

### **Non-technical abstract**

One of the bulk by-products of torrefaction and pyrolysis is biochar. Biocarbon is the carbon rich product obtained when biomass is thermally decomposed mostly under a torrefaction/pyrolysis process. Pyrolysis is the organic matter decomposition under anaerobic conditions. Torrefaction is considered as low temperature pyrolysis, frequently called as biomass and biowaste roasting. Recent research showed that biochar may be used to improve soil properties, to remediate soil contamination, to replace fossil fuels. Frequently, the biochar is considered as a tool of potential relevance to sustainable agricultural development. Additional option, the Waste to Carbon concept is the conversion of organic biowaste into valuable materials, including fuel with high carbon concentration. The pyrolysis and torrefaction turn biomass and biowaste into biochar with a calorific value reaching similar calorific values to black coal.

Besides positive effects of biochar, some negative effects have also been reported. The biochar may contain potentially harmful and toxic substances including volatile organic compounds. The content of this pollutants, their emission depends on the properties of the feedstock and torrefaction/pyrolysis temperature. Application of biochar for agriculture and as a valuable fuel requires practical issues of storage, handling and application. Thus, it needs to be ensured that biochar does not pose any excessive risk to humans by inhalation of harmful volatile organic compounds. Detailed understanding of reasons of such negative effects is not investigated and understood deeply yet. Contaminants within biochar may pose an environmental risk. Additionally, the emission of organic pollutants from biochars may occur, causing the risk to human health. Unfortunately, there is limited information on the impact of various torrefaction/pyrolysis conditions on the chemical characteristics of biochars produced from the same type of feedstock. Therefore, objective of proposed research is to evaluate the effects of torrefaction/pyrolysis temperatures and the content of components of biomass: lignin, cellulose, hemicellulose on the qualitative and quantitative emission of potentially harmful compounds from biochar.

**The scientific aims** of this project are (1) qualitative and quantitative characterization of pollutants formation, emission from biochars in relation to torrefaction/pyrolysis temperature and the content of biomass components, (2) model determination describing the biochar's potential influence on human health.

The project has interdisciplinary character, and will include following tasks:

**Task 1. Biochar generation from components of biomass** – the aim of the task will be the production of biochar from components of biomass: lignin, cellulose, hemicellulose and their mixtures under controlled conditions of torrefaction/pyrolysis 200°C – 600°C.

**Task 2. Determination of physical and chemical properties of biomass components and generated biochars** – the aim of the task will be the physical and chemical characterization of feedstock and biochars for evaluation the phenomenon of pollutants transformation during thermal treatment.

**Task 3. Investigation of the VOCs emission from biochar** - the aim of the task will be the characterization of volatile organic compounds emission from biochars to air and the evaluation of human health risk.

**Task 4. Determination of the model of the impact of technological parameters of biochar production on the VOCs emission from biochar** – the aim of the study will be the building the mathematical model, which may be useful for prediction of potential risk posed by biochar to human health.

**Task 5 - The validation of the model of the impact of technological parameters of biochar production on the VOCs emission from biochar** - the goal of the task is to assess the correctness of volatile organic compound emission prediction by comparing with real measurements.

An effect of proposed research will be the determination of the data covering potential impact on the human health of biochar generated from biomass torrefaction/pyrolysis. This research may show potential impact on work environment of biomass torrefaction/pyrolysis at the early stage of basic research. Presented problems, related to the potential negative influence of biochar on human health are novel and open a new niche for investigations and experiments. It is expected that results obtained on the one, homogenous type of feedstock – biomass components: lignin, cellulose, hemicellulose and their mixtures, will provide the procedure of biochar quality and human health risk due to exposure on volatile organic compounds evaluation, which could be used for examination of biochars obtained from other types of biowaste. The proposed project involves original, experimental and theoretical, as well as interdisciplinary research undertaken to develop new knowledge about the phenomena of pollutants emission from biochars produced from biomass, under different torrefaction/pyrolysis temperatures. This investigation and analysis will be focused on the identification, and on a better understanding of pollutants formation and release from biochar, the influence of external and internal factors on the emission, and on the potential impact on human health. The compliance of biochar with existing pollutants threshold values has been tested before not significantly, which could be highly relevant for human health and safety. The proposed research has great publishing potential, mostly that is a novel and similar works were done in nonsystematic way.