BIOCONCENTRATION AND BIOTRANSFORMATION OF ORGANOPHOSPHORUS FLAME RETARDANTS IN COMMON CARP

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INTRODUCTION

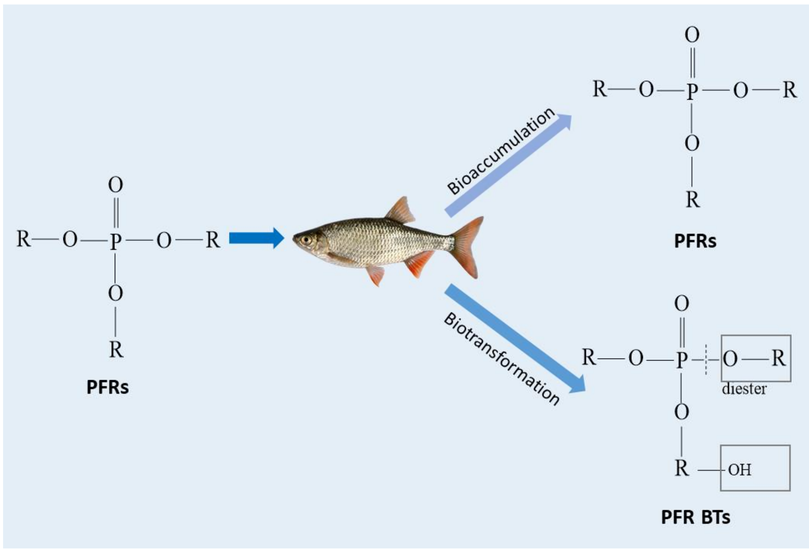
OBJECTIVES

Investigation of tissue specific accumulation and depuration of seven PFRs (TCEP, TCIPP, TBOEP, TDCIPP, TNBP, TPHP, and EHDPHP) and their major biotransformation products (BT) in common carp (*Cyprinus carpio*) exposed to an environmental relevant level of PFRs.

- The gradual phasing out of brominated flame retardants (BFRs) has led to an increase in production and use of organophosphorus flame retardants (PFRs) as primary substitutes[1].
- Understanding the bioaccumulation and biotransformation of PFRs is critical for evaluating their fate and potential toxicity *in-vivo*.
- Only few studies have investigated the potential bioaccumulation and biotransformation of PFRs in fish.

MATERIALS and METHODS

- Exposure experiment of juvenile common carps was performed according to OECD guideline-305[2].
- Exposure period: 28 days at concentrations of 10 µg/L per individual compound; depuration period: 14-days.
- Sampling was performed on days: 3, 7, 14, 21, 28 (during uptake period) and 3, 7, 14 (during depuration period). Each time, 4 individuals were randomly selected and sacrificed.
- The serum, gills, liver, gonads, intestine, brain, kidney, and muscle were collected from each fish and their mass was recorded.
- PFRs and PFR BTs were analyzed by GC-MS/MS and LC-MS/MS, respectively, following previously reported methodologies[1,3].



