia)	5	2020 - 2021	218 ± 19 LJFL (196 – 247)	not available	0.85 ± 032 (0.35 – 1.17)	89.6 ± 8.1 (81.0 – 103.0)	this study
Pacific (Hawaii)	30	not available	not available	(5 – 65)*	(0.05 – 1.30)*	not available	Choy et al., 2009
Pacific (Hawaii)	30	2006	not available	32 ± 17 (6 – 69)	0.47 ± 0.37	not available	Kaneko and Ralston, 2007
Pacific (north east)	56	not available	not available	(25 – 105)	0.80 (0.03 – 2.10)	not available	Shomura and Craig, 1972
Pacific (New Zealand)	34	1976 - 1978	201 (158 – 232)	not available	0.99 ± 0.30 (0.15 – 1.44)	not available	van den Broek et al., 1981
Blue marlin *(Makaira indica)*							
Atlantic (north west)	60	2021 - 2021	not available	not available	4.17 ± 2.61	not available	Rudershausen et al., 2022
Atlantic (north west)	17	1975 – 1977	not available	not available	9.47 ± 4.11	not available	Rudershausen et al., 2022
Atlantic (Grenada and Dominican Republic	62	2017 – 2018	not available	not available	0.91 ± 1.18 (0.09 – 6.23)	not available	Bille et al., 2020
Atlantic (Gulf of Mexico)	9	2002 – 2003	285 ± 23 TL (256 – 311)	not available	10.52 ± 5.03 (4.95 – 18.72)	not available	Cai et al., 2007
Atlantic	7	not available	not available	48 (46 – 50)	0.56 ± 0.05 (– 0.62)	43.0 ± 3.0	Yamashita et al., 2005
Indian (Seychelles)	3	2014 – 2015	219 ± 14 LJFL	not available	0.75 ± 0.87	not available	Bodin et al., 2017
Indian (Mauritius)	9	2021 – 2022	217 ± 41 LJFL (170 – 288)	108 ± 79 (50 – 253)	2.32 ± 2.07 (0.62 – 7.79)	14.9 ± 7.7 (7.0 – 34.0)	this study
Pacific (Gulf of California)	16	2015	182 ± 40 EFL (134 – 261)	not available	4.75 ± 7.40[§] (0.12 – 21.40)	not available	Ordiano-Flores et al., 2021

