Sorption of copper and zinc by *HOTTONIA palustris* L.

Paweł ŚWISŁOWSKI[1], Michał MARCINIAK[2] and Małgorzata RAJFUR[2*]

[1] Independent Chair of Environmental Engineering, University of Opole, Dmowskiego 7-9, 45-365 Opole, Poland
[2] Independent Chair of Biotechnology and Molecular Biology, University of Opole, kard. B. Kominka 6, 45-032 Opole, Poland, *mail: mrajfur@o2.pl

Abstract

The aim of the study was to evaluate the kinetics and sorption equilibrium of selected heavy metals: Cu and Zn in the laboratory in plant water - featherfoil (*Hottonia palustris* L.). *Hottonia palustris* L. is a water-marsh plant, which belongs to the *Primulaceae* family. It is known in the lowlands throughout Europe, particularly in Central and Eastern Europe. In Polans it occurs commonly in lowland areas. The study used featherfoil collected from the Janow reservoir in the Swietokrzyskie Province.

It has been shown that the equilibrium state in the metal salt solution – featherfoil system is reached after about 60 minutes. Under the conditions of the experiment about 36% copper ions and about 49% zinc ions are sorbed with the initial solutions in the first 10 minutes. Numerous studies results suggest differences in the ability to accumulate analytes by a variety of plant species that may be due to i.e. differences in their physiological and morphological structure and the preparation of plant samples for analysis.

To describe the equilibrium was used the Langmuir isotherm model. The relationship between the concentration of analyte in *Hottonia palustris* L. and in the solution in which it was immersed may be used in the future to develop a simple method for phytoremediation of surface waters.

Keywords: heavy metals, *Hottonia palustris* L., kinetics and sorption equilibrium, Langmuir isotherm

Materials and methods

Samples of *Hottonia palustris* L. taken from the Janow water reservoir (Swietokrzyskie Province, PL). The plant samples approx. 5 g d.m. (d.m. - dry mass) weight were placed in perforated polyethylene containers with a volume of approx. 15 cm^3. The containers were immersed in the 200 cm^3 volume of the Cu and Zn salt solutions. During 60 min. concentration of the analyte was periodically determined using *FAAS* method.

To evaluate an influence of the plant preparation on its sorption properties, one sample was immersed during 30 min. in demineralised water before measurement, while the other one was not conditioned.

Fig. 1. *Hottonia palustris* L.

Interpretation of the results

Langmuir isotherm model assumes that on the surface of the adsorbent are located adsorption centers, each of which is able to adsorb only one molecule. This model is described by the equation:

$$c_{(H,1)} = (c_{(H,max)} \cdot K \cdot c_{(r,1)}) \cdot (1 + K \cdot c_{(r,1)})^{-1}$$

where:
$c_{(H,1)}$ – the concentration [mg/g d.m.] of the metal in the *Hottonia palustris* L. at equilibrium state,
$c_{(r,1)}$ – the concentration [mg/dm^3] of metal in solution at equilibrium state,
$c_{(H,max)}$ –the sorption capacity [mg/g d.m.] of *Hottonia palustris* L.,
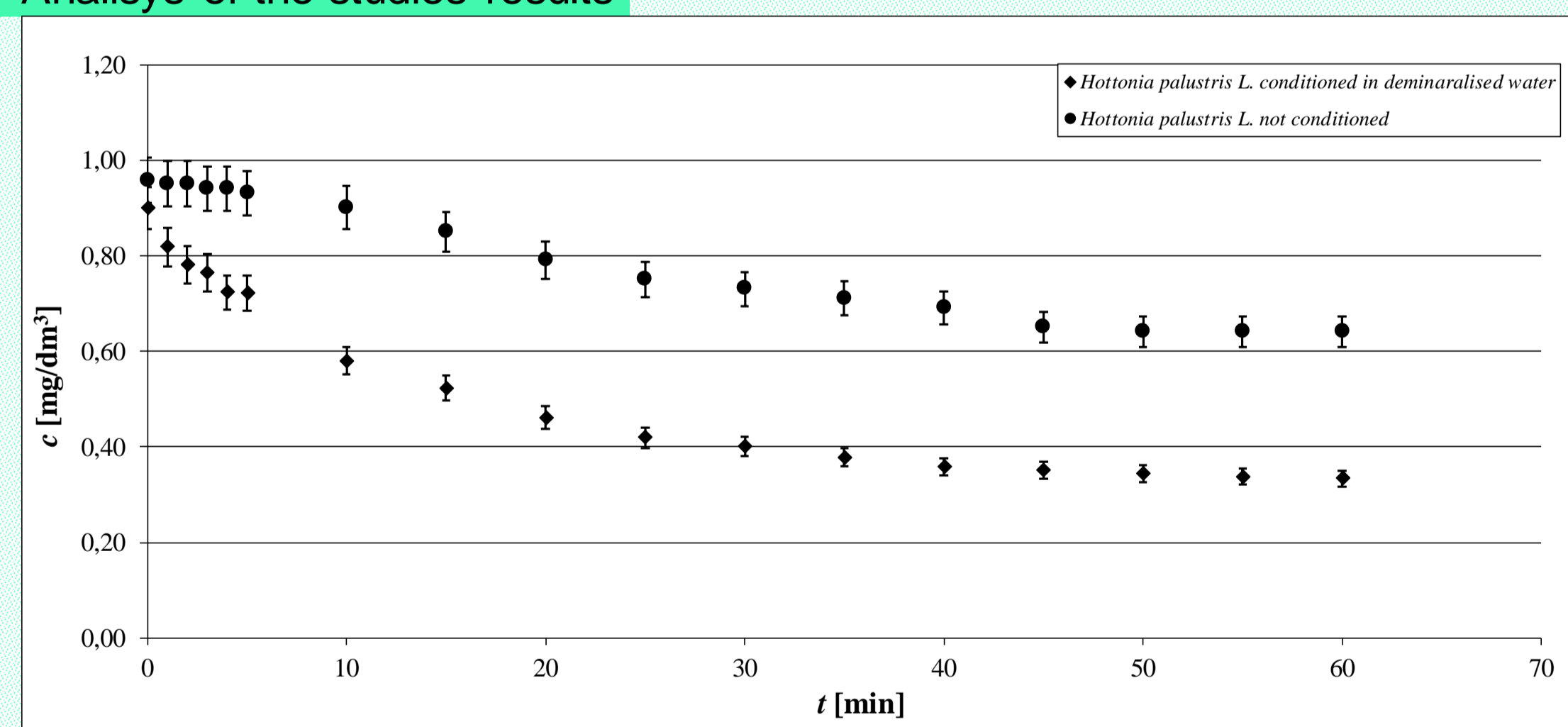K – a constant.

