What physicochemical properties better explain the long-term biodegradability of burning-derived char?

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Fires and field burnings produce char, which represents an important carbon (C) sink due to its high stability against biodegradation. Yet its potential for long-term C sequestration remains elusive as char has large variation in terms of physical and chemical properties depending on source material type and burning conditions. We thus need biodegradability indices that are applicable for the range of chars. The O/C molar ratio has often been used in the literature. On the other hand, H/C molar ratio better correlates with char's chemical composition which is likely to control biological stability against microbial degradation. We thus tested if H/C ratio serves as a better index of the biodegradability than O/C ratio by comparing the chars prepared under different conditions (200–600 ºC, with/without heating temperature duration, low and ambient O_2 levels) from rice straw and husk. We assessed their physicochemical characteristics and chemical composition using solid-state CP/MAS ^{13}C-NMR. Based on 295-day laboratory incubation, we obtained biodegradability at three time scales: short (<100 d), intermediate (295 d), and long (>500 d) using inter- and extrapolation of decay curves. The short-term biodegradability was better explained by O/C ratio whereas the long-term biodegradability was better explained by H/C ratio. The H/C strongly correlated with aromatic and O-alkyl C, while O/C correlated with carboxylic C as well, suggesting that O/C reflected the amount of labile organic matters such as organic acids. Our findings suggest that long-term C fate of burning products is better estimated by H/C ratio rather than O/C ratio at least for the rice residues.

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