Heavy metal accumulation in fish opercula using micro-Computed Tomography technique

D. Panek[a], B. Leszczyński[a], D. Wojtysiak[b], E. Stępień[a]

[a]M. Smoluchowski Institute of Physics, Jagiellonian University ul. Łojasiewicza 11, 30-348 Kraków, Poland, dominik.panek@doctoral.uj.edu.pl

[b]Department of Animal Genetics, Breeding and Ethology, Faculty of Animal Sciences, University of Agriculture in Kraków, Poland

Introduction

Heavy metals accumulation can pose a great danger not only to the organism exposed to the primary contamination but also to further consumers like humans (Figure 1, 2). In this experiment, accumulation of Zinc (Zn) and Cadmium (Cd) was investigated.

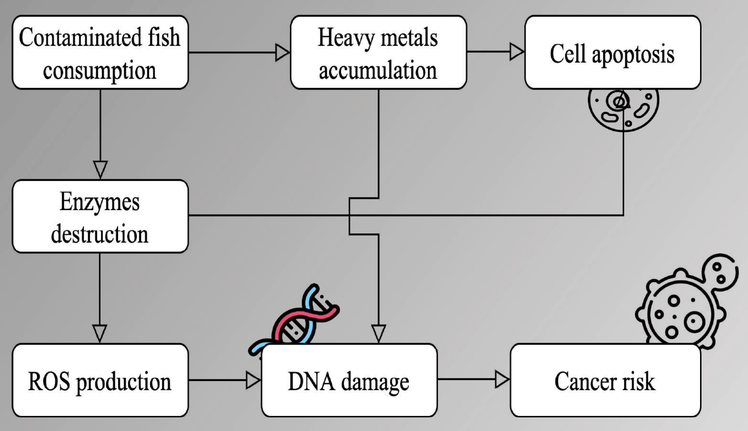

Figure 1. Possible pathways of influence of heavy metals on the the cells.

Materials & Methods

In this study micro-computed tomography (micro-CT) was used [1], and the specimens, were delivered from the Agricultural University in Kraków (Figure 3). Fish were bred in 4 types of environments: (1) no heavy metals, (2) Zn (4mg/l), (3) Cd (4mg/l) and (4) Zn+Cd (4mg/ml). During the measurement samples were stacked on each other. Parameters of the measurement were: energy – 80keV, amperage – 100μA, filter – Al 0.5mm and the pixel size of 5m.

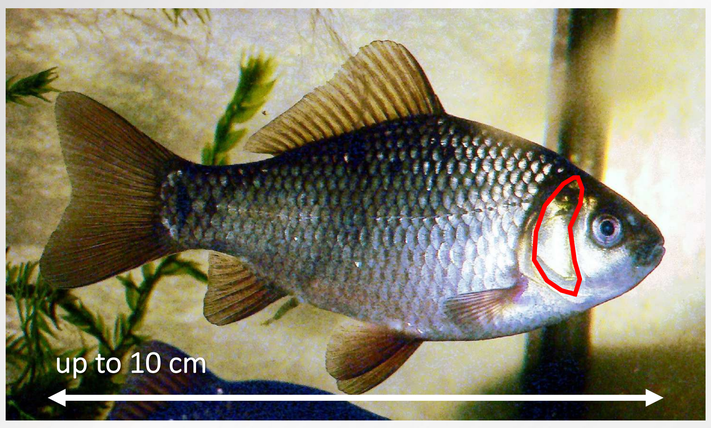

Figure 3. The specimen - C. Carassius. Operculum is marked in red.

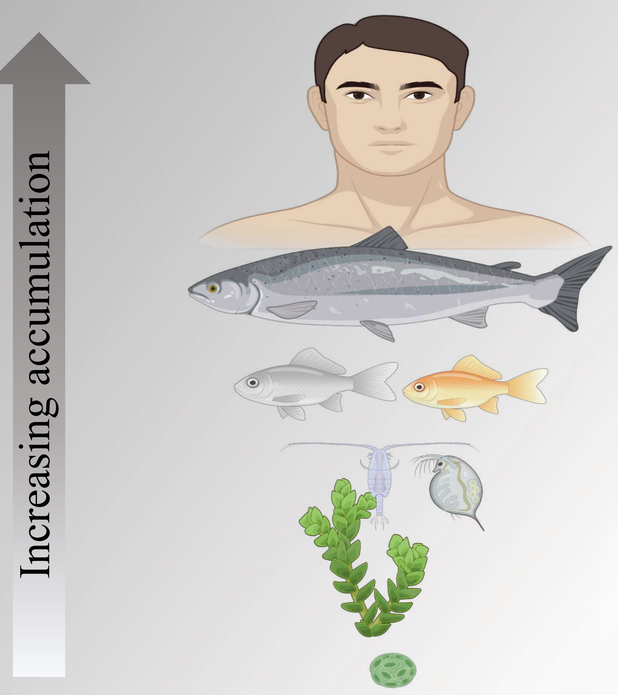

Figure 3. Increasing value of heavy metal accumulation in the food chain.

