PCB contamination in farmed and wild sea bass (Dicentrarchus labrax L.) and exposure evaluation associated with fish consumption

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Introduction

Although polychlorinated biphenyls (PCBs) have been banned in almost all industrialised countries for more than 20 years, they are still present in all environmental media and animal tissues causing concern for human health and environmental safety. In particular exposure of human population, also to background contamination, during the prenatal period, seems to be involved in endocrine disruption and in reproductive and neurobehavioral adverse effects. Food is by far the major route of exposure to these compounds and fish and fishery products represent the most contaminated food items[1].

In order to decrease human and animal exposure to these compounds, recently the European Union regulations on food safety established the maximum allowed levels for dioxins in foodstuffs and animal feeds[2]. In particular until now such limits refer to polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) but they will be soon extended to the dioxin-like and non dioxin-like PCBs.

In the present investigation PCB concentrations have been measured in the edible part of farmed and wild sea bass from the Orbetello Lagoon, in the corresponding feed and in sediment samples of farming ponds and open lagoon. Sea bass is a predator fish widespread in all the Mediterranean Sea, eastern part of the Atlantic Ocean and in the Black Sea; moreover it is one of the most popular and valuable fish sold in Italy. The purpose of this study was to compare PCB contamination in farmed and wild sea bass and to estimate the average intake of PCBs via consumption of fish in Italy.

Materials and Methods

Sampling was carried out during June-July 2003 in the Orbetello Lagoon, a wetland located between the Tuscany Mediterranean coast and Monte Argentario (central Italy). A total of 33 samples of wild sea bass were collected: 13 in the open lagoon and 20 in a fish farm located in the lagoon. One sample of farmed sea bass feed, 3 sediment samples from fish ponds and 1 from the open lagoon were also collected at the same time, and analysed.

All samples were stored at –20 °C until the analysis. The preparative procedure was the following: each sample was homogenised, lyophilised and spiked with a mixture of the twelve $^{13}C_{12}$ dioxin-like PCB congeners, supplied from Dr. Ehrenstorfer Laboratories (Ausburg, Germany) and Cambridge Isotope Laboratories (Andover, MA). After extraction by Soxhlet apparatus (hexane/acetone 4:1), samples were evaporated until dryness and than fat content was gravimetrically determined. Clean-up was carried out overnight adding sulphuric acid (Carlo Erba Reagenti, Milan, Italy) on an Extrelut column (Merck, Darmstad, Germany) and by a silica gel column. Eluate was evaporated to small volume for instrumental analysis which was performed by HRGC-HRMS.

A gas chromatograph TRACE GC, ThermoFinnigan, with GC PAL, CTC Analytics auto sampler, coupled with a Mat 95 XP mass spectrometer working in electric impact ionisation mode, was utilised. The electron energy was 57 eV, the injector temperature was 250 °C and the power resolution > 10000.A SGE HT8, 60m x 0.25mm x 0.25 mm, capillary column was used with the following temperature programme: 120°C for 1 min, 20°C/min until 180°C, 2°C/min until 260°C, 5°C/min until 300°C for 8 min. The HRGC-HRMS was used in the selected ion monitoring (SIM) mode and 59 individual congeners were measured in the same sample injection.

Results and Discussion

The two fish populations showed a different lipid content which, expressed as average ± standard deviation, resulted to be 9.2 ± 2.8 % and 3.6 ± 2.9 %, for farmed and wild sea bass, respectively.

In terms of toxicity equivalent (TEQ)[3], the analytical results indicated a contamination on whole weight basis something higher in farmed in comparison to wild fishes: 2.8±0.9 and 1.4±1.3 pg WHO-TEQ/g (Figure 1).

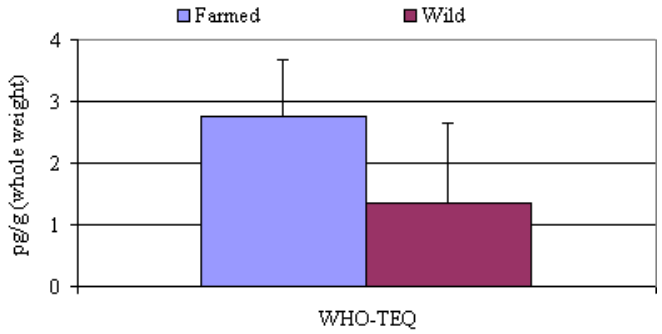

Figure 1. Mean concentration levels with standard deviations of WHO-TEQ due to dioxin-like PCBs in farmed and wild sea-bass from the Orbetello Lagoon.

