Variability of ^{13}C-labeling in plant tissues, implication for biogeochemical studies

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Résumé:

A major challenge in studying the fate of organic carbon in the environment is the multiplicity and diversity of its sources: roots, aerial parts of plants, bacteria, fungi, fauna etc. Indeed, it can be difficult to distinguish the effects of organic matter transformation from those related to variations in the relative contributions of its sources. An alternative approach is to monitor material labeled with stable isotopes. Carbon isotope (^{13}C) labeling of plants is thus widely used to estimate the fate of organic carbon in biogeochemical cycles. While the natural isotope difference between C_3 and C_4 plants (~15‰) was commonly used during the previous century, incubation of artificially ^{13}C-enriched plant tissues is becoming increasingly favored for its potential to decipher detailed mechanisms. Such artificial labeling is achieved by growing plants under $^{13}CO_2$-enriched atmosphere. Nevertheless, incorporation of ^{13}C-label may differ widely among plant compartments and induce significant isotope variability of the obtained tissues. Subsequent incubation of labeled plants may thus lead to inaccurate conclusions if the variability of isotope labeling is not properly taken into account.

The aim of this study was thus to document the isotope variability of plant material after ^{13}C-labeling. Two species representative of frequent vegetation types in temperate ecosystems were investigated: a fast growing grass (*Lollium multiflorum* Lam.) and a deciduous tree (*Fagus sylvatica* L.). Labeling was obtained by growing plants several months under continuously ^{13}C-enriched CO_2 in a controlled chamber (RUBIC 1, BioEMCo, Grignon, France). Either seedlings were placed in the chamber at the cotyledon stage or seeds were directly germinated in the chamber. Plant samples were recovered at the end of the labeling period, dried and analyzed by an automatic unit that combines an elemental analyzer with an isotope ratio mass spectrometer. For both species, significant isotope variability among plant organs was revealed within a given plant. The earliest leaves appeared much less labeled than the latest leaves, probably due to higher contribution of unlabeled carbon originating from seeds and/or the natural atmosphere preceding the labeling period. The heterogeneity observed here for labeled leaves is significantly higher than that usually observed for natural leaves. In the same way, the isotope signal within a given leaf appeared much more variable in labeled leaves than in natural leaves. These results show the necessity for (1) integrating the initial variability when interpreting results derived from labeled tissues and (2) necessity of beginning plant labeling experiment as early as possible within plant life cycle.