# COMPARING ELIMINATION PATTERN OF PCBs IN JUVENILE AND ADULT SEABASS (*Dicentrarchus labrax*)

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## INTRODUCTION

The bioaccumulation of persistent, highly hydrophobic chemicals, such as polychlorinated biphenyls (PCBs), in fish has been widely studied in the 1980's. Bioaccumulation studies in fish generally follow a whole body concentration approach without considering the internal distribution of contaminants between fish tissues.
Little information is available for understanding and predicting organ-specific bioaccumulation in species. Up to now, it is unclear to what extent whole body bioaccumulation models under- or overestimate organic-specific concentrations.
The goal of the present study is to derive and compare organ-specific elimination rates for juvenile and adult seabass.

## METHODOLOGIES

### Laboratory experiment

Seabass was studied for PCB congeners accumulation and elimination, after being fed with food highly contaminated with PCBs 18, 44, 49, 52, 101, 105, 118, 138, 180 and 187. Congeners were selected to cover different chlorination degrees. The stable congener PCB153 was not included intentionally, and was used as internal control. The commercial food pellets usually supplied in the fish farm were covered by a PCB solution in ethanol and the solvent was allowed to slowly dry with pellet homogenization. PCB concentrations were analyzed in 5 pools of food for determination of levels and contaminant's homogeneity. The concentrations of individual PCBs used were between 1440 and 1750 ng $g^{-1}$. The food was supplied to the fish through water. Introducing food externally to fish contaminants may partition between food pellets and water. To evaluate the possible indirect accumulation of PCBs via the aqueous phase, the water was also analyzed.
Specimens with approximately 15 g and 250 g in weight were transferred to two 2000 L tanks with a natural photoperiod. Water was at ambient temperature, which ranged from 15 to 25ºC during the experiment. Aeration was set to maintain 100% oxygen saturation in water. The water was continuously filtered through mechanical, charcoal and extensive biological filters before being recycled. After accommodation, the fish were exposed to a contaminated diet for 12 days, following a depuration period of 12 weeks. Water was sampled for analysis at the beginning of the exposure (day 0) and at the end (day 12). After the exposure period all water was replaced and the tanks and filter system was cleaned. The fish condition factors were stable during the experiment. The exposure concentrations of PCBs were at similar levels as other studies[1] referred as NOEC-levels for fish, and below the effect levels determined by Konemann, (1981)[2]. No mortality was observed.
Five individuals were periodically sampled at days 0, 1, 12, 26, 40, 55, 72, 92. Blood samples were collected from sedated fish and serum was separated by centrifugation. Serum and other tissues were conserved at -20ºC until analysis. Serum was analyzed according to Hovander et al. (2000)[3], with a reduction of the serum volume to about 1 mL, and minor alterations of solvent volumes. PCB30, PCB65 and PCB204 were used as internal standards. Recoveries were between 60% and 105%, and the quantification limit of PCBs was 0.03 ng $g^{-1}$ (wet weight).

Water and tissues were analyzed according to Antunes et al. (2007)[4]. Tissues were Soxhlet extracted, and water liquid-liquid extracted, both with n-hexane. Lipids were determined gravimetrically. Extracts followed to Florisil clean-up and GC-ECD quantification.

**Kinetic elimination rate constants**

Elimination was calculated assuming first order kinetics. The elimination rates were calculated from the day of maximum concentration until the end of experiment. For this the minimum square error method was used to fit the following equation to the experimental results.

$$C_{tissue}(t) = C\max_{tissue} \cdot e^{-k_2 \cdot t}$$

The model OMEGA was also used to determine a theoretical elimination rate constant. This model combines classical fugacity theory with allometric regressions in order to predict chemical accumulation in aquatic or terrestrial food chains. The model has extensively been described before[5, 6, 7, 8.]

## RESULTS

**Adults**. The elimination rate constants ($k_2$) are presented in Figure 1. Muscle's measured $k_2$ values were similar to the expected by the OMEGA model, which decrease with $K_{ow}$. In liver $k_2$ values were higher than expected and also they increased with $K_{ow}$ ($r = 0.91$; $p < 0.001$). Serum had the lowest $k_2$ for lower chlorinated PCBs, but values increased highly with $K_{ow}$. For the highest $K_{ow}$ values of $k_2$ in serum were similar to the values obtained for liver. The high PCB concentrations verified in visceral fat during a long period, indicate no elimination in this period.

**Juveniles.** Differences in tissues elimination rate constants are lower than in adults, and closer to the total body concentrations estimated by OMEGA model. However it still visible a trend for more hydrophobic PCBs have faster elimination of in serum and liver.

