Comparative study of humic acids from soils and from leaves

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Introduction

Humic acids are a key component of the terrestrial ecosystem as they are responsible for many physical and chemical properties of soils; buffering capacity, metal-binding capacity, transport and fate of contaminants, stability of aggregates of soil particles and water-holding capacity all depend on the amount and nature of humic substances in a soil. [1]

The current project is looking into the properties and ability of humic acids extracted from leaves, to improve the stability and fertility of soil. The humic acid was extracted from fresh and aerobically incubated leaves by traditional alkali extraction. Three species of trees commonly grown in St George, Utah were selected: *Prunus x Cistena*, *Pyrus, Calleryana Bradford*, and *Chilopsis Linearis*.

Materials and Methods

Humic Acid Extraction

Leaves from the trees, *Prunus x Cistena* , *Pyrus Calleryana Bradford,* and *Chilopsis Linearis* were collected from same location in St George, Utah in Fall 2019. Half of the collected leaves were dried and the other half were aerobically incubated for four months. A mineral soil sample was collected from eastern South Dakota and leonardite sample was purchased from International Humic Substance Society. Humic acid was isolated using a traditional alkali extraction method (Figure 1).

The humic acids were air dried until a constant mass was obtained. The percent humic acid was calculated as

$$\frac{\textit{mass of dried humic acid}}{\textit{total mass of leaves}} \times 100.$$

Analysis

Chemical composition of humic acid samples was analyzed with *FTIR* Carry 630 Agilent.

^{13}C DPMAS NMR spectra were measured at 7 Tesla with samples spinning at 9 kHz, combined with a T_1C correction obtained from a CP/T_1 - TOSS experiment[3]. Number of scans=8000.

Results

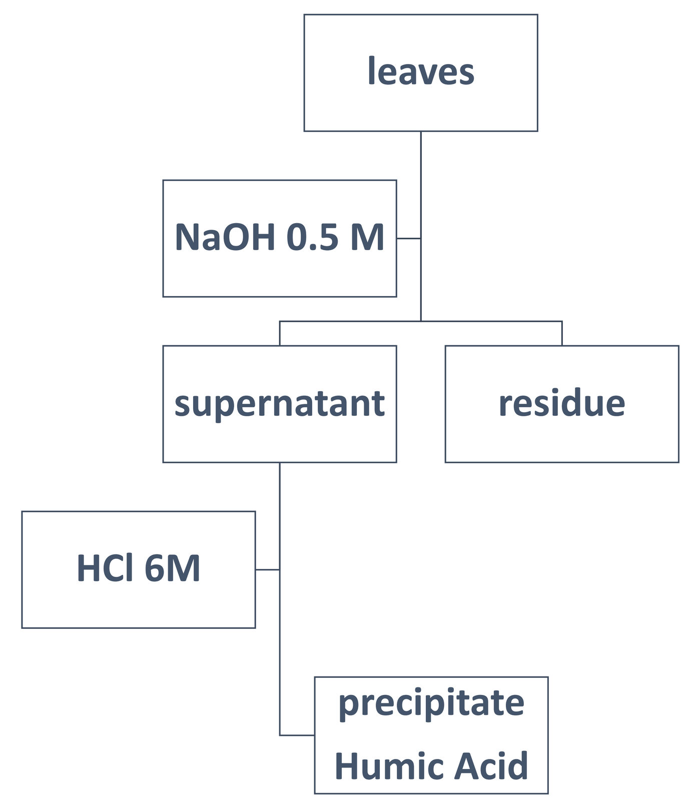

Figure 1. Humic acid extraction

Prunus x Cistena (RT)

Pyrus Calleryana Bradford (PT)

Chilopsis Linearis (FT)

% Humic Acid (w/w)					
	RT	PT	FT	Leonardite	Soil
dried	6.4	4.1	5.6	78	2.4
incubated	5.3	7.2	3.3		

