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Characterization of organic matter's quality evaluated through ^{13}C NMR of the Serra do Sudeste's soils in Rio Grande do Sul

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Introduction

Due to the absence of significant research work on the characterization of soil organic matter (SOM) in the region of Serra do Sudeste do Rio Grande do Sul, the purpose of this work is to evaluate qualitatively the physical fractions of a Lithic Leptosol (RL), Haplic Planosol (SX) and Haplic Vertisol (VX) under a native grassland in Torrinhas, 2nd District of Pinheiro Machado, RS.

The soil sampling was performed on the soil's layer from 0.000 to 0.025 m and part of the undisturbed samples were used for the density physical fractionation of the SOM [1], in which a solution 2.0 Mg m^{-3} of sodium polytungstate was used. The energy dispersion per ultrasound was of 357 J mL^{-1} for RL, 374 J mL^{-1} for the SX and 461 J mL^{-1} for VX.

The samples of the free light fraction (FLF) and occluded light fraction (OLF) were treated with aqueous solution of HF 10%, to perform the analysis on the ^{13}C nuclear magnetic resonance (NMR).

Results and Discussion

The spectra were similar for the different soil types analyzed (Figure 1). In the region between 25-35 ppm, the C alkyl signal is from methylene, derived from long chain aliphatic. In the region of C O-alkyl (60-110 ppm), one can observe two distinct peaks; the one at 72-75 ppm is assigned to cellulose and the other at 105 ppm, derived from hemicellulose and other carbohydrates. The signal between 160-230 ppm corresponds, in part, to the carboxyl groups of organic acids [2].

In the analyzes of different soil types, there was a predominance of substituted C alkyl groups (C O-alkyl/C di-O-alkyl + C N-alkyl/C methoxyl), whose proportion varied from 36% to 37%, followed by C alkyl groups (26% to 36%). The aromatic structures (C aryl + C phenyl) contributed approximately with 13% of the composition of the samples, the carboxyl groups with 8% and carbonyl groups with 6% (Table 1).

Considering that the substituted C alkyl groups indicate the presence of polysaccharides and proteins structures in the SOM and that these compounds are easily decomposed by microorganisms; it can be inferred that the presence of these structures in the OFL indicates the process of physical protection of SOM by occlusion in the interior of stable aggregates.

Analyzing the chemical composition of FLF of the SOM, the proportions of substituted C alkyl, varied from 37% to 51% for RL and VX, respectively. For C alkyl, these ratios ranged 26-32% for VX and RL, respectively. Possibly the greatest abundance of substituted C alkyl in the FLF of VX can be explained by the differences in chemical composition (recalcitrance) of crop residues and its relationship with the environment where the decomposition occurs.

With respect to the aromatic structures (C aryl + C phenyl), the highest percentage was found in RL (17%). These higher proportions found in the substituted C alkyl groups, in relation to the aromatic structures; show that carbohydrates are the main organic constituents of the soil, although they have low molecular recalcitrance. This fact, associated with the aromatic compounds that correspond to smaller proportions, is an indication that the colloidal and the physical protection of SOM are overlapping the magnitude of protection by recalcitrance [3].

In OFL, similar proportion was observed among the functional groups of carbon in comparison to FLF. However, in the average of the different types of soils studied, there was a

decreased of 3%, in FLF compared to OFL, for the substituted C alkyl groups and for the C alkyl. These variations indicate an increase in the degree of decomposition of OFL [4].

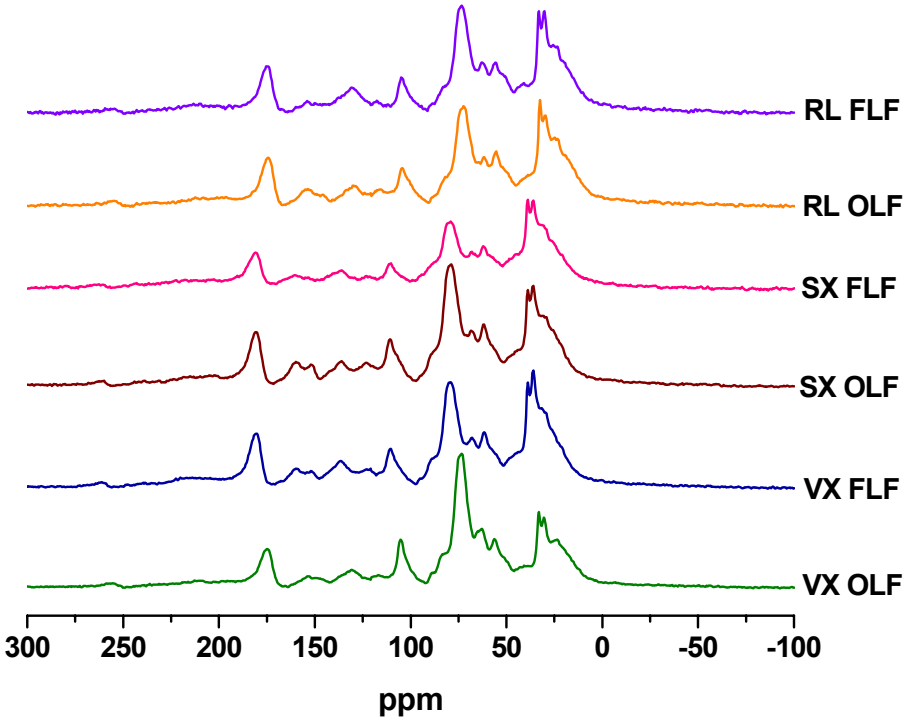

Figure 1. ^{13}C NMR spectroscopy of free light fraction (FLF) and occluded light fraction (OLF) of organic matter in a Lithic Leptosol (RL), Haplic Planosol (SX) and Haplic Vertisol (VX), under native grassland in the layer of 0.000 to 0.025 m.

Table 1. Percentage distribution of the C's functional groups determined by ^{13}C NMR spectroscopy in the free light fraction (FLF) and occluded light fraction (OLF) of organic matter in a Lithic Leptosol (RL), Haplic Planosol (SX) and Haplic Vertisol (VX), under native grassland in the layer of 0.000 to 0.025 m.

Soils *	Distribution of types of C / chemical shifts (ppm)						
	C alkyl	C N-alkyl C Methoxyl	C O-alkyl C di-O-alkyl	C-aryl	C phenolic	C carboxyl	C carbonyl
	0 – 45	45 – 60	60 - 110	110 - 140	140 - 160	160 - 185	185 - 230
				FLF			
RL	32	10	27	13	4	8	6
SX	30	10	33	8	5	8	5
VX	26	9	42	7	3	7	6
				OFL			
RL	36	10	27	8	4	8	7
SX	33	9	29	9	5	9	6
VX	27	15	32	8	4	8	6

*RL – Lithic Leptosol; SX – Haplic Planosol and VX – Haplic Vertisol.

Conclusions

The occluded light fraction has a higher proportion of more recalcitrant compounds in relation to the free light fraction, suggesting a more advanced stage of humification, regardless of the soil's type.

In the fractions analyzed there is no evidence of charred material, due to the absence of fires in this study area.

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