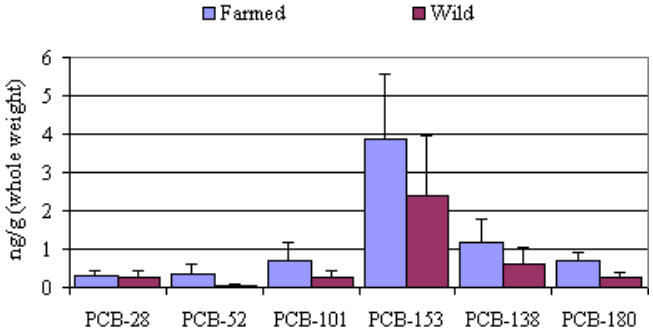

Figure 2. Mean concentration levels with standard deviations of the six non dioxin-like indicator PCBs in farmed and wild sea bass from the Orbetello Lagoon

Concentration values detected in the individual samples were frequently close to, and in one sample exceeding, the EC limit of 4 pg WHO-TEQ/g fresh weight established for PCDDs and PCDFs from the European Commission[2]. Figure 2 shows the average concentration values in the two fish groups of the six indicators of non dioxin-like PCBs. The congener #153 is the most abundant detected (3.9±1.7 and 2.4±1.5 ng/g whole weight in farmed and wild bass, respectively) followed by congeners #138 and #180. This pattern, which can be considered a “fingerprint” of the biological samples, also characterise the feed and the sediment samples analysed (Figure 3).

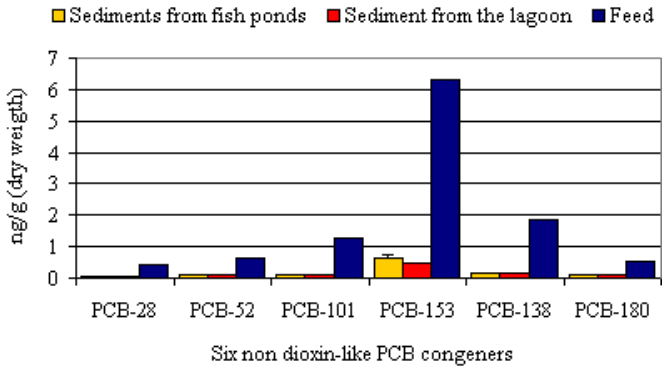

Figure 3. Concentration levels of the six non dioxin-like indicator PCBs in feed and pond sediments of farmed sea bass and in a sediment sample from the Orbetello Lagoon.

Contamination level, expressed as WHO-TEQ, in the feed sample resulted of 2.3 pg/g product, a value marginally exceeding the EC limit of 2.25 pg WHO-TEQ/g product in feed for fish, established from EC for PCDDs and PCDFs[4]. Finally, results of sediment analysis showed contamination levels very similar in all the samples analysed. Concentration values, expressed as WHO-TEQ, resulted 0.2 and 0.3 pg/g dry weight in the fishing ponds and in the open lagoon, respectively.

In order to estimate the human PCB intake due to fish consumption in Italy, concentration values in sea bass obtained in the present study were combined with Italian food consumption data[5]. Results indicated an average intake due to ingestion of farmed and wild sea bass of 0.01 and 0.004 pg WHO-TEQ/kg b.w. (considering 60 kg as average body weight), respectively. Assuming that contamination levels in all the consumed fish could be the same of those found in the present study, the daily intake would reach 1.4 and 0.7 pg WHO-TEQ/kg b.w., using farmed and wild sea bass data respectively. These values are already close alone to the Tolerable Daily Intake (TDI) of 2 pg WHO-TEQ/kg b.w. adopted by the *Scientific Committee on Food* (SCF)[6] and shows the elevated contribution of fish to the total intake of dioxin-like compounds through the diet.

Acknowledgements

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