

Summary

Terrestrial invertebrates such as Lumbricidae earthworms and Helicidae snails are bioindicator organisms. Waste rock was considered a potential source of heavy metals in the environment. Because earthworms live in the soil, and snails, like earthworms, have contact with the soil through their integuments and digestive tracts, an analysis of the physicochemical and biological properties of soil with and without waste rock deposits was conducted, which is used as a material in reclamation. The presence of waste rock in the soil affected its physicochemical parameters and biological activity, with this effect depending mainly on the type of agricultural use and the type of vegetation cover in the area. The transfer of seven metals (Cr, Ni, Cd, Ba, Pb, Zn, and Cu) was observed across various location, soil, plant, and animal configurations, with the waste rock deposit serving as a key element. Selected metals influenced the lipid metabolism of earthworms, leading to changes in the composition and oxidation of fatty acids. The observed changes in the composition and oxidation of fatty acids were synchronized with the activity of enzymatic (SOD and CAT) and levels of non-enzymatic (TBARS) biomarkers of oxidative stress. The effect of metals on the physiological parameters studied in earthworms depended on the duration of the deposit and the land use of areas with a waste rock deposit. In earthworms originating from wasteland with a long-term deposit (over 10 years) of waste rock, the least favorable physiological response was observed at the level of fatty acid peroxidation. It was found that land use in the form of cereal crops or meadows maintained in good agricultural condition reduced, within a physiologically perceptible range, the negative impact of metals on the studied earthworms. Selected metals influenced the physiological response in snails, which was associated with changes in the composition of biomarker fatty acids, the peroxidation index, and the unsaturation index of fatty acids, including potential peroxidation of biomarker fatty acids. Snails collected from a site with a waste rock deposit showed a noticeable decrease in polyunsaturated fatty acid content compared to field samples without a deposit, as well as to laboratory samples, which may suggest potential fatty acid peroxidation. In the case of snails, the use of an approach combining the collection of material from the environment with experimental metal supplementation under laboratory (controlled) conditions made it possible to increase the versatility of the proposed physiological biomarkers. This approach also allows for the assessment of the impact of indirect environmental factors on biomarker fatty acids in these mollusks. The analyses conducted confirmed the validity of using selected terrestrial invertebrates as a source of

biomarkers of biological response to selected metals, indicating their potential and possible application in ecotoxicological studies.

Keywords: earthworms, Lumbricidae, snails, Helicidae, waste rock, heavy metals, biomarker fatty acids