Prediction by NIRS of the biochemical composition of various raw materials used in the organic fertiliser industry

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Introduction

The nature and characteristics of composts and organic fertilisers can vary in a large range as they may originate from very different sources of raw materials, and their elaboration may also vary according to producers.
In order to evaluate the potential quality of organic fertlisers (carbon and nitrogen transformations when added to soils), it is useful to investigate the relationships between their characteristics and their transformations. The fibre content estimated by Van Soest fractions, proved to be a good indicator of the potential capacity of C and N transformations. Nevertheless, a complete fibre analysis (5 fractions) is expensive and time-consuming.
This is why a programme was set up to evaluate the potential of NIRS to assess the quality of raw materials used in compost and organic fertilisers elaboration.

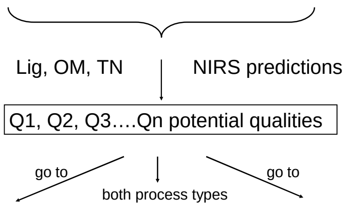


Fig 1. : Utilisation of NIR predictions in the decision scheme for the elaboration of composts and organic fertilisers

Materials

The raw materials originated from

(i) industrially pre-processed plant residues, principally collected in the largest organic fertiliser factory in France or from other sources : wet and dry grape skins, de-oiled grape pips, coffee cake, de-fatted cocoa bean, cocoa skin, olive pulp, maize cob, barley straw, rice hulls, rapeseed cake, soybean cake;

(ii) tropical plant residues samples collected on-field in Brazil and Kenya, as parts of trees, shrubs, crops, cover crops, potentially utilisable in composting. The 706 samples were chosen in order to encompass a wide variability.

Methods

The parameters measured were Lignin (LIG), Organic Matter by loss on ignition (OM) and Total Nitrogen Kjeldahl (TN).

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 in ring cups. Spectra acquired in reflectance were corrected with SNVD 2,5,5 (WIN-ISI) mathematical treatment. Calibrations were performed using a modified partial least square regression (mPLS, WIN-ISI).

Results and discussion

All the parameters varied widely (SD, Table 1), because of the diversity of the raw materials. The models developed for the three parameters were reasonably accurate, as their determination coefficients were above 0.9, the SECV were close to their corresponding SEC, and the RPD (SD/SECV) were all equal or above 3.

Table 1: Performance of calibration models

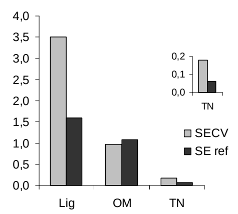
		population		calibration statistics			
constituent (in % DM)	**n**	**mean**	**SD**	**SEC**	**R²**	**SECV**	**RPD**
Lignin	124	28.1	16.0	3.03	0.96	3.51	4.6
Organic matter (l.o.i.)	317	93.2	3.0	0.78	0.93	0.97	3.1
Total Nitrogen (Kjeldahl)	271	2.3	0.5	0.16	0.92	0.18	3.0

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

Figure 2: SE ref, standard errors of reference data, and SECV, standard errors of cross validation.

The precision of the models was satisfactory as the SECV values were from 1 (OM) to 3 fold (TN) the SE values of the reference methods (Fig. 2).

For example, the SECV associated with LIG was just twice its SEref. Considering the cost and time required to obtain this fraction, the precision of the NIR prediction is sufficient for our purpose.



The SECV were lower than the normative tolerances (max 3.0 g $100g^{-1}$ b.w. for OM, and min-max 0.2 – 0.3 g $100g^{-1}$ b.w. for TN) for composts (French Norm NFU#44051).

Figure 3: Prediction of lignin (Lig), organic matter (OM) and total nitrogen (TN)

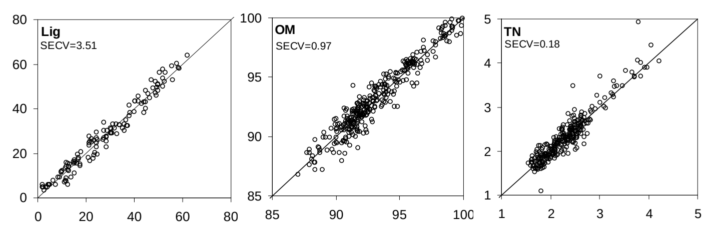


Figure 3 shows the result of LIG, OM and TN predictions. The agreement is particularly good for LIG, as ever seen. Dispersion is more noticeable for OM and TN, with some outlier values. For TN, the outliers values can both be due to the reference measurement or to the calibration, by lack of a sufficient number of samples with TN values above 3.

Conclusions and perspectives

The precision of the models obtained is sufficient for a global characterisation of samples. It is concluded that the major parameters used in quality characterisation of compost and organic fertilisers can be valuably estimated by NIRS, and that this tool can be applied to quality control in routine.