COMPARISON OF PCB AND DDT CONTAMINATION IN CULTIVATED AND WILD SEA BASS FROM RIA DE AVEIRO, PORTUGAL

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Introduction

Fish accumulate chemical substances either directly from the surrounding environment or from their diet. The characteristics of organochlorine compounds and of the aquatic environment as well as the lipid content influences the bioaccumulation [1]. In fish farming are used commercial diets and its levels of micro-contaminants may influence pollutant concentration in cultivated fish [2]. Besides the artificial diet, in these systems of culture, fish also consumes natural preys produced in the ponds, which also contribute to the contamination burden.

Ria de Aveiro is a coastal lagoon located in the northern of Portugal permanently connected to the sea that receives inputs from agriculture, urban and industrial activities. In this study the concentration of eighteen PCB congeners and of DDT compounds were compared in muscle and liver of wild and cultivated sea bass (*Dicentrarchus labrax*) and was evaluated the relative importance of diet as source of contamination.

Materials and Methods

Sea bass samples were collected in Ria de Aveiro and in two farms located at the sampling area. Length and weight were measured and selected 10 individuals of similar length from each site. Muscle and liver of individual fish were taken for chemical analysis. Commercial feed pellets sub samples supplied to fish farming was also taken for analysis.

PCBs and DDTs were extracted from freeze-dried tissues and from diet pellets with hexane using Soxhlet apparatus for 6 h. Fat content was determined gravimetrically from aliquots of the extracts. The remaining extracts were cleaned-up with Florisil and sulphuric acid. After concentration each sample was injected into a Hewlett-Packard 5890 series II gas chromatograph equipped with an electron capture detector. A DB-5 (J&W Scientific) capillary column (60 m × 0.25 mm i.d.) was used for the quantification. Helium and argon:methane 90:10 were used as the carrier and the makeup gases, respectively. A mixture of 18 individual CBs, p,p'-DDE, p,p'-DDD and p,p'-DDT was used as external standard for quantification. Recovery of the Florisil column was evaluated with a standard solution and more than 85 % of each compound was obtained. One way analysis of variance was used to compare concentrations [3]. A 5 % significance level was used for the statistical tests.

Results and discussion

Organochlorine concentrations

Concentrations of tPCB (calculated as the sum of individual CB levels) and tDDT (calculated as the sum of concentrations of p,p'-DDE, p,p'-DDD and p,p'-DDT) in muscle and liver of sea bass collected in Ria de Aveiro and in two farms are presented in Figure 1. tPCB in tissues of sea bass from Ria was at least double of tDDT concentrations however, sea bass from farming showed similar levels of these contaminants (student test, $p<0.05$). Concentrations of our study (155-295 and 108-336 ng g^{-1} lipid, respectively, for tPCB and tDDT) were lower than those reported by Pastor et al. [1], respectively, 800±50 and 513±97 ng g^{-1} lipid, for sea bass from the Ebro Delta, in western Mediterranean.

Concentrations on a dry weight basis in wild sea bass were lower than in fish from farming (Fig. 1), showing, in general, farming 2 the highest values (ANOVA, $p<0.05$). Lipid content of an organism may influence its organochlorine concentrations [4]. The observed differences in concentrations may be attributed partly to higher lipid content in fish from farms 1 and 2 (17 %, 66 % and 12 %, 44 %, respectively, in muscle and liver) than those from Ria (5 %, 26 %). Normalization of concentrations to lipid content reduced, in general, the variability between Ria and farms, however, did not reduce between the two fish farms. In fact, tissues of sea bass from farm 2 showed lower lipid content and higher dry weight tPCB and tDDT concentrations than tissues of fish from farm 1, so, lipid content may not explain the difference in dry weight concentrations of fish from these two sites. This may not be also attributed to a different contamination of the diet pellets, because they were fed with diet of similar tPCB (26 and 25 ng g^{-1} dw, respectively, for farming 1 and 2) and tDDT (19 and 26 ng g^{-1} dw) levels. Other factors may be related to the observed variability in levels between the two fish farms such as differences in contamination of the natural component of the diet and differences in physiological condition of the individuals.