Results

Figure 5 shows distributions of shades of grey, and Figure 6 shows differential analysis (novel approach to accumulation analysis). Figure 7. represents the reconstructed samples from the images taken during the measurement.

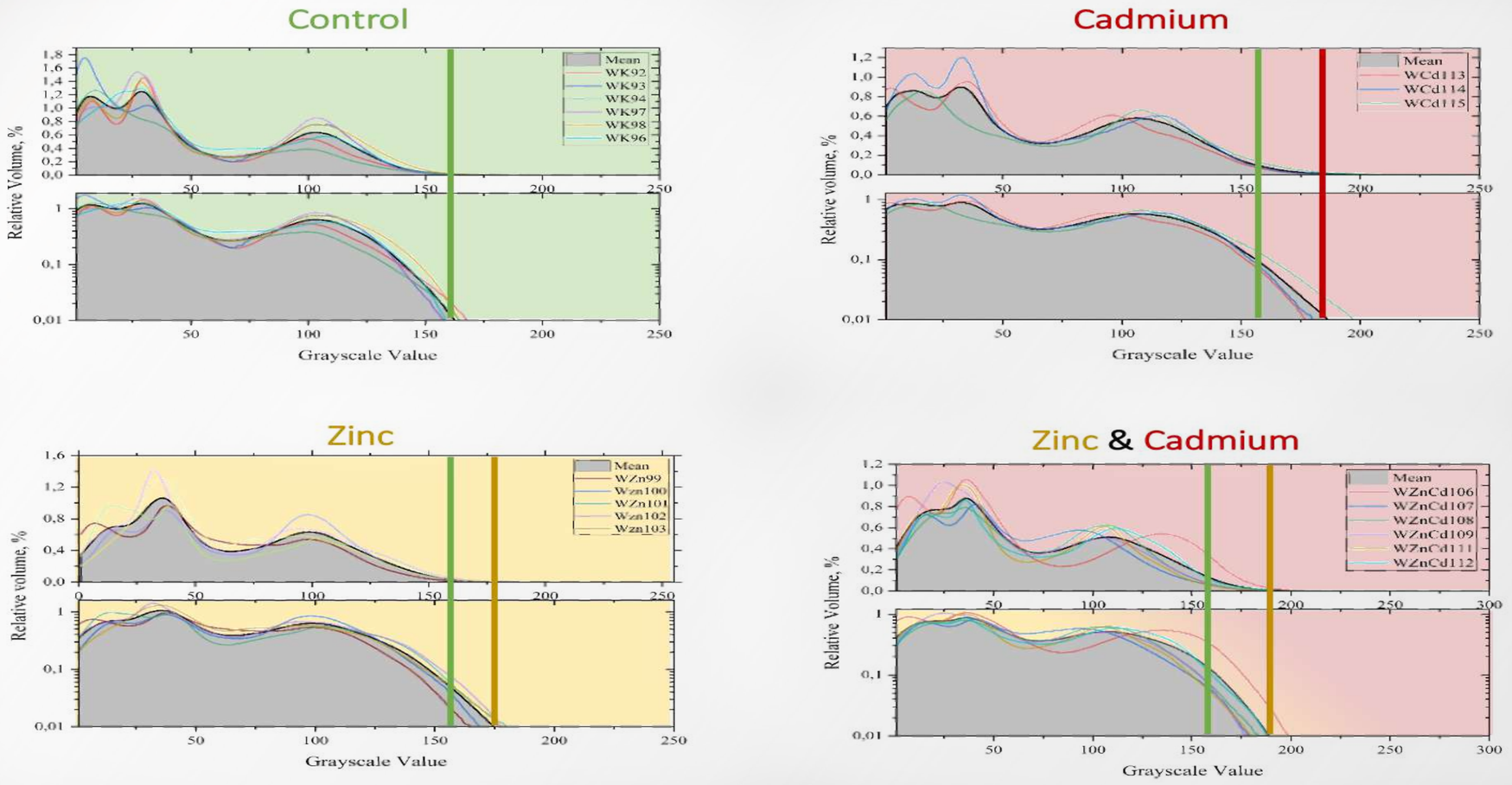

Figure 5. Histograms of grey shade distributions for treatment and control groups. Higher greyscale vale correspond to the higher density within the sample.