Ocean (site)	*n*	Sampling years	Fish size (cm) mean ± sd (range)	Total fish weight (kg) mean ± sd (range)	Total Hg (µg.g-1, ww) mean ± sd (range)	%MeHg (%) mean ± sd (range)	reference
Pacific (Gulf of California)	99	2005 – 2012	(180 – 290)* LJFL	not available	1.91 (0.01 – 55.00)*	not available	Vega-Sánchez et al., 2017
Pacific (French Polynesia)	11	2016 – 2017	not available	(49 – 245)*	1.120 ± 1.030 (0.070 – 2.600)	19.2 ± 21.6 (3.6 – 68.6)	Manceau et al., 2021
Pacific (Hawaii)	50	2006	not available	98 ± 64 (33 – 319)	2.38 ± 3.00	not available	Kaneko and Ralston, 2007
Pacific (Hawaii)	19	2002	not available	81 ± 32 (38 – 147)	1.62 ± 1.14 (0.06 – 3.88)	not available	Brooks, 2004
Pacific (Hawaii)	46	1974	not available	not available	3.12 (0.09 – 10.00)	13.0	Shultz and Ito, 1979
Pacific (New Caledonia)	7	2021	246 ± 53 LJFL (189 – 315)	not available	4.58 ± 2.90 (1.30 – 9.23)	9.3 ± 4.6 (5.0 – 19.0)	this study
Pacific (Hawaii)	35	1973	not available	114 ± 68 (49 – 415)	4.34 ± 3.91 (0.13 – 16.80)	15.3 ± 10.2 (3.1 – 46.2)	Shultz and Crear, 1976
Pacific (Hawaii)	19	1972	not available	82 ± 35 (51 – 198)	2.06 ± 1.96 (0.30 – 8.35)	21.5 ± 12.1 (3.4 – 62.2)	Shultz et al., 1976
Pacific (Hawaii)	37	not available	not available	(43 – 411)	(0.70 – 7.86)	not available	Shomura and Craig, 1972
Pacific (Hawaii)	27	not available	not available	118 ± 74 (43 – 355)	4.78 ± 3.72 (0.35 – 14.00)	29.0 ± 19.9 (5.0 – 70.8)	Rivers et al., 1972
Pacific (Ecuador)	8	not available	not available	not available	2.57 ± 1.58 (1.06 – 5.88)	not available	Yánez-Jácome et al., 2023
Black marlin *(Makaira nigricans)*							
Indian (Sri Lanka)	24	2009 - 2010	54 ± 24 (25 – 118)	157 ± 28 (90 – 210)	0.49 ± 0.38 (0.11 – 0.51)	not available	Jinadasa et al., 2014
Pacific (Australia)	42	1973	306 ± 40 (198 – 371)	318 ± 116 (68 – 572)	7.27 ± 3.86 (0.50 – 16.50)	not available	Mackay et al., 1975
Pacific (New Caledonia)	3	2021	242 ± 20 LJFL (219 – 257)	not available	4.49 ± 1.12 (3.23 – 5.37)	14.7 ± 5.1 (9.0 – 19.0)	this study
not available	25	not available	not available	not available	0.42 ± 0.17 (0.11 – 0.77)	67.7 ± 12.9 (53.3 – 96.2)	Kacprzak and Chvojka, 1976

References used in the document

Bille, L., Crovato, S., Manfrin, A., Dalla Pozza, M., Toson, M., Franzago, E., Pinto, A., Mascarello, G., Muzzolon, O., Tosi, F., Negroni, G., Cappi, G., Obregon, P., Ravarotto, L., Binato, G., 2020. Mercury contents in commercial Billfish species of the Western Central Atlantic: Assessing the potential risks to human health of Billfish consumption. Food Control 110, 107002. https://doi.org/10.1016/j.foodcont.2019.107002

Biton-Porsmoguer, S., Bănaru, D., Harmelin-Vivien, M., Béarez, P., Bouchoucha, M., Marco-Miralles, F., Marquès, M., Lloret, J., 2022. A study of trophic structure, physiological condition and mercury biomagnification in swordfish (Xiphias gladius): Evidence of unfavourable conditions for the swordfish population in the Western Mediterranean. Marine Pollution Bulletin 176, 113411. https://doi.org/10.1016/j.marpolbul.2022.113411

Blum, J.D., Popp, B.N., Drazen, J.C., Anela Choy, C., Johnson, M.W., 2013. Methylmercury production below the mixed layer in the North Pacific Ocean. Nature Geoscience 6, 879–884. https://doi.org/10.1038/ngeo1918

Bodin, N., Lesperance, D., Albert, R., Hollanda, S., Michaud, P., Degroote, M., Churlaud, C., Bustamante, P., 2017. Trace elements in oceanic pelagic communities in the western Indian Ocean. Chemosphere 174, 354–362. https://doi.org/10.1016/j.chemosphere.2017.01.099

Brambilla, G., Abete, M.C., Binato, G., Chiaravalle, E., Cossu, M., Dellatte, E., Miniero, R., Orletti, R., Piras, P., Roncarati, A., Ubaldi, A., Chessa, G., 2013. Mercury occurrence in Italian seafood from the Mediterranean Sea and possible intake scenarios of the Italian coastal population. Regulatory Toxicology and Pharmacology 65, 269–277. https://doi.org/10.1016/j.yrtph.2012.12.009

Branco, V., Vale, C., Canário, J., Santos, M.N. dos, 2007. Mercury and selenium in blue shark (Prionace glauca, L. 1758) and swordfish (Xiphias gladius, L. 1758) from two areas of the Atlantic Ocean. Environmental Pollution 150, 373–380. https://doi.org/10.1016/j.envpol.2007.01.040

Brooks, B., 2004. Mercury levels in tuna and other major commercial fish species in Hawaii. Presented at the Proceedings of the 2004 National Forum on Contalinants in Fish, San Diego, CA, USA, p. 24.

