Comparative analysis of qualitative and quantitative volatile organic compounds emission from chicken manure derived biochar and hydrochar

Considering **increasing poultry breeding industry**, especially in Poland, and therefore high and still growing amount of chicken manure, finding the most efficient and viable way of its management is required. Two fast developing ways are torrefaction and hydrothermal carbonization. However, apart from positive impact on the economy and environment, the negative effects of these processes and their products application also have to be considered, with one of them being the emission of **volatile organic compounds**. **So far, few researchers focused on the emissions of volatile organic compounds from biochar and hydrochar, with some information about the emission from manure in general, and very little information about the emission from chicken manure derived materials.** Such emissions can affect soils and living organisms, as well as **humans** during production, transportation, storage, and application. **Unfortunately, the systematic information regarding the impact of various thermochemical processes and their conditions on the emission of volatile organic compounds from chicken manure is limited. The scientific aim of this project is comparative analysis of qualitative and quantitative volatile organic compounds emission from biochar and hydrochar in relation to torrefaction and hydrothermal carbonization processes conditions. It is hypothesized that** adjusting temperatures of these processes will mitigate the emissions of volatile organic compounds and improve material properties. **Accordingly, the scientific aims will include** determination of the fuel properties and nutrients content of the substrate and products, qualitative and quantitative characterization of the volatile organic compounds emission from the substrate and products, comparative analysis of processes parameters (time and temperature) and their influence on the products characteristics, determination of a mathematical model to describe the effects of the processes on the quality and quantity of emitted volatile organic compounds, fuel properties, and nutrients content of the product.

The project has an interdisciplinary character, and will consist of five individual tasks:

Task 1. Production of biochar from chicken manure

Production of 36 samples of biochar from chicken manure via torrefaction at the temperatures of 200, 250, and 300 ˚C in 60 and 120 min.

Task 2. Production of hydrochar from chicken manure

Production of 36 samples of hydrochar from chicken manure via hydrothermal carbonization at the temperature range of 200, 250, and 300 ˚C in 60 and 120 min.

Task 3. Determination of properties of feedstock and generated biochar and hydrochar samples

Determination of physicochemical parameters of feedstock and derived biochar and hydrochar samples. Fuel properties, macronutrients content, and specific surface area will be evaluated.

Task 4. Investigation of the VOCs emission from feedstock, biochar, and hydrochar

The evaluation of the emission of volatile organic compounds from feedstock and biochar and hydrochar samples using HS-SPME/GC-MS method. The emissions will be compared with standard threshold values.

Task 5. Determination of the model

A mathematical model will be built in order to predict potential risk posed by biochar and hydrochar to the environment and human health, and to understand the correlations between processes parameters and material properties and emissions.

The effect of proposed research will be comparative analysis of two thermochemical processes, i.e. torrefaction and hydrothermal carbonization, in regards to main products' properties and the emissions of volatile organic compounds. This will then allow to understand the external factors (process temperature and time, as well as type of used chicken manure) influencing the volatile organic compounds emission and other properties of the derived products. The evaluation of the emissions of volatile organic compounds will allow to understand the possible adverse effects of biochar and hydrochar applications on human health, with this important area of study being still a niche. Creating a mathematical model will make understanding the mechanisms easier, and also allow to predict the emissions and properties of materials from other sources. Additionally, this proposed research will create the possibility to mitigate the emissions of volatile organic compounds through adjusting the conditions of the processes, and therefore minimizing the human health threat and soils contamination.