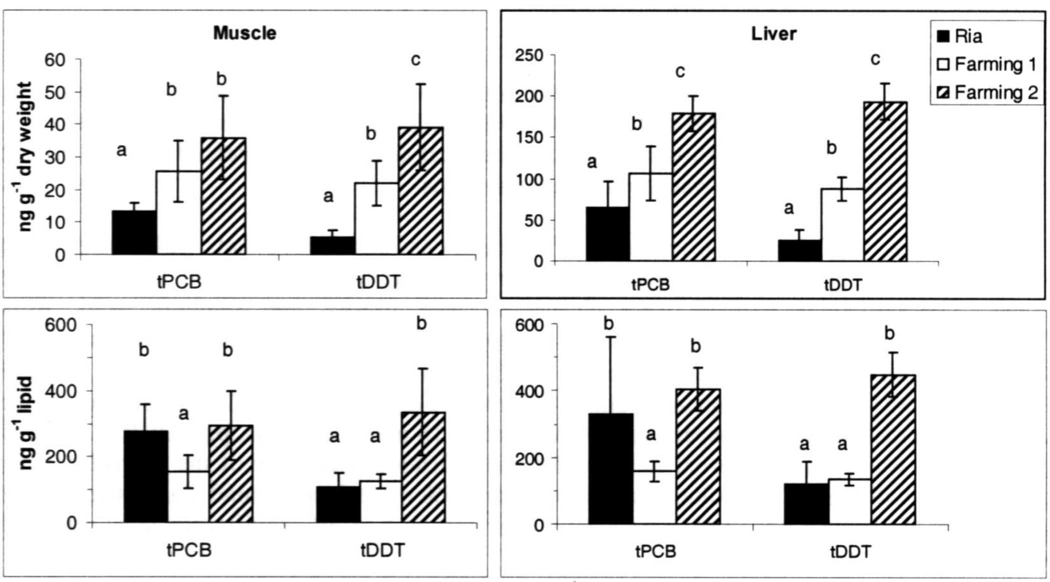

Figure 1. Concentrations of tPCB and tDDT (ng g^{-1}) in muscle and liver of sea bass from Ria de Aveiro and from farms 1 and 2. Different letters represent significant differences ($p<0.05$) according to ANOVA followed by Scheffé test.

Composition

From the DDT compounds, DDE was present in the highest concentration in tissues of all the analysed organisms and in pellet diet, representing more than 79 % of tDDT.

The relative distribution of PCB congeners may differ in aquatic organisms because the contamination sources have different congener patterns. The patterns of PCBs would become enriched

