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Thermogravimetry and FT-IR spectroscopy: efficient approaches for organic amendments stability analysis?

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Introduction

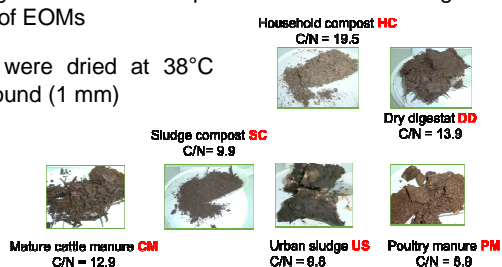
- ▶ Spreading of exogenous organic material (EOMs) is an opportunity to provide nutrients for crops, improve soil fertility and decrease chemical fertilizers
- ▶ EOMs have different physico-chemical characteristics, which depend on their origin and the processes of their treatments. These characteristics can strongly influence their behavior and nutrient release after spreading

▶ **Objective** : Develop technical solutions easy to implement and able to predict EOM behaviour in soils

Materials and Methods

- ▶ Six organic materials representative of the large classe of EOMs

- ▶ EOMs were dried at 38°C and ground (1 mm)



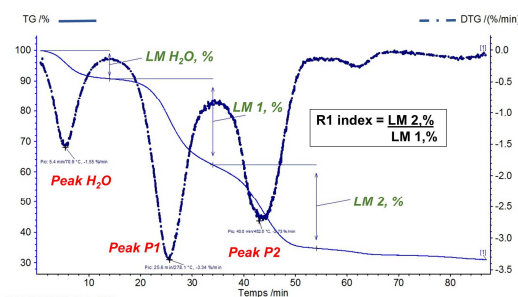
- ▶ Three analytical techniques and 4 replicates :

FT-IR spectroscopy : 4000–400 cm⁻¹, resolution set to 4 cm⁻¹ and 32 scans recorded

Van Soest biochemical fractionation ¹ & 3 days carbon mineralization in soil ² : biological stability of EOMs (I_{ROC} indicator³)

Thermogravimetric analysis (TG) : Oxidizing atmosphere (80% O₂/ 20% N₂) between 23-900°C, for calculated thermal stability index R1 (Fig 1)

Fig 1. Example of TG profile (TG: loss mass curve, % ; DTG: first derivative, LM% : Loss Mass



Results

FT-IR spectra :

- ▶ EOMs show different compositions in biochemical functions (Fig. 2), specifically in Aliphatic and Amide functions

TG analysis :

- ▶ Two exothermic peaks of combustion: Aliphatic peak (268-300°C) as cellulose and lignocellulosic and aromatic peak (441-497°C) for recalcitrant compound (results not shown)

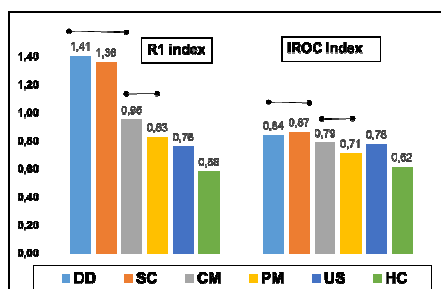


Fig 3. Stability of OEMs with R1 and I_{ROC} indexes

— : scale of stability

- ▶ Similar classification of EOMS stability between R1 and I_{ROC} indexes (Fig 3) : **Very strong** (digestat, sludge compost); **middle** (manures), **low** (sludge, household compost)

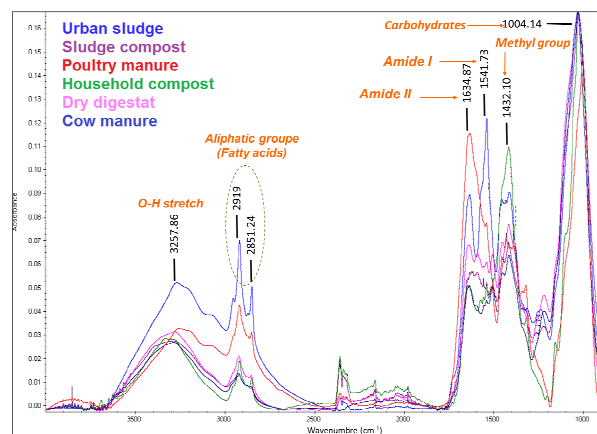


Fig 2. Infrared spectroscopic characteristics for EOMs

Conclusions & Perspectives

- ▶ TG and IR spectra show they potential to provide a classification of EOMs according to their stability
- ▶ FT-IR analysis could be further refined to develop an indicator such as R1 or I_{ROC}
- ▶ As a perspective, these approaches should be compared with sequential chemical extractions coupling with 3D fluorescence spectroscopy ⁴

¹ Lashermes et al. 2009. Europ. J. of Soil Sci., 60, 297-310 ; ² AFNOR, 2009. French standard XPU 44-162 ; ³ AFNOR, 2009. French standard XPU 44-163 ; ⁴ Jimenez, J. et al. (2014). Water Res. 50, 359–72.