RESULTS and DISCUSSION

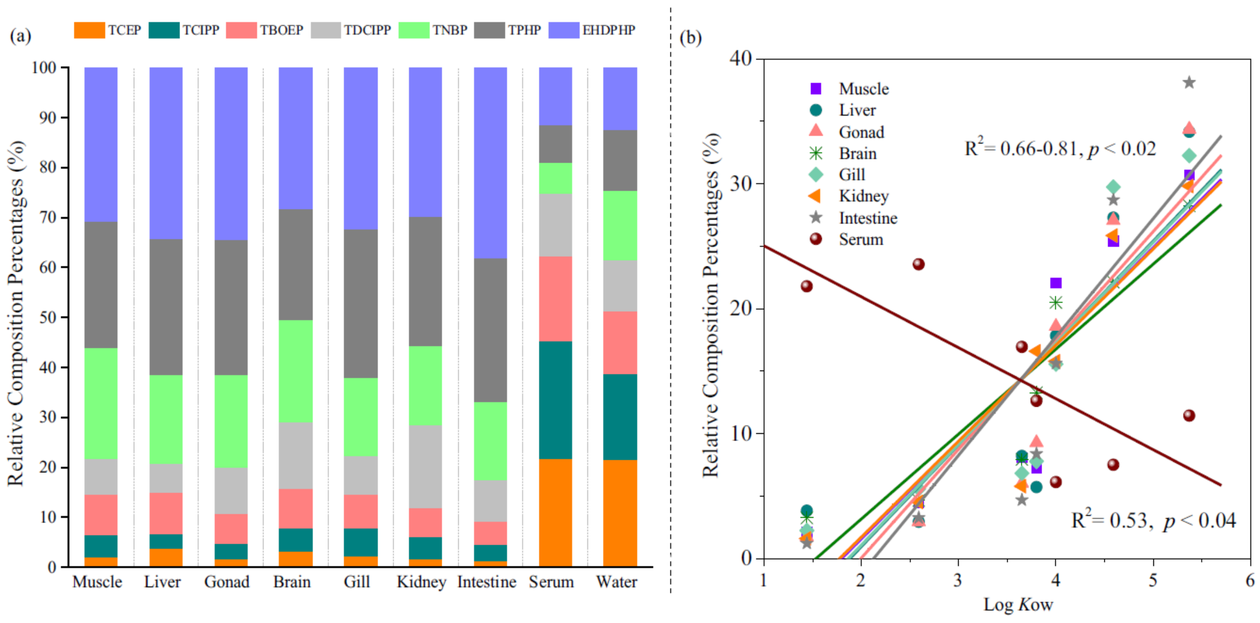


Fig. 1 Relative composition percentage (%) of each PFR in fish tissues and water at the steady state (a), and correlations between the relative contributions and the log K_{ow} values of PFRs (b).

- Accumulation of each PFR in fish appears to be tissue-specific, and the concentrations of PFRs at steady-state varied among tissues (Fig. 1a).
- Log *K*ow of PFRs was positively correlated to the relative % composition of individual PFRs in all tissues ($p < 0.02$), but negatively correlated in serum ($p < 0.04$) (Fig. 1b).
- This difference might be due to the higher polarity of serum vs other tissues, favoring the accumulation of PFRs with lower log *Kow* values (i.e. TCEP and TCIPP).

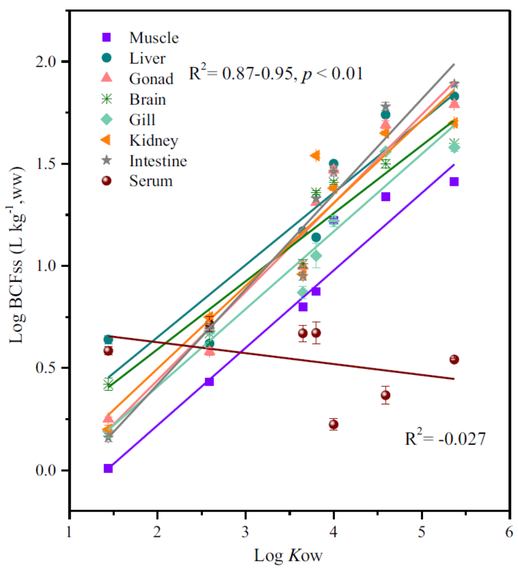


Fig. 2 Relationships between bioconcentration factors (BCFs) and log *Kow* of PFRs.

- Significant correlations ($p < 0.01$) between log *K*ow and the log bioconcentration factor (BCFww) of PFRs were also found in all investigated tissues, except for serum (Fig. 2).
- Dialkyl and/or diaryl phosphate esters (DAP) and hydroxylated PFRs (HO-PFRs) were the major BTs for PFRs, with higher levels in liver and intestine vs the other tissues.

