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EDITED AND REVIEWED BY
Andrew R. Zimmerman,
University of Florida, United States

*CORRESPONDENCE
Antoni Sánchez,
antoni.sanchez@uab.cat

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Editorial: Innovative uses of biochar in environmental applications

Antoni Sánchez*

Department of Chemical, Biological and Environmental Engineering, Autonomous University of Barcelona, Barcelona, Spain

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Editorial on the Research Topic
Innovative uses of biochar in environmental applications

Biochar is the solid product resulting from the pyrolysis of organic matter. Nowadays, it is gaining widespread research and policy attention due to its unique properties and characteristics. On the one hand, and in most of the cases, biochar is produced by the pyrolysis of waste carbon sources as forestry biomass, wood rejected materials and a wide diversity of solid organic waste (wastewater and digested sludge, solid fraction of manure, organic fraction of municipal solid waste, among others). The pyrolysis process transforms labile forms of organic matter into very stable carbon, resulting in a net carbon sequestration that can be used as carbon credits. On the other hand, biochar is a highly porous material, stable and easy to recover, and when chemically functionalized, with a wide range of attractive chemical properties. Considering these two facts, the use of biochar in environmental applications has grown exponentially in recent years and practically each week, novel uses of biochar for environmental remediation are presented.

The Research Topic entitled Innovative Uses of Biochar in Environmental Applications was born with the idea of collecting some of these novel uses of biochar. As expected, one of the papers is related to the advantageous role of biochar as a fertilizing agent. Thus, Laan et al. describes the changes the available of phosphorous that occur when applied to soil, an Research Topic that is of special relevance as biochar has been presented as slow-release support for NPK fertilization, particularly in cases of excess application of manure. The use of biochar for fertilization purposes is today a worldwide Research Topic, with numerous studies taking place at field scales.

Another emerging and central biochar environmental applications is in water and wastewater treatment. From water purification for human consumption or irrigation, including advanced Research Topic in wastewater treatment such as development of biofilms and nutrients removal, biochar has been demonstrated to be similar, or even superior, to activated carbon. In Karre and Cai, the authors review the efficacy of biochar for the removal of nitrobenzene from both aqueous and soil phases. This is an excellent example of how biochar can be used for the removal and recovery of highly recalcitrant organic pollutants, a Research Topic of enormous interest in today's scientific literature. In fact, biochar is leading a new generation of highly effective bioadsorbents that can be used for water and soil remediation or gas purification.

The last two papers published in this Research Topic are, in my opinion, of particular interest. Recently, biochar has been discovered to be an effective additive to improve the

yield of biomethane during the anaerobic processing of several organic wastes. In this time of energy scarcity due to the world's geopolitical situation, the search for locally-available renewable energy sources has resulted in a boost in anaerobic digestion, with hundreds of new plants either in design stages of entering operation. Thus, the positive effect of biochar on this process is highly relevant. García-Prats et al. shows how biochar from lignocellulosic waste enhances the anaerobic digestion of organic fraction of municipal solid waste (OFSMSW), a relevant new waste stream as new regulations on the separate Research Topic of OFSMSW are entering into force in Europe and in other parts of the world. In this paper, the authors also demonstrate that the optimal ratio of biochar to OFSMSW is relatively low (5%). Although this ratio will obviously depend on the type of biochar, it can be the base of preliminary environmental and economic analyses. In the paper published by Almegbl et al., more information is presented on this Research Topic. In this study, carbon-based materials was used to improve the pretreatment of waste-activated sludge to disintegrate the sludge matrix and amend the process of anaerobic digestion. Graphene and biochar were observed to accelerate direct interspecies electron transfer (DIET) to reach a higher biogas production potential. Further, biochar-amended digestate shows improved dewaterability when compared to graphene. However, the authors state that a techno-economic analysis and life cycle assessment are required to explore the feasibility of biochar-amended anaerobic digestion processes.

In summary, this conclusion could also be the conclusion of this Research Topic: biochar is a very promising material for a large number of environmental applications. But studies at pilot and full-scale are needed to validate the overall environmental and economic performance of its use.

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Conflict of interest

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