Analisys of the studies results

Fig. 2. The course of changes in the concentration of Cu^{2+} in the solutions, in which were dipped prepared and unprepared samples of *Hottonia palustris* L.
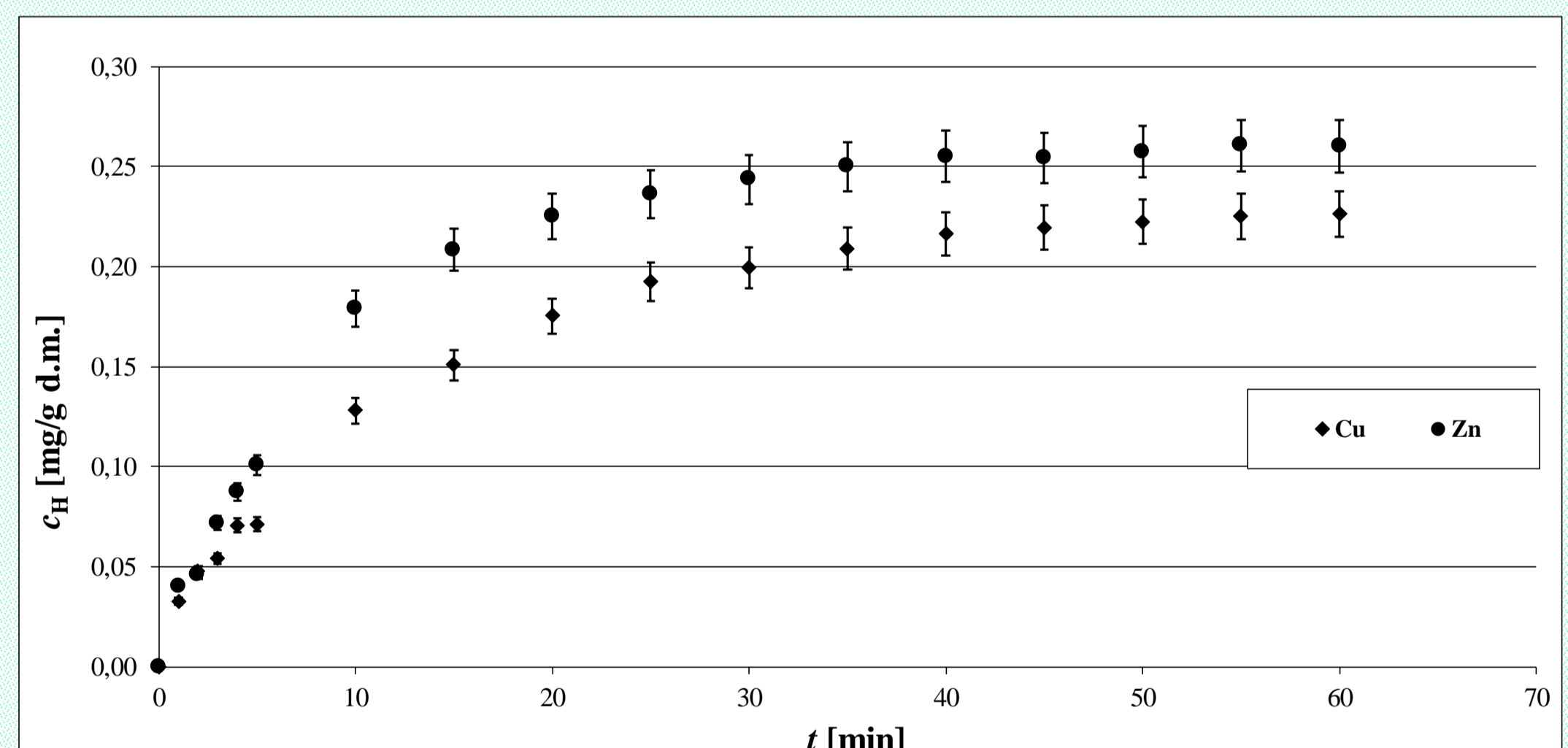