- The BT/PFR ratios in fish liver ranged from 0.11 ± 0.02 for EHDPHP to 1.36 ± 0.15 for TCIPP, indicating an intensive biotransformation of PFRs and a consequent substantial lower accumulation in fish[4] (Fig. 3).

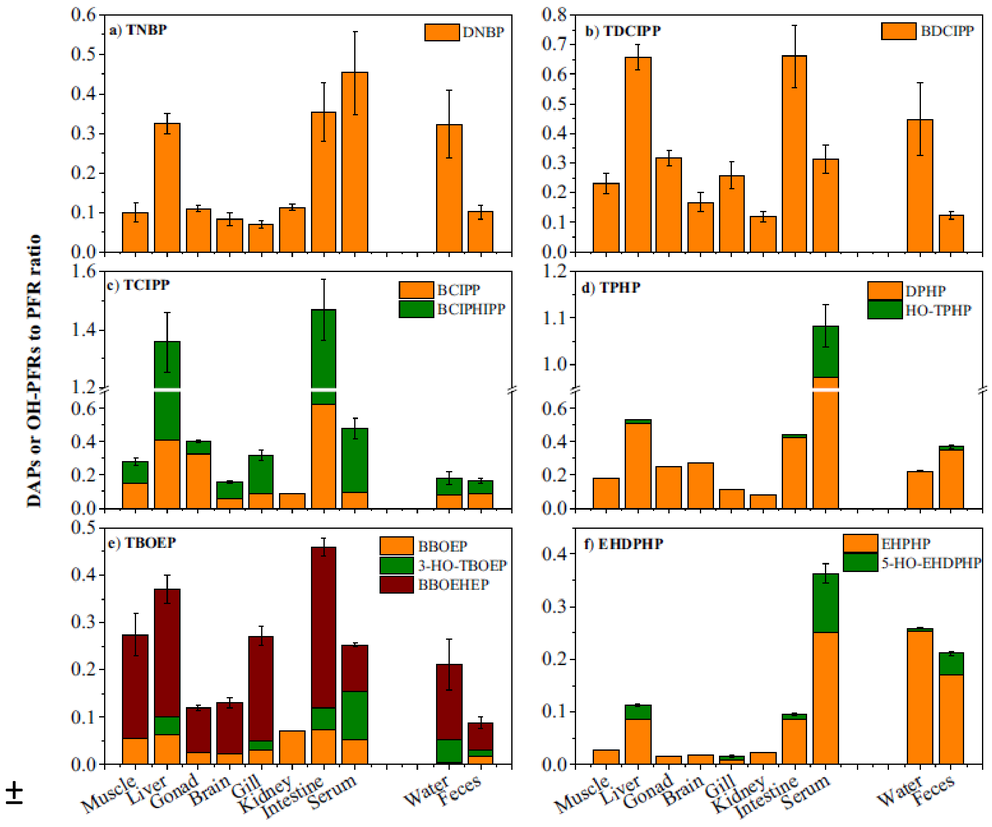


Fig. 3 Ratio of the major PFR BT to their parent compounds in tissues of common carp.

CONCLUSIONS

- Our results suggest that the hydrophobicity and the biotransformation processes of PFRs play significant roles in the distribution and accumulation of PFRs in common carp.
- The DAP and HO-PFR BTs quantified in fish tissues demonstrated an intensive biotransformation of PFRs and a consequent substantial lower accumulation in fish.
- Critical information for further understanding the bioconcentration, tissue distribution and biotransformation of PFRs in fish is provided.

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REFERENCES

1.Poma G, Sales C, Bruyland B. et al. (2018); Environ. Sci. Technol. 52 (4): 2331–2338.
2.OECD. (2012); Bioaccumulation In Fish: Aqueous and Dietary Exposure. Test Guideline No.305.
3.Bastiaensen M, Xu F, Been F. et al. (2018); Anal. Bioanal. Chem. 410: 7871–7880.
4.Tang B, Poma G, Bastiaensen M. et al. (2019); Environ. Intern. 126: 512–522.