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Different pathways but same result? Comparing chemistry and biological effects of burned and decomposed litter

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Litter burning and biological decomposition are oxidative processes co-occurring in many terrestrial ecosystems, producing organic matter with different chemical properties and differently affecting plant growth and soil microbial activity. Here, we tested the chemical convergence hypothesis (i.e. materials with different initial chemistry tend to converge towards a common profile, with similar biological effects, as the oxidative process advances) for burning and decomposition. We compared the molecular composition of 63 organic materials - 7 litter types either fresh, decomposed for 30, 90, 180 days, or heated at 100, 200, 300, 400, 500 °C - as assessed by 13C NMR. We used litter water extracts (5% dw) as treatments in bioassays on plant (Lepidium sativum) and fungal (Aspergillus niger) growth, and a washed quartz sand amended with litter materials (0.5 % dw) to assess heterotrophic respiration by CO_2 flux chamber. We observed different molecular variations for materials either burning (i.e. a sharp increase of aromatic C and a decrease of most other fractions above 200 °C) or decomposing (i.e. early increase of alkyl, methoxyl and N-alkyl C and decrease of O-alkyl and di-O-alkyl C fractions). Soil respiration and fungal growth progressively decreased with litter age and temperature. Plant growth underwent an inhibitory effect by untreated litter, more and less rapidly released over decomposing and burning materials, respectively. Correlation analysis between NMR and bioassay data showed that opposite responses for soil respiration and fungi, compared to plants, are related to essentially the same C molecular types. Our findings suggest a functional convergence of decomposed and burnt organic substrates, emerging from the balance between the bioavailability of labile C sources and the presence of recalcitrant and pyrogenic compounds, oppositely affecting different trophic levels.