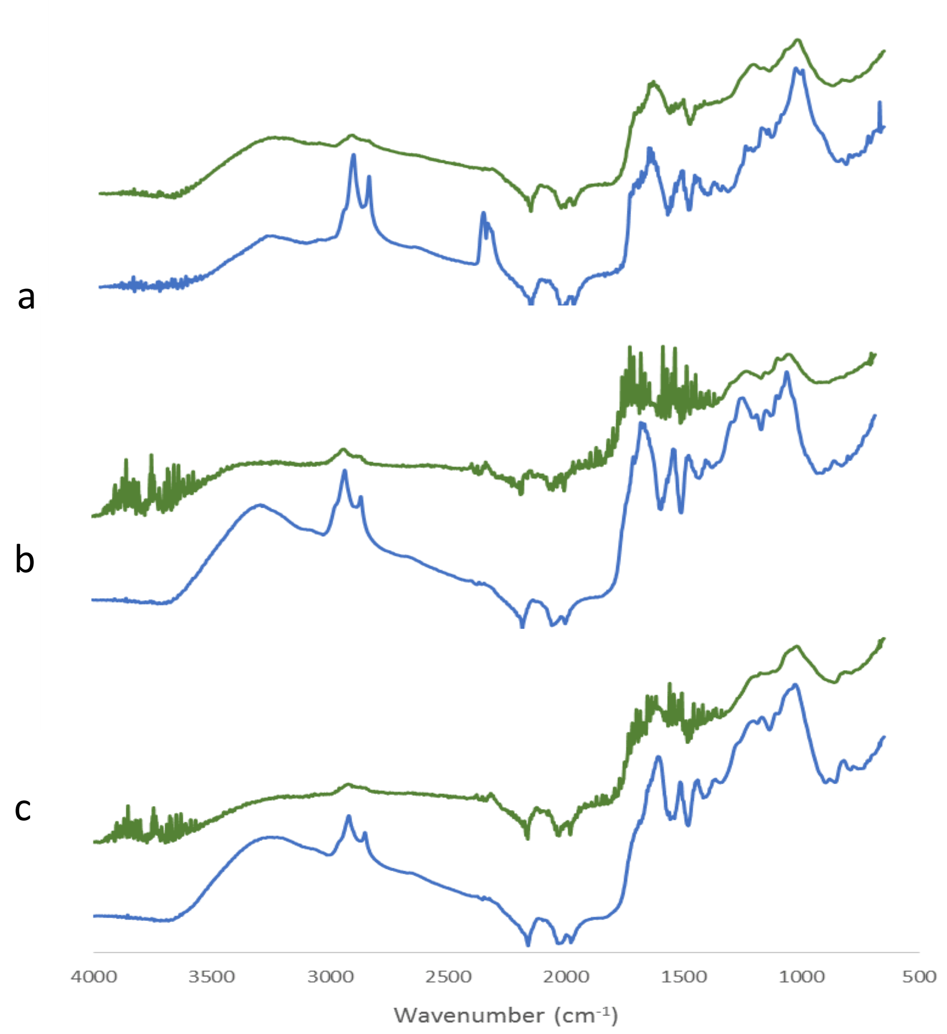

Figure 2. FTIR of humic acid extracted from dried leaves (blue) and aerobically decayed leaves (green) of *Chilopsis Linearis* (FT) (a), *Pyrus Calleryana Bradford* (PT) (b), and *Prunus x Cistena (*RT) (c).