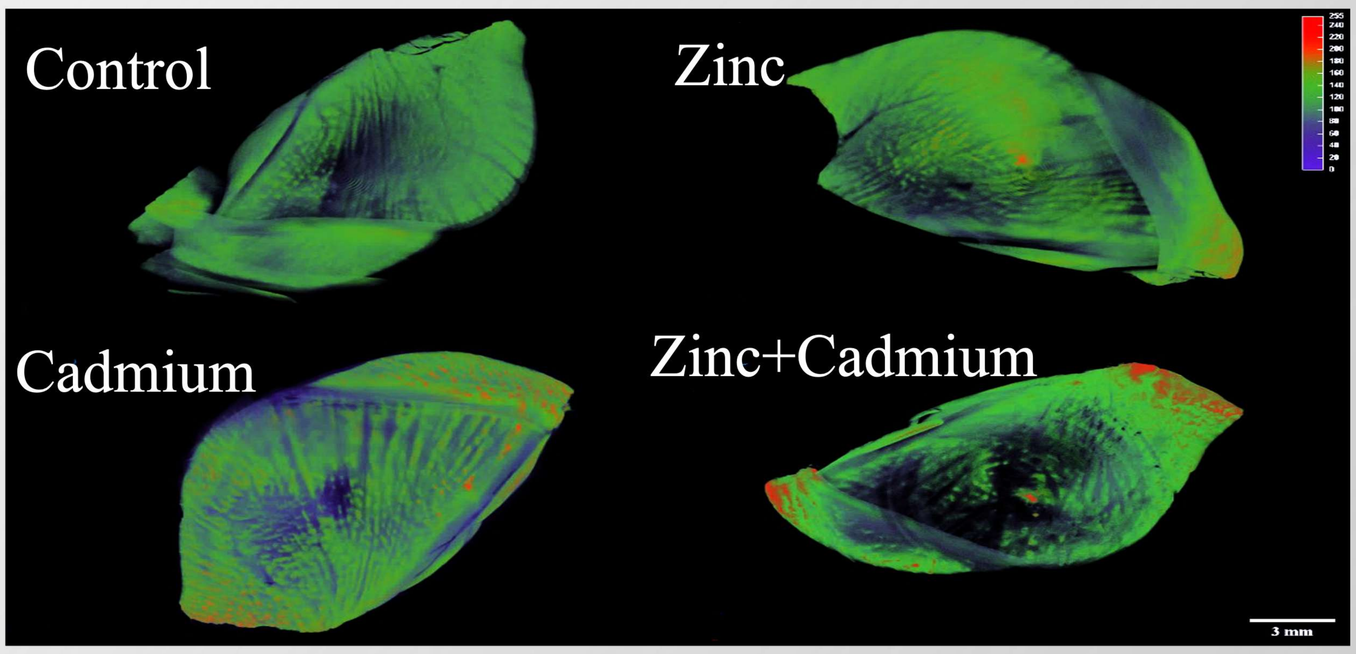

Figure 6. Visualizations of the opercula. Green and blue-purple colours correspond to the lower density, and red corresponds to the higher density observed in the samples

Conclusions

Maximum value of shade of grey corresponds to the atomic number of accumulated elements: 162 for control, 175 for Zn, 187 for Cd and 190 for Zn and Cd. Furthermore, accumulation of two heavy metals is additive, what is confirmed by comparing values of areas under the curves: 1.7 for Zn, 6.13 for Cd and 7.39 for Zn and Cd mixture.

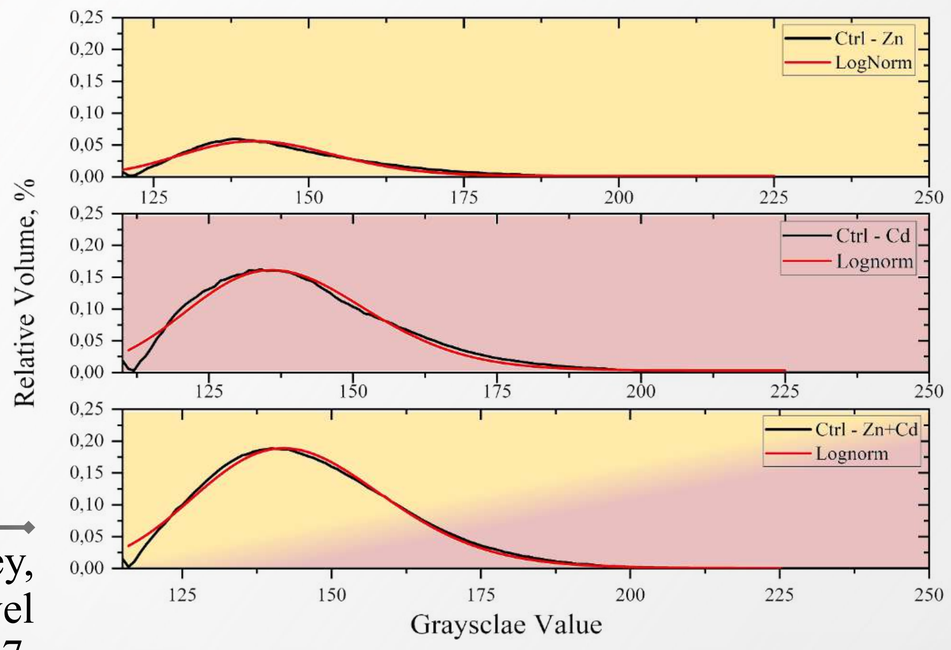

Figure 6. Differential analysis with fitted Log-normal curve.

References

[1] Leszczyński B, Sojka-Leszczyńska P, Wojtysiak D, Wróbel A, Pędrys R. Visualization of porcine eye anatomy by X-ray microtomography. Exp Eye Res. 2018.

[2] Leszczyński B, Skrzat J, Kozerska M, Wróbel A, Walocha J. Three dimensional visualisation and morphometry of bone samples studied in microcomputed tomography (micro-CT).