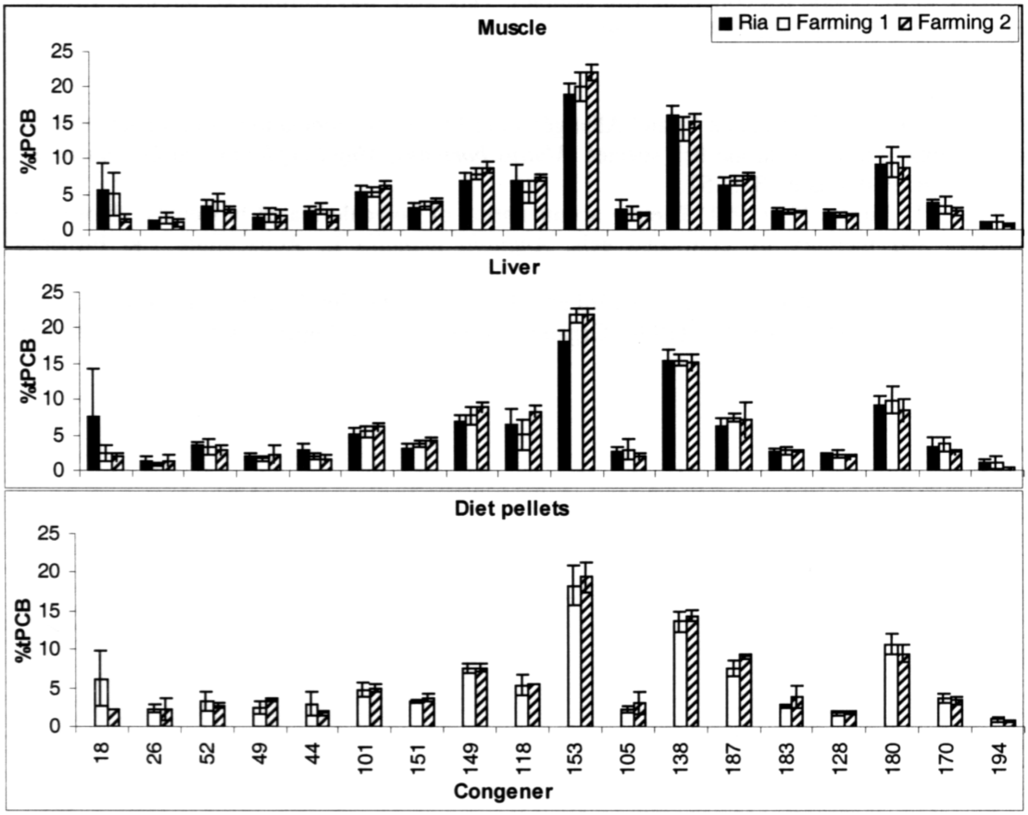

Figure 2. PCB congener patterns in sea bass collected in Ria de Aveiro and in two fish farms and in diet pellets.

Table 1. Correlation coefficients (r^2) of relative proportions of PCB congeners in pellet diet with those in muscle and liver of sea bass from fish farms.

	Farm 1 / Diet 1	Farm 2 / Diet 2
Muscle	0.98	0.97
Liver	0.95	0.96

in more hydrophobic congeners in predators relative to their prey as a result of digestive fractionation[4]. In our study PCB patterns, determined as the concentration ratios between individual congener and tPCB, did not vary among wild and cultivated sea bass. The pattern of PCBs in muscle and liver of all individuals was very similar and CBs 153 and 138 (hexachlorobiphenyls) were the dominant congeners (Fig. 2). The overall PCB congener distribution in tissues of sea bass from farms resembled that of diet pellets (Fig. 2) being the relative proportions of individual chlorobiphenyl congeners both in fish tissues and in diet significantly correlated (Table 1). These results imply that commercial diet is a major source of PCBs and a fractionation of PCB congeners, between sea bass and diet pellets, in farms was not significant. This is in accordance with findings of Kucklick and Baker [4] with other species and contrasts with other works of the same author that found a selective accumulation of more hydrophobic PCB congeners in food chain transfer. In cultivated sea bass the relative proportions of PCB congeners were similar to those in its diet pellets, which may indicate that assimilation efficiency may not systematically vary with the hydrophobicity.

Acknowledgements

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References

1. Pastor D., Boix J., Fernández V. and Albaigés J., (1996) Bioaccumulation of organochlorinated contaminants in three estuarine fish species (*Mullus barbatus, Mugil cephalus* and *Dicentrarchus labrax*). Mar. Pollut. Bull. 32: 257.
2. de Boer J., Pieters H., (1991) Dietary accumulation of polychlorinated biphenyls, chlorinated pesticides and mercury by cultivated eels, *Anguilla anguilla* L. Aquaculture and Fisheries Management 22:329.
3. Zar J.H. (1996) Biostatistical analysis (3rd ed.). Ed. Prince-Hall Int. Inc. 1996, London.
4. Kucklick J.R. and Backer J.E. (1998) Organochlorines in Lake Superior’s food web. Environ. Sci. Technol. 32, 1192.