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Quantification of the lignin in plants and soils – literature review and experimental approaches

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The quantity and quality of the plant organic inputs are important parameters of carbon (C) budgets in soils (Kögel-Knabner, 2002). Lignin is an important component of this plant material, since it represents the second most abundant natural polymeric material. Lignin has properties that suggest a slower decomposition than other plant compounds in soil. Soil lignin is often quantified by cupric oxide oxidation (CuO) under alkaline conditions (Goni and Eglinton, 1996). This method is particularly useful in turnover studies, because it is possible to measure the isotopic signature of the lignin monomers that are separated with this method (Dignac et al. 2006, Heim et al. 2007). However, CuO is not a reference method for plants and is not often used for this purpose. Moreover, this method is considered as strictly qualitative by many workers. In this study we tried to estimate the quantification potential of this method, first through a review of lignin quantification in plants, then by an experimental approach using mixtures of lignin substrates and soil to estimate the recovery potential of the CuO method.

First, we reviewed the methods that are used to quantify lignin in plants. Methods differ by their isolation procedures and by their quantification approaches. Briefly, three categories of methods are used. Non-invasive methods do not physically isolate lignin, but describe lignin within the original sample, which is not or only minimally modified. Solublisation methods use the properties of different solvents, such as dioxane, to isolate lignin by solubilization under specific conditions (particularly alkali or acidic conditions). Finally, direct method procedures extract all non-lignin compounds from

plant material by acidolysis or with solvents and leave lignin as a residue. Three different quantification approaches are available: gravimetry, spectroscopy and analysis of compounds specific to lignin (mainly by gas chromatography). In total, we found 13 combinations of isolation and quantification procedures that can be used to quantify lignin.

We compared data from 14 publications, where lignin is quantified simultaneously by the Acid Detergent Lignin method (ADL) and another method in biomass (legumes, grasses, hard- and softwood). Klason lignin (Klason) and Acetyl Bromide Soluble Lignin (ABSL) quantified an average of 2.7 and 2.9 times more lignin than ADL. Conversely, CuO recovered an average of 20 % of the ADL value.

In a second step, we designed an experimental approach to estimate the quantification potential of the CuO method in soil. Three substrates (pure commercial lignin, wheat straw and chestnut wood) were added at increasing rates (0, 5, 10, 25, 50 and 75 % Csubstrate/Csoil) in a soil. The lignin in the mixtures was analysed using CuO and ABSL methods.

First results show that the recovery of the added lignin quantity by the CuO method is not complete and that the type of the added substrate affects the proportion that is actually recovered. With this study, we will have a clearer view of how confident we can be with the quantification of CuO extraction in soil and we should be able to propose a correction or at least a comparison with other methods.

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