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Determination of compost maturity using near infrared spectroscopy (NIRS)

Ivoneta Diethart, Eva Erhart, Marion Bonell, Katrin Fuchs, Dieter Haas, and Wilfried Hartl
Bio Forschung Austria, Vienna, Austria (i.diethart@bioforschung.at)

The objective was to examine whether near infrared spectroscopy (NIRS) can be used as an alternative, quick method to determine compost maturity. A crucial prerequisite was to use a suitable reference parameter that describes the maturity of compost well and is also predictable with NIRS. A sum parameter for maturity was developed, which was calculated from contents of dissolved organic carbon (DOC), nitrate nitrogen (NO_3-N), ammonium nitrogen (NH_4-N), oxygen consumption (with Oxitop® method) and from Solvita™-maturity index (with Solvita™ test), with the individual parameters weighted differently in the calculation.

For the calibration 476 compost samples were collected from 28 composting plants in Austria and Czech Republic. The dried and ground samples were physico-chemically analyzed using conventional methods and scanned with an AOTF-NIR spectrometer (wavelength range 1200-2150 nm). Most of the samples (360) originated from the composting plant of the City of Vienna (C1), the other samples (116) originated from smaller composting plants (C2) which employ different compost process technologies and methods. Besides, the samples differed in their input material composition due to seasonal effects (proportion of greenwaste, biowaste, wood, leaves, etc.) and in composting time.

Multivariate analyses were performed to model the data using the statistical programme Unscrambler©. A principal component analysis (PCA) performed on the spectral data showed that samples differ tendentially according to their origin. Calibration models were developed for a) all samples (one overall model) and b) two groups of samples divided according to the PCA results. The first submodel S1 mainly consisted of samples from composting plant C1 and the second submodel S2 of samples from composting plants C2 and of several samples from C1. The performance of the overall model showed good results with correlation coefficients of r(cal)= 0.89 and r(val)= 0.82 and an average error of prediction of 1.24 (with the values of the sum parameter for compost maturity ranging from 0.5 to 12). The results of submodel S1 performed better with r(cal)= 0.91, r(val)= 0.89 and an average error of prediction of 0.95. The submodel S2 showed correlations of r(cal)= 0.89, r(val)= 0.82 and an average error of prediction of 1.36. The validation of the models showed that the use of submodels resulted in better predictions, especially for the C1 samples. For C2 samples the appropriate model needed to be selected as for some samples the overall model performed better. In general, prediction results of C1 samples were better than those of C2 samples due to a lower influence of factors such as different process technologies.

It is expected that prediction will still improve with further calibration and integration of samples of similar origin into the respective models.

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