PRACTICAL ASSESSMENT OF BIOCHAR STABILITY INDICATORS:SENSITIVITY TO FEEDSTOCK TYPE AND PRODUCTION CONDITIONS

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Addition of biochar to soil, among other beneficial abilities has the potential of the carbon sequestration, improvement of soil fertility, and remediation of contaminated land (e.g., heavy metals immobilization). In a long-term perspective, these positive properties depend on the resistance against decomposition (stability) of the biochar in the soil matrix. The stability is influenced by the biochar production process parameters (i.e., pyrolysis), feedstock's origin, and the (a)biotic environmental conditions [1]. Due to numerous factors impacting on the stability, its objective assessment is a complex task, and one assessment method can be not sufficient. In literature has been reported several biochar stability indicators, but each of them rather covers the influence of the specific factor, than give complete information of biochar's stability. Therefore is legitimate to ask the question, are the stability predictors show any similarities between each other? An investigation of possible correlations among results from different stability assessment methods can lead to the improvement of the understanding of the biochars stability, and development of one, objective assessment's method. [2]. In this study, were analyzed 24 biochar samples produced from a variety of the feedstock: algal biomass, agricultural residues and wastes, woody biomass, and industrial wastes. Highest treatment temperature (HTT) during pyrolysis ranged from 300 °C to 750 °C with a residence time of the materials from 10 to 90 minutes and the heating rate from 5 to 25 °C/min. For the indicators similarity assessment, the stability indicators were derived, among others: H/C ratio, recalcitrance index (R_{50}), stability according to the Edinburgh stability tool (EST) [2], compounds ratios from analytical pyrolysis measurement (e.g., benzene/toluene ratio). The Principal Component Analysis (PCA) was performed to grasp possible trends in this high-dimensional data. Two main principal components (i.e., dimensions) of PCA retained ca. 70% of the original variance in the data, which is satisfactory value, especially for such inhomogeneous data matrix. Results arrangement indicated that the first principal component (PC1) could be strongly linked with the biochar's stability, and the second component (PC2) can be related to the biochar's feedstock origin. The H/C ratio, VM content (d.b.), benzene/toluene ratio, the EST and the R_{50} shown the highest impact on the first component and were assumed as the feedstock-independent biochar's stability indicators. The FC and ash content (d.b.), O/C ratio, phenol/benzene ratio were shown the highest impact on PC2. Therefore, they were assumed as the feedstock-dependent parameters. Since the feedstock properties are usually treated as unchangeable parameters, the correlations between the feedstock-independent, so production-dependent predictors were investigated. The H/C ratio shown a good Pearson correlation with benzene/toluene ratio (-0.76) and a bit weaker with EST (-0.61). The benzene/toluene ratio was shown correlation with R_{50} index (0.56) and EST (0.67). In conclusion, successful division of the stability indicators on the feedstock-dependable and -independent was achieved. It allowed observing a correlation between pairs of stability indicators. Therefore the existence of the similarities between certain parameters was proven. Future analysis of the data should focus on the ruling out possible multicollinearity in the stability indicators dataset. It will allow minimizing and clear the dataset for the objective stability assessment. That can open the route for establishing one, multipart stability parameter, which can be beneficial in biochar stability improvement studies and allow for broader application of the biochar in the future.

References:
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