## DISCUSSION

The internal redistribution of PCBs between fish tissues appear to be very relevant for the adults fishes studied in this experiment. The present study used adult fish acquired from a fish farm, therefore with high fat content in tissues and viscera. Both factors may reduce the internal distribution of PCBs producing significant differences in the tissues elimination rates. The lower differences observed between juvenile tissues were in accordance with O'Connor and Pizza (1987[9]), who did not observe significant differences between tissue elimination rates in stripe bass from the Hudson river below 5 g.

Comparing the $K_2$ of the juveniles with ones of the adults, we can observe that the internal distribution in the juveniles produced smaller differences between tissues $K_2$, than in the adults. This was expected if we assume that transport is controlled by passive diffusion of the compounds inside the organism. PCBs elimination was faster in juveniles, as expected by the theoretical model OMEGA. This was due to the higher contact of smaller fish with the water and food, they have higher respiration and food ingestion rate constants (*i.e*. higher respiration and food ingestion *per* fish mass). The transport of organochlorines from water and food, and the growth dilution of compounds are function of (weight $^{-0.25}$), therefore all this accumulation mechanisms are higher for smaller fish. The metabolization of PCBs was higher in adults than in juveniles, however, this mechanism of elimination of PCBs was insignificant when compare with the other.

The present study indicates that in adult fishes internal distribution of PCBs is slow, producing different elimination rates in the tissues. The internal organs can act as a contaminant sink, producing a variation pattern in muscle that differs from the overall body. This factor is enhanced if the organism has high lipid content. In juvenile fish the effects of the slow internal distribution are not significant, and all the tissues have elimination rates not significantly different from the all body concentrations.

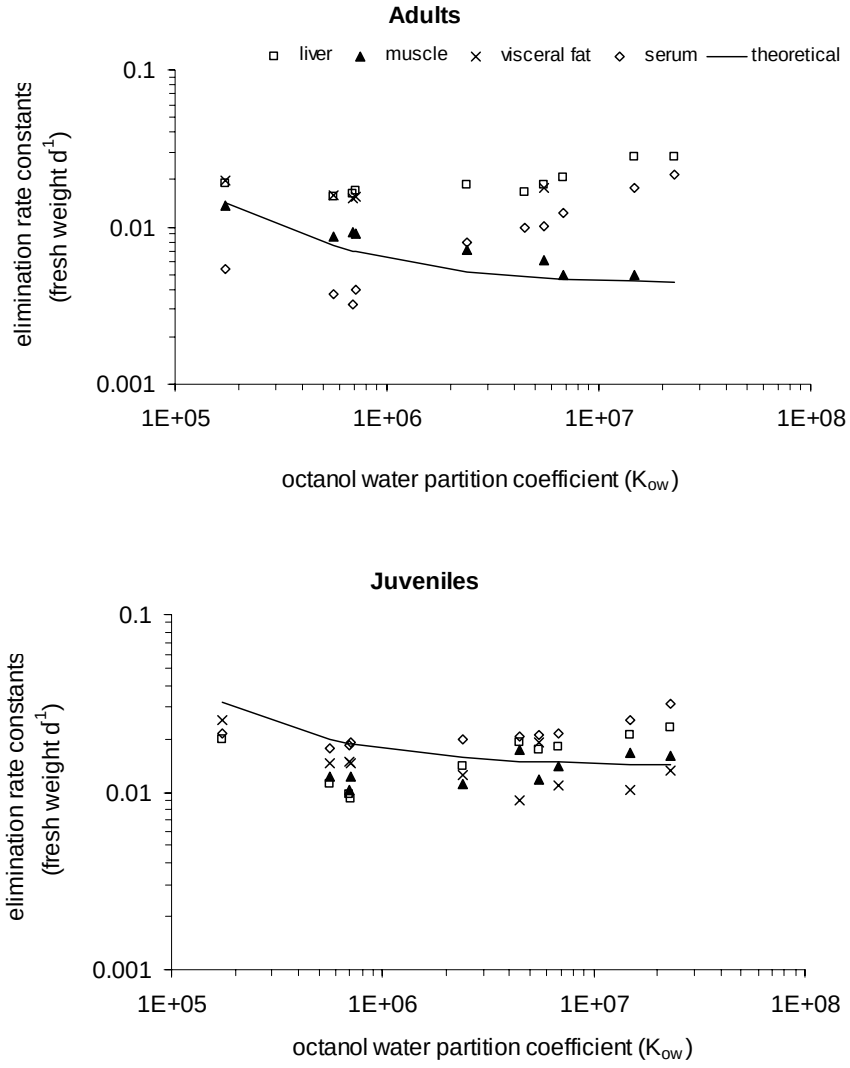


Figure 1. Elimination rate constants calculated based on in wet weight concentrations, Dots refers to measured $K_2$, and line to the theoretical elimination rate calculated using the model OMEGA.

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