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ABSTRACTS

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TRACE METALS IN GILTHEAD SEABREAM (*Sparus aurata*) FARMED IN COPPER ALLOY MESH AND ANTIFOULING COATED NYLON NET CAGES WITH POTENTIAL HEALTH RISK ASSESSMENT

Murat Yigit[1*], Barbaros Celikkol[2], Sevdan Yilmaz[1], Musa Bulut[1], Baris Ozalp[1], Robert Dwyer[3], Masashi Maita[4] and Yesim Buyukates[1]

[1] COMU, Faculty of Marine Science and Technology, Canakkale (Turkey)
[2] UNH, Departments of Mechanical and Ocean Engineering, New Hampshire (USA)
[3] ICA, New York (USA)
[4] TUMSAT, Department of Marine Science, Tokyo (Japan)
E-mail: muratyigit@comu.edu.tr

Introduction

Adopting a new technology of copper alloy mesh (CAM) may provide solutions for the problems related to the expansion of cage farms, including the reduction of biofouling (Carvalho et al., 2014), improvement of fish welfare (Moe et al., 2009) and reduction of environmental impacts relative to traditional nylon nets (Ayer et al., 2016). However, whether the farmed fish in the CAM pens are safe for human consumption still remains to be answered. This study was undertaken to compare trace metals in fish cultured in CAM or antifouling-coated or non-coated nylon nets, and potential health risks to human when consuming the farmed fish.

Materials and Methods

Gilthead seabream (mean weight 122 g) were grown in offshore cages equipped with three different net materials (CAM; traditional nylon net with TNN_{+AF}; or without antifouling paint TNN_{-AF}) in water temperature ranging between 11.4 and 24.6 °C for 210 days. Cu, Zn, Fe, and Mn in fish tissues from three different nettings were investigated and individual dietary exposure of human to trace metals by fish consumption was estimation for the health risk assessment.

Results

Results showed that Cu, Zn, Fe and Mn in the liver, gills and skin tissues were higher than fish muscles. Mean levels of trace metals in the muscles of fish from the three net pens (CAM, treated and untreated nylon) declined in the order of Fe(5.76) > Zn(5.56) > Cu(0.53) > Mn(0.27); Zn(5.20) > Fe(3.97) > Cu(0.52) > Mn(0.27); and Zn(3.61) > Fe(3.12) > Cu(0.52) > Mn(0.16) mg/kg wet weight, respectively. Metals in fish tissues in all experimental groups did not exceed maximum levels suggested by the EU or US-FDA regulations for seafood. Target hazard quotients (THQs) were less then "1" (Table I and II).

Discussion

In all three net materials, Cu (0.40-7.38 mg/kg), Zn (3.61-53.06 mg/kg), Fe (3.12-19.88 mg/kg), and Mn (0.16-0.27 mg/kg) levels in the tissues were 3 to 30 fold lower than the permissible upper limits of international standards (WHO, 1989). Concentrations of Cu, Zn, Fe and Mn in liver, gills, skin and muscle tissues of fish from CAM and antifouling coated nylon net pens were similar, which is in agreement with earlier reports (Kalantzi et al., 2016, Yigit et al., 2016). This could be an indication of sufficiently slow leaching of copper into the water and adequately fast water exchange so that the natural homeostasis of fish and its detoxification process was not adversly affected (Solberg et al., 2002). The EDC rates for Cu, Zn, Fe, and Mn in the muscles of fish from CAM, TNN_{+AF}, and TNN_{-AF} were below the US-IOM guidelines (IOM, 2006). Maximum ADCL or ACR were highest in the TNN_{-AF} group, however, values obtained in the CAM or TNN_{+AF} pen showed no health risks, 110-620 times higher than daily fish consumption per capita of 63 g (Failler et al., 2007) in Europe. The sum of THQs was lower than the risk level of "1", showing no risks related to fish consumption.

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Table I. Dietary reference intakes (DRI) of metals, estimated daily consumption (EDC) and individual risk rate (IRR) through the consumption of fish cultured in different net materials

	DRI (mg/day/person)			EDC (mg/day/person)			IRR		
Metal	EAR	RDA	TUL	CAM	TNN_{+AF}	TNN_{-AF}	CNC	TNN_{+AF}	TNN_{-AF}
Cu	0.7	0.9	10.0	0.033	0.035	0.028	0.003	0.004	0.003
Zn	9.4	11.0	40.0	0.350	0.328	0.227	0.009	0.008	0.006
Fe	6.0	8.0	45.0	0.363	0.250	0.178	0.008	0.006	0.004
Mn	BDL	2.3*	11.0	0.018	0.016	0.010	0.002	0.002	0.001

EAR (estimated average requirement), RDA (recommended daily allowance), TUL (tolerable upper limit), *AI (adequate intake), BDL: below detectable limits

Table II. Maximum allowable daily fish consumption limit (ADCL), maximum allowable fish consumption rate (ACR), and target hazardous quotients (THQ) of metals by consuming fish from different net materials

	ADCL (kg/day/person)			ACR (meal/wk/person)			THQ		
Metal	CAM	TNN_{+AF}	TNN_{-AF}	CAM	TNN_{+AF}	TNN_{-AF}	CAM	TNN_{+AF}	TNN_{-AF}
Cu	18.87	17.86	22.73	581.8	550.7	700.8	0.0033	0.0035	0.0028
Zn	7.19	7.69	11.08	221.9	237.2	341.7	0.0088	0.0082	0.0057
Fe	7.81	11.34	15.96	240.9	349.5	492.1	0.0081	0.0056	0.0039
Mn	39.27	42.31	68.75	1211.5	1304.6	2120.0	0.0016	0.0015	0.0009
Total Hazard Index							0.0218	0.0188	0.0133

Based on meal size of 0.227 kg fish/meal, and adult human consumer weight of 70 kg

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