Cai, Y., Rooker, J.R., Gill, G.A., Turner, J.P., 2007. Bioaccumulation of mercury in pelagic fishes from the northern Gulf of Mexico. Canadian Journal of Fisheries and Aquatic Sciences 64, 458–469. https://doi.org/10.1139/f07-017

Chen, M.-H., Chen, C.-Y., Chang, S.-K., Huang, S.-W., 2007. Total and organic mercury concentrations in the white muscles of swordfish (Xiphias gladius) from the Indian and Atlantic oceans. Food Additives and Contaminants 24, 969–975. https://doi.org/10.1080/02652030701305470

Choy, C.A., Popp, B.N., Kaneko, J.J., Drazen, J.C., 2009. The influence of depth on mercury levels in pelagic fishes and their prey. Proceedings of the National Academy of Sciences 106, 13865–13869. https://doi.org/10.1073/pnas.0900711106

Cladis, D.P., Zhang, R., Tan, X., Craig, B., Santerre, C.R., 2015. Postharvest Correlation between Swordfish (Xiphius gladius) Size and Mercury Concentration in Edible Tissues. Journal of Food Protection 78, 396–401. https://doi.org/10.4315/0362-028X.JFP-14-449

Dabeka, R., McKenzie, A.D., Forsyth, D.S., Conacher, H.B.S., 2004. Survey of total mercury in some edible fish and shellfish species collected in Canada in 2002. Food Additives & Contaminants 21, 434–440. https://doi.org/10.1080/02652030410001670184

Esposito, M., De Roma, A., La Nucara, R., Picazio, G., Gallo, P., 2018. Total mercury content in commercial swordfish (Xiphias gladius) from different FAO fishing areas. Chemosphere 197, 14–19. https://doi.org/10.1016/j.chemosphere.2018.01.015

Forsyth, D.S., Casey, V., Dabeka, R.W., McKenzie, A., 2004. Methylmercury levels in predatory fish species marketed in Canada. Food Additives & Contaminants 21, 849–856. https://doi.org/10.1080/02652030400004259

Jinadasa, B.K.K.K., Chathurika, G.S., Jayaweera, C.D., Jayasinghe, G.D.T.M., 2019. Mercury and cadmium in swordfish and yellowfin tuna and health risk assessment for Sri Lankan consumers. Food Additives & Contaminants: Part B 12, 75–80. https://doi.org/10.1080/19393210.2018.1551247

Jinadasa, B.K.K.K., Edirisinghe, E.M.R.K.B., Wickramasinghe, I., 2014. Total mercury, cadmium and lead levels in main export fish of Sri Lanka. Food Additives & Contaminants: Part B 7, 309–314. https://doi.org/10.1080/19393210.2014.938131

Jinadasa, B.K.K.K., Edirisinghe, E.M.R.K.B., Wickramasinghe, I., 2013. Total mercury content, weight and length relationship in swordfish (Xiphias gladius) in Sri Lanka. Food Additives & Contaminants: Part B 6, 244–248. https://doi.org/10.1080/19393210.2013.807521

Kacprzak, J.L., Chvojka, R., 1976. Determination of Methyl Mercury in Fish by Flameless Atomic Absorption Spectroscopy and Comparison with an Acid Digestion Method for Total Mercury. Journal of Association of Official Analytical Chemists 59, 153–157. https://doi.org/10.1093/jaoac/59.1.153

