Abstract

Doctoral thesis entitled: „Risk assessment of biochar application for contaminants immobilization in terms of PAHs persistence in biochar-amended soil" comprises eight articles, thematically related to each other, and published in peer-reviewed scientific journals with an impact factor.

Research carried out as a part of the doctoral thesis consisted of two main stages. In the first one, the potential of biochar for the remediation of contaminated soil was analyzed. The results of the research obtained as part of the field experiment (Publications D1 and D2) allowed for the analysis of changes in the bioavailable fraction of PAHs in contaminated soil with the addition of biochars or activated carbon. Both activated carbon and biochar caused a decrease in the bioaccessible fraction (C_{acc}) of PAHs in the soil, with a better effect achieved for activated carbon. As for the bioavailable fraction (C_{free}), the direct addition of adsorbents to the soil did not (in the case of biochar) or caused only a slight (in the case of activated carbon) reduction in the sum of C_{free} PAHs. On top of it, biochars obtained from sewage sludge or sewage sludge with the addition of willow were tested for adsorption properties concerning two PAH compounds, phenanthrene and pyrene (Publication D3). Changing the pyrolysis conditions had a varied effect on the adsorption properties of biochars concerning phenanthrene and pyrene. The structure and properties of biochars changed, which largely determined the binding mechanism of the tested PAHs by biochar.

In the second stage, the risk of adding biochar from sewage sludge to uncontaminated soil was assessed. The literature review concerning the topic was published in one of the articles (Publication D4) As a part of the pot experiment, soil tests with the addition of biochars from sewage sludge obtained in various ways were carried out. The differences include the production temperature (500, 600, and 700^{o}C), the feedstock (willow addition to the sludge before pyrolysis), and the carrier gas (nitrogen or carbon dioxide). The conducted research concerned changes in the content of total and bioavailable fractions of PAHs in the soil (Publications D5 and D7) and ecotoxicological properties of soil (Publications D6 and D8) in relation to organisms from different trophic levels. Research has shown that the addition of willow to sewage sludge increases the persistence (based on C_{tot}) and reduces the bioavailability (based on C_{free}) of PAHs in soil with the addition of biochar. This is beneficial for the environment and increases the safety of using such material as an additive

to soils. In addition, both the mixing of willow with sludge and the change of the carrier gas from N_2 to CO_2 reduced the toxicity of biochars.