Fig. 3. The course of changes in the concentration of Cu^{2+} and Zn^{2+} in *Hottonia palustris* L., which was introduced to the metal salt solutions
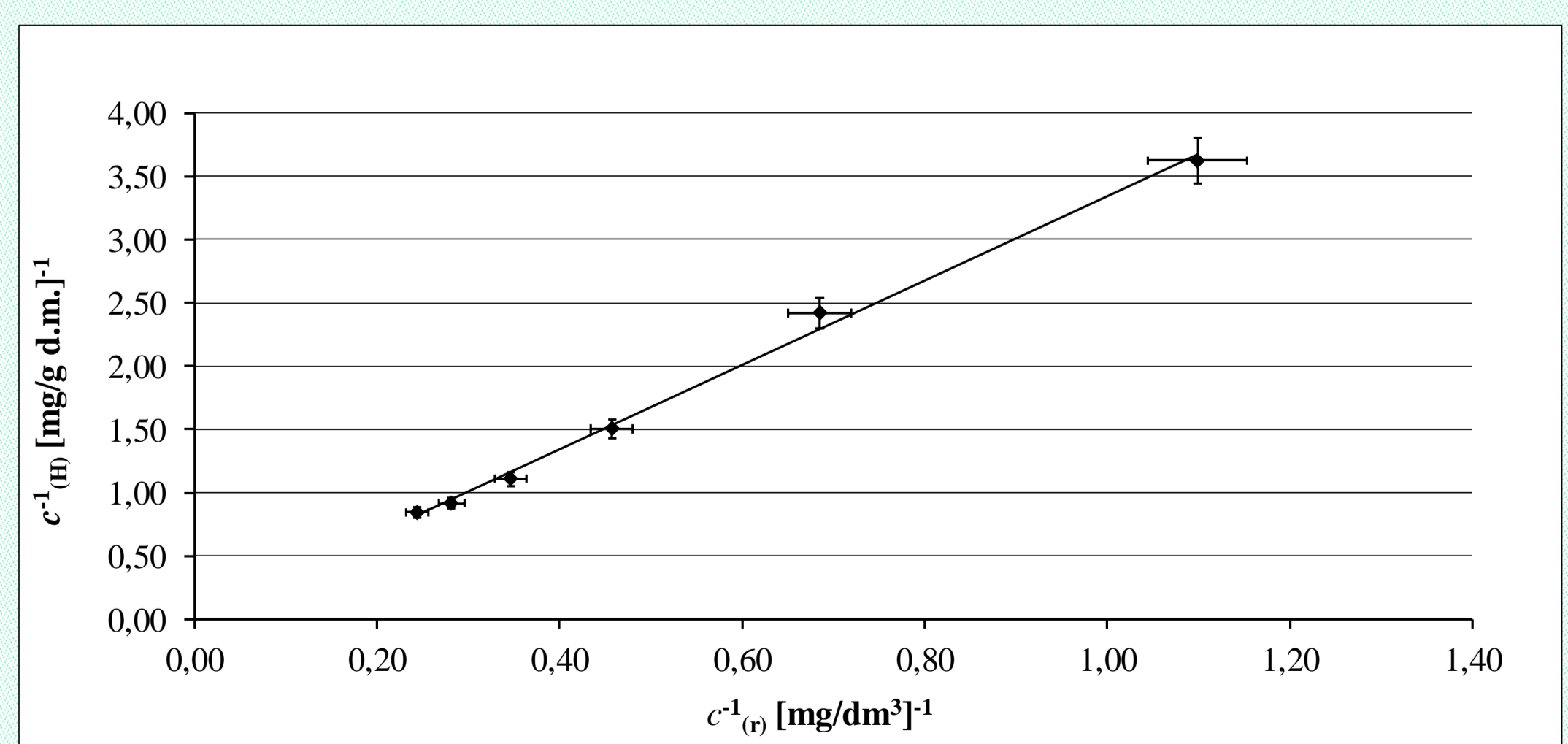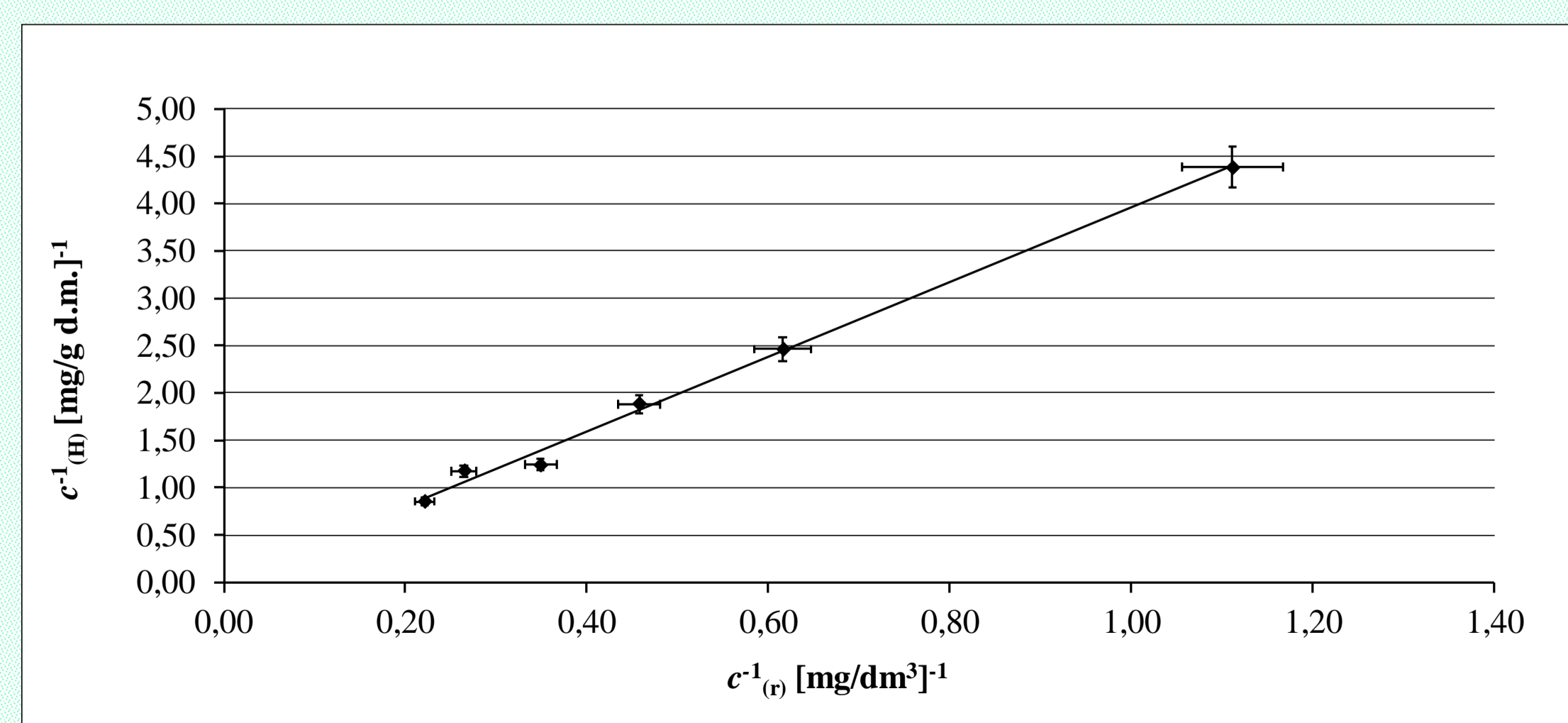

Fig. 4. Langmuir isotherm describing the sorption equilibrium of: copper in a Cu salt solution (left) and zinc in a Zn salt solution (right) – *Hottonia palustris* L. system

Conclusions

The results indicate that *Hottonia palustris* L. is a good sorbent of Cu^{2+} and Zn^{2+} ions from aqueous solutions. Within 60 minutes of the process about 63% of copper and about 71% zinc is sorbed. The results show that the parameters of sorption of heavy metal ions in *Hottonia palustris* L. depend on the method of sample preparation. Accurate determination of sorption parameters accelerate further studies on the use of *Hottonia palustis* L., as biosorbent in water phytoremediation and in the process of waste water purification.