Kamps, L.R., Carr, R., Miller, H., 1972. Total mercury-monomethylmercury content of several species of fish. Bull. Environ. Contam. Toxicol. 8, 273–279. https://doi.org/10.1007/BF01684556

Kaneko, J.J., Ralston, N.V.C., 2007. Selenium and Mercury in Pelagic Fish in the Central North Pacific Near Hawaii. Biol Trace Elem Res 119, 242–254. https://doi.org/10.1007/s12011-007-8004-8

Kojadinovic, J., Potier, M., Le Corre, M., Cosson, R.P., Bustamante, P., 2006. Mercury content in commercial pelagic fish and its risk assessment in the Western Indian Ocean. Science of The Total Environment 366, 688–700. https://doi.org/10.1016/j.scitotenv.2006.02.006

Kumar, M., Aalbersberg, B., Mosley, L., 2004. Mercury levels in Fijian seafoods and potential health implications. Institute of Applied Sciences, University of the South Pacific.

Mackay, N.J., Kazacos, M.N., Williams, R.J., Leedow, M.I., 1975. Selenium and heavy metals in black marlin. Marine Pollution Bulletin 6, 57–61. https://doi.org/10.1016/0025-326X(75)90132-0

Manceau, A., Azemard, S., Hédouin, L., Vassileva, E., Lecchini, D., Fauvelot, C., Swarzenski, P.W., Glatzel, P., Bustamante, P., Metian, M., 2021. Chemical Forms of Mercury in Blue Marlin Billfish: Implications for Human Exposure. Environ. Sci. Technol. Lett. 8, 405–411. https://doi.org/10.1021/acs.estlett.1c00217

Mehouel, F., Bouayad, L., Hammoudi, A.H., Ayadi, O., Regad, F., 2019. Evaluation of the heavy metals (mercury, lead, and cadmium) contamination of sardine (Sardina pilchardus) and swordfish (Xiphias gladius) fished in three Algerian coasts. Vet World 12, 7–11. https://doi.org/10.14202/vetworld.2019.7-11

Mendez, E., Giudice, H., Pereira, A., Inocente, G., Medina, D., 2001. Total Mercury Content—Fish Weight Relationship in Swordfish (Xiphias gladius) Caught in the Southwest Atlantic Ocean. Journal of Food Composition and Analysis 14, 453–460. https://doi.org/10.1006/jfca.2001.1005

Monteiro, L.R., Lopes, H.D., 1990. Mercury content of swordfish, Xiphias gladius, in relation to length, weight, age, and sex. Marine Pollution Bulletin 21, 293–296. https://doi.org/10.1016/0025-326X(90)90593-W

Ordiano-Flores, A., Galván-Magaña, F., Sánchez-González, A., Soto-Jiménez, M.F., Páez-Osuna, F., 2021. Mercury, selenium, and stable carbon and nitrogen isotopes in the striped marlin Kajikia audax and blue marlin Makaira nigricans food web from the Gulf of California. Marine Pollution Bulletin 170, 112657. https://doi.org/10.1016/j.marpolbul.2021.112657

Rivers, J.B., Pearson, J.E., Shultz, C.D., 1972. Total and organic mercury in marine fish. Bull. Environ. Contam. Toxicol. 8, 257–266. https://doi.org/10.1007/BF01684554

Rodrigues, M.V., Yamatogi, R.S., Sudano, M.J., Galvão, J.A., de Pérez, A.C.A., Biondi, G.F., 2013. Mercury Concentrations in South Atlantic Swordfish, Xiphias gladius, Caught off the Coast of Brazil. Bull Environ Contam Toxicol 90, 697–701. https://doi.org/10.1007/s00128-013-0989-4

Rudershausen, P.J., Cross, F.A., Runde, B.J., Evans, D.W., Cope, W.G., Buckel, J.A., 2022. Total mercury, methylmercury, and selenium concentrations in blue marlin Makaira nigricans from a long-term dataset in the western north Atlantic. Science of The Total Environment 159947. https://doi.org/10.1016/j.scitotenv.2022.159947

