Effect of addition of biochar on improvement the quality parameters of compost used for land reclamation

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Various wastes (e.g. sewage sludge, fly ash, contaminated soil) are used in the composting process to ensure decontamination (removal of organic pollutants) of composts for land reclamation in the areas deteriorated by the exploitation of mineral raw materials. The use of such wastes improves the economy of the process, and, at the same time, it recycles wastes that would be difficult to apply in the framework of the principles of a circular economy. Since the cost of biochar has to be included in the economy of the whole process, it has to be compensated by improving the environmental parameters of the compost or the operational technological parameters (odour).

Urban greenery, and biodegradable waste from kitchens and catering, which is composted in enclosed heated air-intake fermenters, is used as the basic raw material for compost production. After aerobic fermentation in the fermenters was completed, the fermentate was mixed with the sludge from the wastewater treatment plant, contaminated soil and biochar (5%), and was left to mature for 60 days. For comparison, a second technological test without the addition of biochar and the third test without the addition of sludge and soil (only fermentation with biochar) were performed in parallel.

During this time, parameters affecting the technological process (VOC emissions to the atmosphere) and those affecting compost quality (in leachate: the release of VOC and parameters used to assess compost stability to extract, oxygen uptake ratio (OUR), including phytotoxicity and ecotoxicity, were monitored. The addition of biochar to the fermentation process caused the average temperature throughout the body to rise above 60 °C for 20 days. After mixing the feedstocks, there was a short local temperature increase to > 70 °C after 2 days, initiated by an increase in the concentration of gaseous VOCs. A temperature above 70 °C is undesirable as it can affect the living conditions of chemotrophic bacteria.

The processes of decomposition of cellulose, hemicellulose, lignin and carbohydrates were accelerated due to higher temperatures or higher microbial activity. A higher degree of humification was achieved – an increase in humic acid concentration in the resulting compost. The leachability of problematic ecotoxic compounds derived from anthropogenic compounds contained in compost (plastics) has been reduced, which was demonstrated by the comparison with the composition of the leachate extracted from the substrate (standard compost product made from fermentate with sludge and soil). The addition of biochar reduced the emissions of VOC and NH_3 released during periodical turning in the yard. The degree of mineralisation of nitrogen compounds was also reduced and thus improved the fertilising properties of compost. There was no evidence of phytotoxicity to *Lepidium sativum* or *Lactuca sativa*; biochar is likely to have stimulatory growth effects. Ecotoxicity monitoring on *Daphnia magna* shows that the highest inhibition was achieved in compost produced from fermentate with the addition of biochar. The monitoring of the dissolved organic matter (DOC) and chemical oxygen demand (COD) in the aqueous leachate shows that the nanoparticles of biochar pass directly into the leachate, whereas in the case of compost with added soil and sludge, they can be sorbed by these particles. Compliance with ecotoxicological indicators is crucial in terms of legislation when using these products made from waste for land reclamation.

The addition of biochar to the compost accelerates all degradation processes and minimises emissions, but it can affect ecotoxicity in *Daphnia magna* by leaching nanoparticles of biochar. It is, therefore, preferable to use it in the final product of the substrate, which has a filter function in this case and reduces the leachable fraction of “biochar nanoparticles”.