FIRE EFFECT ON LIPID COMPOSITION AND HYDROPHOBICITY OF SANDY SOILS

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Introduction

Low soil-water affinity and soil water repellence (SWR, hydrophobicity) prevents water from wetting or infiltrating soils in burnt and unburnt ecosystems, causing changes on their hydrology, geomorphology, geochemistry, and biochemistry. A wildfire may destroy, develop or enhance SWR in previously wettable or water-repellent soils (e.g., Doerr et al., 2009; Jordán et al., 2013 and references therein). Hydrophobicity is at least in part attributed to a lipid-like cover, rich in fatty acids (FAs). Recently, we have shown that FAs had a major role in the water repellency observed in sandy soils in Doñana National Park (DNP, SW-Spain) under trees (*Quercus suber, Pinus pinea*) and shrubs (*Pteridium aquilinum, Halimium halimifolium*) vegetation (Jiménez-Morillo et al., 2016).

To get further insight into how fire affect the distribution of soil lipids and their role in SWR, a study was performed on different size fractions of a DNP sandy soil under *Quercus suber* cover. Two soil samples were taken, one in a burnt site and another in an adjacent unburnt (control) one, both having the same physiographic characteristics. SWR was determined using water-drop-penetration-time test in the <2 mm sieved (bulk) soils and in six size fractions: 1-2 mm, 0.5-1 mm, 0.25-0.5 mm, 0.1-0.25 mm, 0.05-0.1 mm and <0.05 mm. Lipids were extracted from all samples (n = 14), and the FAs and neutral lipids identified and quantified by GC/MS and GC/FID, and the carbon isotope composition ($\delta^{13}C$ values in ‰ vs. VPDB) of the individual saponifiable compounds determined by GC/C/IRMS.

Results

The SWR values of soil samples and fractions were statistically different ($p < 0.01$), for both, the fire affected and unaffected soils, and different grain-size fractions. SWR values in burnt bulk soil and 0.05-0.1 mm fraction were higher than in unburnt homologues. The coarser and finest soil fractions (1-2 mm and <0.05 mm, respectively) of the unburnt soil were found the most hydrophobic; in contrast, the finer fractions (0.05-0.1 mm and <0.05 mm) were the most hydrophobic in burnt soils. The total amount of lipids and total FAs were higher in burnt bulk sample and in all the size fractions, except for the coarser one, which had twice the amount of lipids, compared to the burnt one. All samples showed similar distribution of saponifiable lipids, characterized by straight chain saturated acids in the C_{14}-C_{32} range and only differing in their relative abundances. In bulk soil and <0.5 mm fractions the concentrations (µg FA/g soil) of the FAs were higher in burnt compared to unburnt soil (this difference was small or absent in C_{22}). For the coarser fractions, the opposite trend was observed in most FAs, except C_{18}, and for $C_{<20}$ acids in the 0.5-1 mm fraction. All the samples showed generally very similar distribution of non-saponifiable lipids, dominated by C_{27}, C_{28} and C_{29} sterols and triterpenols, and a less abundant homologous series of *n*-alkan-1-ols in the C_{14} to C_{29} range and small amount of *n*-alkanes in the C_{17} to C_{30} range. Bulk soil and the size-fractions, except the coarser one, had higher concentrations in most neutral lipids. Principal component analysis (PCA) performed on lipid concentration, concentration ratios and SWR (Fig. 1A) indicated that hydrophobicity of soils was positively correlated to the total lipid content, normal $C_{>24}$ FAs and branched $C_{>24}$ FAs, and negatively correlated with the even/odd FAs ratio. The scatterplot of the PC1 *vs* PC2 scores showed that all burnt samples formed a cluster at values around 0, the unburnt coarse (>0.5 mm) and finest (<0.05 mm) fractions were positively correlated with SWR and total lipids, the bulk and intermediate fractions (0.5-0.05 mm) negatively (Fig. 1B). Average $\delta^{13}C$ values ranged from -36 to -26‰ with no significant differences between short ($C_{<21}$) and long ($C_{>21}$) chain FAs pointing to SOM of major plant C_3 origin (-35 to -25‰). In addition the average C isotope composition did not show significant (*p>0.05*) differences between burnt and unburnt particle size fractions. Thermal transformation pathways explain the changes of the $\delta^{13}C$ of the individual fatty acids.

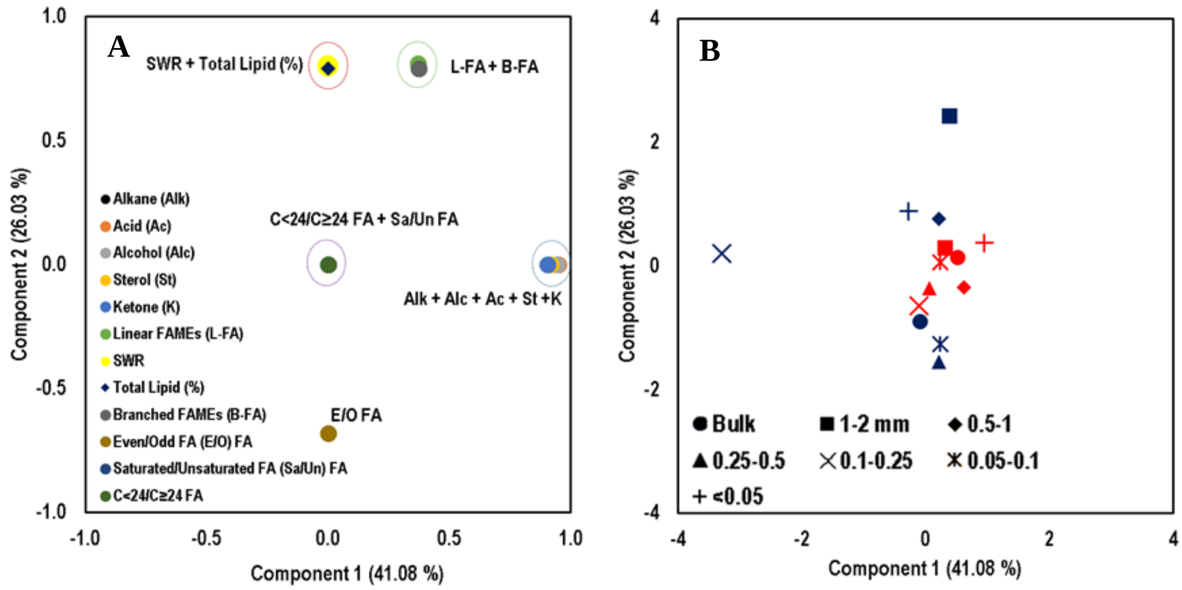

Figure 1: *Principal components analysis (PCA) of lipid concentrations, concentration ratios and SWR.* ***A)*** *Loadings of variables;* ***B)*** *Scores of samples. Red symbols indicate burnt and blue unburnt samples.*

References

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