**Activated biochars reduce the exposure of polycyclic aromatic hydrocarbons in soils**

Michał Kołtowski1, Isabel Hilber2, Thomas D. Bucheli2, Barbara Charmas3,
Jadwiga Skubiszewska-Zięba3, Patryk Oleszczuk1

1Department of Environmental Chemistry, Faculty of Chemistry, Maria Curie-Sklodowska University,
Maria Curie-Sklodowska Sq. 3, 20-031 Lublin, Poland, michal.koltowski@poczta.umcs.lublin.pl, patryk.oleszczuk@poczta.umcs.lublin.pl

2Agroscope Reckenholz-Tanikon, Reckenholzstrasse 191, 8046 Zürich, Switzerland, isabel.hilber@agroscope.admin.ch, thomas.bucheli@agroscope.admin.ch

3Department of Chromatographic Methods, Faculty of Chemistry, Maria Curie-Sklodowska University,
Maria Curie-Sklodowska Sq. 3, 20-031 Lublin, Poland, barbara.charmas@poczta.umcs.lublin.pl, jskubisz@poczta.umcs.lublin.pl

Total concentrations of organic pollutants such as polycyclic aromatic hydrocarbons (PAHs), e.g. emitted during hard coal production, in soils are often used for risk assessment and in legislation. However, they may overestimate the actual exposure to organisms. Bioaccessibility describes the mass of contaminants that can be desorbed over time (Cbioacc), whereas bioavailability characterizes the aqueous or freely dissolved concentration (Cfree) for instance in the pore water. The exposure to organisms, thus the bioavailability and bioaccessibility of PAHs can be reduced by adding biochar into the soil. To increase the binding or the adsorption capacity of the PAHs to the biochar the specific surface area (SSA) can be enlarged by activation. The aim of this study was therefore to evaluate the binding effectiveness of PAHs to such activated biochars by observing a decrease in the Cbioacc and Cfree.

A commercial manufacturer provided biochar from willow which was slowly pyrolysed at 600°C and at low oxygen content (1-2%). To improve the biochar porous structure and binding capacity it was subjected to a range of activations by microwaves (in a microwave reactor under an atmosphere of superheated steam) and in the quartz fluidized bed reactor at 800°C using the carbon dioxide and superheated steam. Original and activated biochars were added at 5 % w/w into three different soils, each: 1) from a landfill, where industrial wastes from a coking plant were deposited (KB), 2) from the area of a coking battery (KOK), and 3) from the area of a bitumen processing plant (POPI). The total PAHs concentration in control soils was determined by Soxhlet extraction with hexane for 36h. The Cfree of the PAHs was determined by using polyoxymethylene strips and the Cbioacc by using silicone rods.

The SSA of biochar subjected to the activations improved significantly. The SSA in the original biochar was
11 m2 and in the activated biochars 443 m2 (microwave activation), 512 m2 (CO2 activation) and 841 m2 (N2 activation). The soils had total concentrations (sum (Ʃ) of the 16 US EPA PAHs) of 40 mg/kg (KOK), 17 mg/kg (KB) and 9 mg/kg (POPI). The Cfree was reduced in comparison to the control soils by 74%, 48%, and 0% in the POPI, KOK, and KB soil, respectivley, after the amendment of original biochar. The amendment of activated biochar reduced the Cfree in the POPI and KOK soil up to 86%, each and the one of the KB up to 70% in comparison to the unamended soils. The original biochar could reduce the Cbioacc only in the POPI soil by 49% in comparison to the control soil. In contrast, the activated biochars could reduce the Cbioacc by almost 100% in all soils in comparision to the unamended soil. The most effective biochar was that modified under a N2 atmosphere by water vapour.