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The Role of Laccase in Peatland Carbon Cycling: Method and Mechanism

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Abstract: The large reservoir of organic carbon in peatland is essential for the global carbon cycle. Laccase, probably the largest class of phenol oxidases in soil, plays a key role in the primary degradation of recalcitrant polyphenolics such as lignin. However, the traditional method used to test laccase activity may not be suitable for peatland. We found ferrous iron in peatland can significantly affect the measurement of laccase activity by delaying the ABTS•+ absorbance dynamic inflection point. Through the multi-factor interference test, we proposed a novel method based on delay dynamics (MDD) to determine laccase activity in peatland and applied it to the investigation of Dajiuhupeatland. The results show that the laccase activities measured using MDD (24.45±10.89 μmol·g^{-1}·h^{-1}) are considerably higher than that measured by the traditional method (12.10±12.06 μmol·g^{-1}·h^{-1}). In addition, our investigation indicated Fe-bound OC contents varied regularly with the succession gradients characterized as different vegetation. Microbial community analysis results show the potential impact of fungi as well as laccase on the accumulation of Fe-bound OC appears to be greater than that of bacteria in peatland. Furthermore, the simulation results confirmedlaccasewas capable of promoting the formation of Fe-OM association, which showed that DOC coprecipitating into an Fe-OM association was dramatically increased from 3.3%, 6.35% and 8.21% without laccase to 10.16%, 19.37% and 21.53% in the presence of laccase at an initial Fe/C molar ratio of 0.1, 0.25 and 0.5, respectively. Combining the above results, we propose that while laccase is involved in lignin degradation, it also enhances carbon sequestration by promoting the formation of Fe-OM associations in peatland.

key words: peatland, carbon cycling, laccase, delay dynamics, Fe-bound OC

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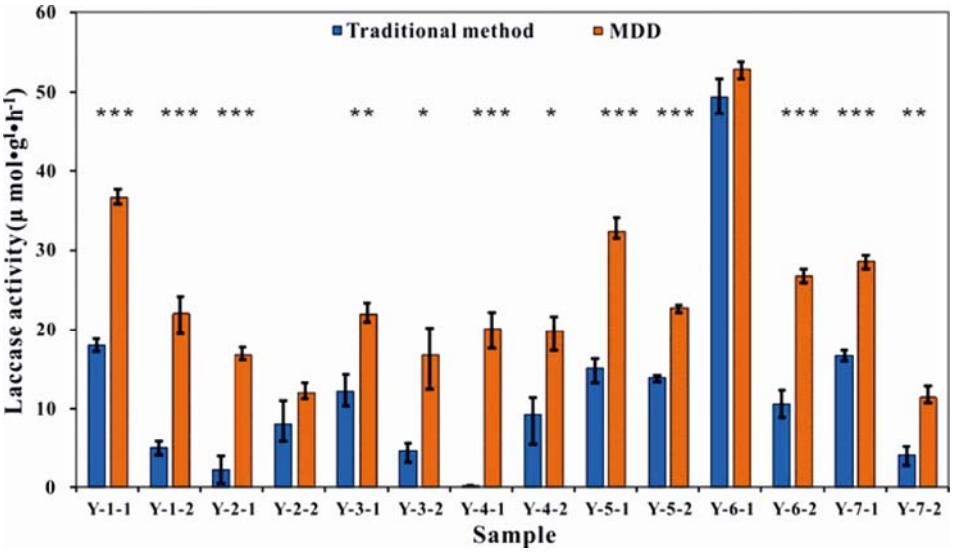

Fig. 1. Comparison of laccase activity results based on the traditional method and MDD.
The statistical significance of the difference (*P<0.05,**P<0.01, ***P <0.001)

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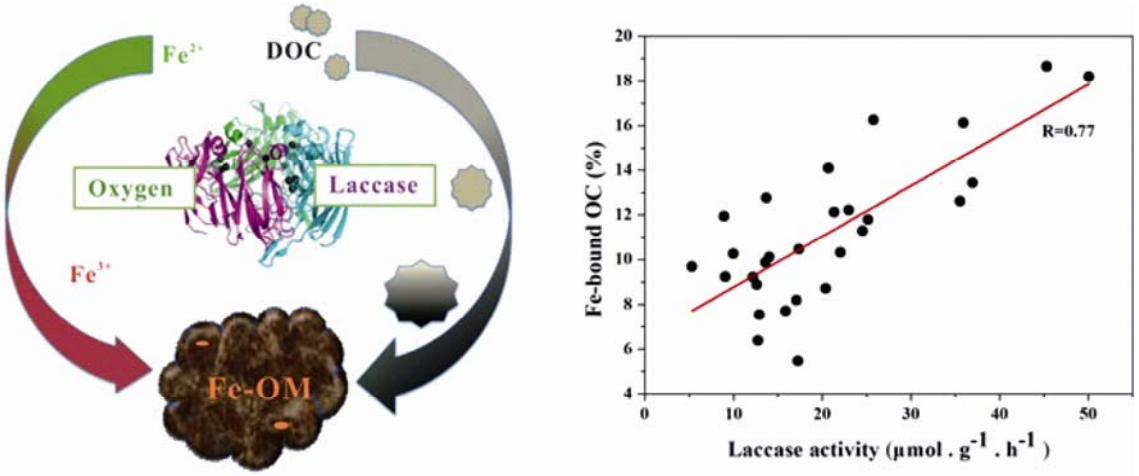

Fig. 2. Promoting effect of laccase on the accumulation of Fe-bound OC in peatland

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