Possible use of NIRS for the management of composting process

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Introduction

Composting agro-food wastes according to industrial processes can provide organic fertilisers with known (and constant) quality levels. For the industrial manufacturer, it is important to control the quality of a compost during its elaboration. A key of success is to respect the major composting stage: the thermophilic phase. The challenge is to complete this phase without wasting any supplementary week of composting.

The aim of this work was to explore the possibility of predicting by NIRS the composting degree.

When starting a new fabrication, the initial mixing of a 2000 tons pile can take several weeks (up to 12). Also, it is interesting to better know the composting age of a sub-pile.

The particular aim of this study was thus to estimate by NIRS the composting age as an important parameter of the composting degree.

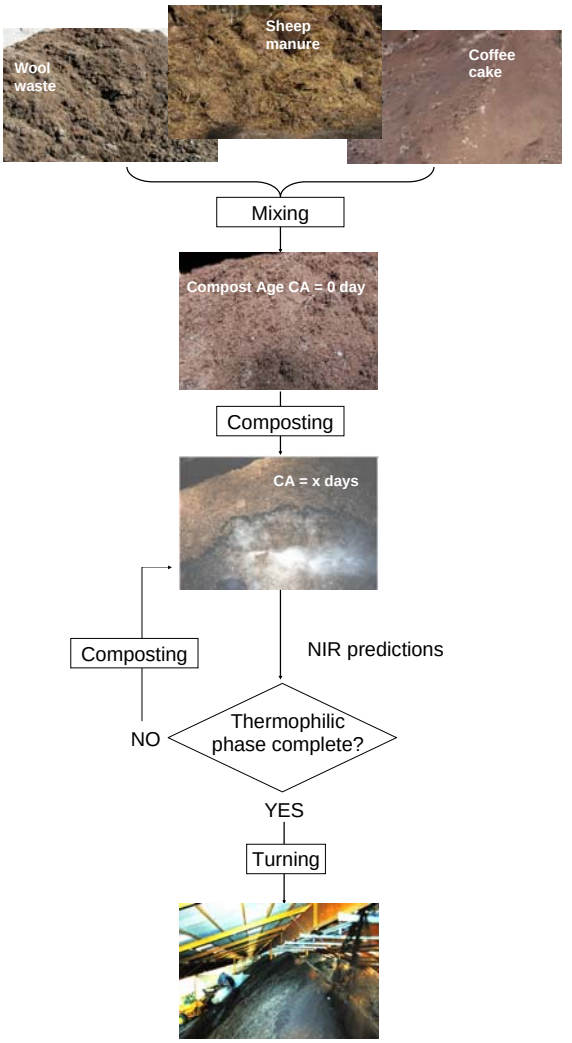

Fig 1. : Utilisation of NIR predictions during the management of the first stages of composts elaboration

Materials and methods

The parameter measured was the compost age, CA, in days. When starting a new compost pile, CA=0, and the duration of the phase is 60 days on average.

Due to the heterogeneity of fresh materials, samples were dried (40°C) ground (<1mm sieve) before being scanned on a NIRS 6500 (Foss NIRSystems) in duplicate ring cups. Spectra acquired in reflectance were corrected with SNVD 2,5,5 (WIN-ISI) mathematical pre-treatment and calibrations were performed using a multiple linear regression (MLR, WIN-ISI).

Results and discussion

The compost age (CA) varied widely (SD, Table 1), as the compost intermediates were included (CA from 0 to 103 d) coming from 6 series.

A series corresponds to a unique pile sampled regularly along the thermophilic phase. The model developed for CA was reasonably accurate, as the determination coefficient was close to 0.9; however, the RPD was under 3. The SECV was close to the corresponding SEC, indicating an acceptable robustness of the model.

Table 1: Performance of the general calibration model

		population		calibration statistics			
parameter (in day)	**n**	**mean**	**SD**	**SEC**	**R²**	**SECV**	**RPD**
Compost age	83	32.4	23.5	9.35	0.84	9.8	2.4

SD, Standard Deviation of parameter in the population
SEC, Standard Error of Calibration
SECV, Standard Error of Cross-Validation
RPD = SD / SECV

Another calibration strategy was tempted. A particular MLR model was elaborated (Table 2) with a single series of 22 samples coming from an unique pile along the thermophilic phase.

Table 2: Performance of the particular calibration model

		population		calibration statistics			
parameter (in day)	**n**	**mean**	**SD**	**SEC**	**R²**	**SECV**	**RPD**
Compost age	22	50.4	32.6	6.04	0.97	6.96	4.7

SD, Standard Deviation of parameter in the population
SEC, Standard Error of Calibration
SECV, Standard Error of Cross-Validation
RPD = SD / SECV

As ever seen for the general model, the population considered for the particular model had a high SD. The equation developed with 22 samples had a SEC reduced by about one third compared that of the general model. The R² overpassed 0.95, and the SECV was under seven days. Then the corresponding RPD was nettly above 3.

Conclusions and perspectives

These preliminary results show that it seems possible to assess the degree of composting, even if more efforts should be devoted to decrease the SECV to a more acceptable level (useful 4 d., ideal = 1 d.).