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Decomposition and transformation of cutin and cutan biopolymers in soils: effect on their sorptive capabilities

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Plant cuticle materials, especially the highly aliphatic biopolymers cutin and cutan, have been reported as highly efficient natural sorbents. The objective of this study was to examine the effects of decomposition on their sorption behavior with naphthol and phenanthrene. The level of cutin and cutan was reduced by 15 and 27% respectively during the first 3 mo of incubation. From that point, the level of the cutan did not change, while the level of the cutin continued to decrease up to 32% after 20 mo. 13C NMR analysis suggested transformation of cutan mainly within its alkyl-C structure which are assigned as crystalline moieties. Cutin, however, did not exhibit significant structure changes with time. The level of humic-like substances increased due to cutin decomposition but was not influenced in the cutan system after 20 mo of incubation. This indicates that the cutin biopolymer has been decomposed and transformed into humic-like substances, whereas the cutan was less subject to transformation.
Decomposition affected sorption properties in similar trends for both cutin and cutan. The Freundlich capacity coefficients (KFOC) of naphthol were much lower than phenanthrene and were less influenced by the decomposition, whereas with phenanthrene KFOC values increased significantly with time. Naphthol exhibited non-linear isotherms; and nonlinearity was decreased with incubation time. In contrast, phenanthrene isotherms were more linear and showed only moderate change with time. The decrease in the linearity of naphthol isotherms might relate to the transformation of the sorption sites due to structural changes in the biopolymers. However, with phenanthrene, these changes did not affect sorption linearity but increased sorption affinities mainly for cutan. This is probably due to decomposition of the rigid alkyl-C moieties in the cutan biopolymer. Our data suggest that both biopolymers were relatively stable in the soil for 20 mo. Cutan is less degradable than cutin and therefore is more likely to accumulate in soils and contribute to the refractory aliphatic components of soil organic matter.