Sardenne, F., Bodin, N., Médieu, A., Antha, M., Arrisol, R., Le Grand, F., Bideau, A., Munaron, J.-M., Le Loc'h, F., Chassot, E., 2020. Benefit-risk associated with the consumption of fish bycatch from tropical tuna fisheries. Environmental Pollution 267, 115614. https://doi.org/10.1016/j.envpol.2020.115614

Shomura, R.S., Craig, W.L., 1972. Mercury in several species of billfishes taken off Hawaii and southern California. In proceedings from the International Billfish Symposium, Kailua-Kona, Hawaii, pp. 160–163.

Shultz, C.D., Crear, D., 1976. The Distribution of Total and Organic Mercury in Seven Tissues of the Pacific Blue Marlin, Makaira nigricans.

Shultz, C.D., Crear, D., Pearson, J., Rivers, J., Hylin, J., 1976. Total and organic mercury in the Pacific blue marlin. Bulletin of environmental contamination and toxicology 15, 230–4. https://doi.org/10.1007/BF01685166

Shultz, C.D., Ito, B.M., 1979. Mercury and selenium in blue marlin, Makaira nigricans, from the Hawaiian islands. Fishery Bulletin 76.

Soto-Jiménez, M.F., Amezcua, F., González-Ledesma, R., 2010. Nonessential Metals in Striped Marlin and Indo-Pacific Sailfish in the Southeast Gulf of California, Mexico: Concentration and Assessment of Human Health Risk. Arch Environ Contam Toxicol 58, 810–818. https://doi.org/10.1007/s00244-009-9452-2

Storelli, M.M., Giacominelli-Stuffler, R., Storelli, A., Marcotrigiano, G.O., 2005. Accumulation of mercury, cadmium, lead and arsenic in swordfish and bluefin tuna from the Mediterranean Sea: A comparative study. Marine Pollution Bulletin 50, 1004–1007. https://doi.org/10.1016/j.marpolbul.2005.06.041

Storelli, M.M., Marcotrigiano, G.O., 2001. Total Mercury Levels in Muscle Tissue of Swordfish (Xiphias gladius) and Bluefin Tuna (Thunnus thynnus) from the Mediterranean Sea (Italy). Journal of Food Protection 64, 1058–1061. https://doi.org/10.4315/0362-028X-64.7.1058

Torres-Escribano, S., Vélez, D., Montoro, R., 2010. Mercury and methylmercury bioaccessibility in swordfish. Food Additives & Contaminants: Part A 27, 327–337. https://doi.org/10.1080/19440040903365272

van den Broek, W.L.F., Tracey, D.M., Solly, S.R.B., Avrahami, M., 1981. Mercury levels in some New Zealand sea fishes. New Zealand Journal of Marine and Freshwater Research 15, 137–146. https://doi.org/10.1080/00288330.1981.9515906

Vega-Sánchez, B., Ortega-García, S., Ruelas-Inzunza, J., Frías-Espericueta, M., Escobar-Sánchez, O., Guzmán-Rendón, J., 2017. Mercury in the Blue Marlin (Makaira nigricans) from the Southern Gulf of California: Tissue Distribution and Inter-Annual Variation (2005–2012). Bull Environ Contam Toxicol 98, 156–161. https://doi.org/10.1007/s00128-016-1962-9

Yamashita, Y., Omura, Y., Okazaki, E., 2005. Total mercury and methylmercury levels in commercially important fishes in Japan. Fisheries Sci 71, 1029–1035. https://doi.org/10.1111/j.1444-2906.2005.01060.x

Yánez-Jácome, G.S., Romero-Estévez, D., Vélez-Terreros, P.Y., Navarrete, H., 2023. Total mercury and fatty acids content in selected fish marketed in Quito – Ecuador. A benefit-risk assessment. Toxicology Reports 10, 647–658. https://doi.org/10.1016/j.toxrep.2023.05.009