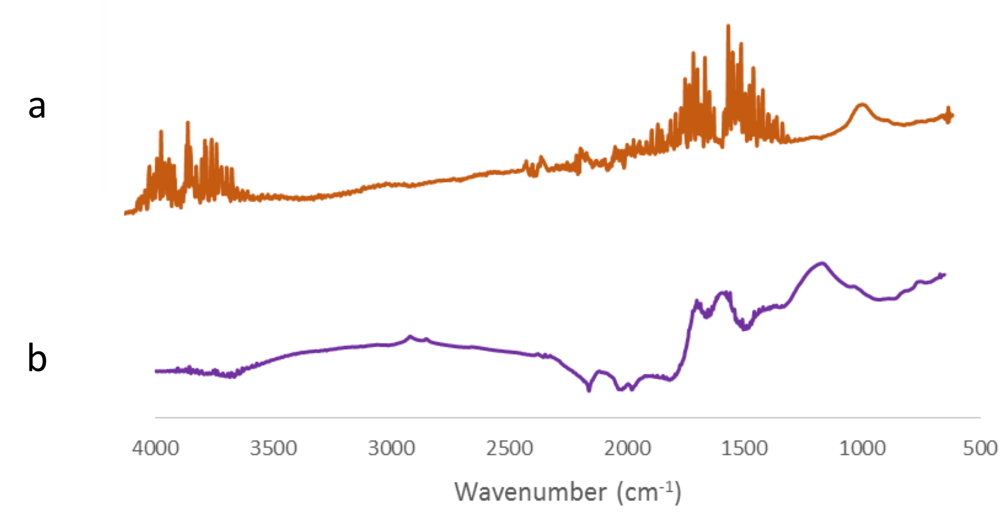

Figure 3. FTIR of mineral soil (a) and leonardite (b) samples.

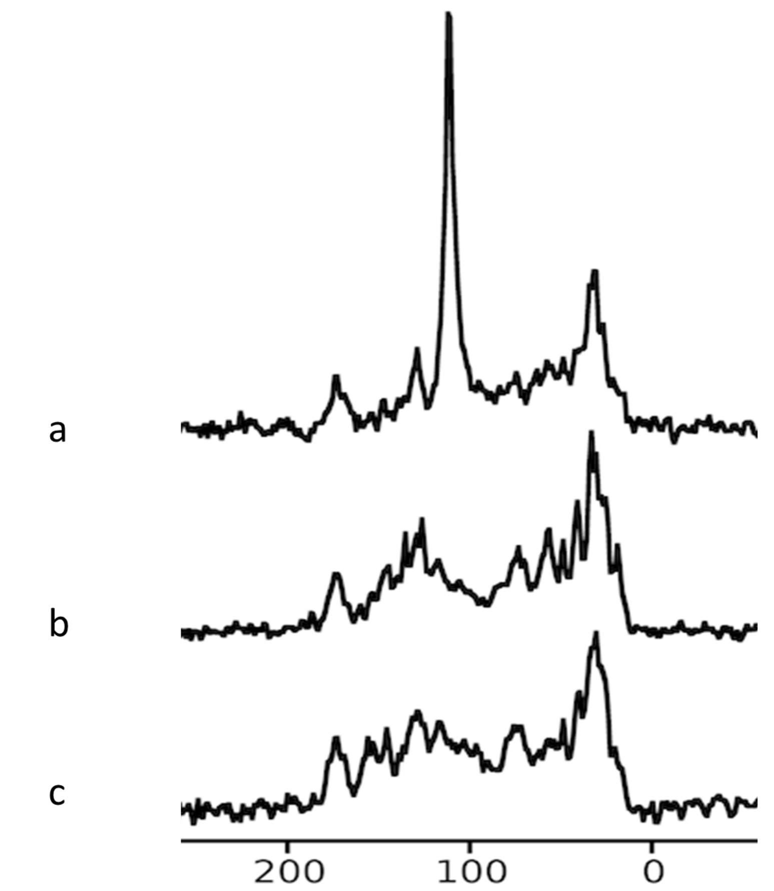

Figure 4. NMR of dried leaves of *Chilopsis Linearis* (FT) (a), *Pyrus Calleryana Bradford* (PT) (b), and *Prunus x Cistena (*RT) (c).

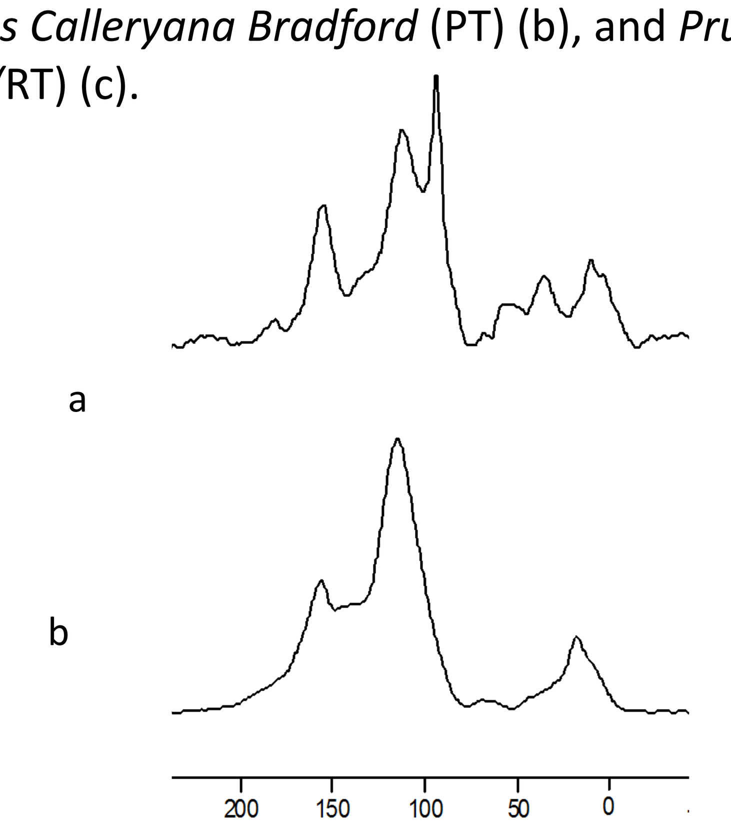

Figure 5. NMR of mineral soil (a) and Leonardite (b) samples.

Summary

Similar amounts of humic acids were extracted from the incubated leaves and the dried leaves (Table 1). The amounts were higher than the humic acid extracted from mineral soil and much less than leonardite.

The FTIR spectra (Figures 2, 3) of humic acids from leaves, leonardite and soil were similar but different in intensity.

Major absorption bands[2] are in the regions of 3400–3200 cm^{-1} (H-bonded OH groups), 2970–2800 cm^{-1} (aliphatic C–H stretching), 2600–2000 cm^{-1} (secondary amides C=N stretching), 1750–1650 cm^{-1} (C=C conjugated with C=O and COO^-), 1600-1500 cm^{-1} (aromatic C=C, COO^-), 1400-1390 (C-O stretching of phenolic OH), 1280–1230 cm^{-1} (C–O stretching and OH deformation of COOH) and 1020 cm^{-1} (C–O stretching of polysaccharide or Si–O of silicate impurities). The spectra show predominance of OH, COOH and COO^- groups which are the most characteristic features of humic acid materials.

The NMR spectra (Figures 4, 5) of humic acids from leaves show similar carbon distribution with leonardite and mineral soil, with less pronounced aromatic presence (110-165 ppm).

References

1. Harper, S.M.; Kerven G.; Edwards D.; Ostatek-Boczynski. Characteristics of fluvic and humic acids from leaves of *Eucalyptus camaldulensis* and from decomposed hay. *Soil Biology & Biochemistry.* **2000**, 32, 1331-1336.
2. Giovanela, M.; Parlanti, E.; Soriano-Sierra, E.J.; Soldi, M.S.; Sierra, M.M.D. Elemental compositions, FT-IR spectra and thermal behavior of sedimentary fulvic and humic acids from aquatic and terrestrial environments, Geochemical Journal. 2004, 38, 255-264.
3. Chilom, G., Bruns A.S., Rice J.A., 2009. Aggregation of humic acid in solution: Contribution of different fractions. Organic Geochemistry 40, 455-460.

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