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Predicting the biochemical methane potential of wide range of organic substrates by near infrared spectroscopy

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HIGHLIGHTS

- The use of near infrared spectroscopy (NIRS) to predict the biochemical methane potential (BMP) was investigated.
- The NIRS appears as a suitable method for the fast prediction of BMP.
- The integration of the entire diversity of waste remains nevertheless difficult.
- The NIR model for non-stabilised substrates could be practically used.

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ABSTRACT

The use of near infrared spectroscopy (NIRS) as an alternative method to predict the biochemical methane potential (BMP) of a broad range of organic substrates was investigated. A total of 296 samples including most of the substrates treated by anaerobic co-digestion were used for NIRS calibration and validation. The NIRS predictions of the BMP values were satisfactory (Root Mean Square Error = 40 ml CH_4 g^{-1} VS_{fed}; $r^2 = 0.85$). The integration of the entire substrate diversity in the model remained nevertheless difficult due to the specific organic matter properties of stabilised substrates and the high level of uncertainty of the BMP values. The elaboration of a model restricted to "fresh" substrates allows the practical use of the NIR technique to design and operate anaerobic co-digestion plants. The addition of more samples in the dataset in order to perform local calibrations would probably make the elaboration of a global NIR-model possible.

1. Introduction

The Biochemical methane potential (BMP) evaluates the ultimate amount of methane produced by any given waste or biomass under anaerobic conditions. The information provided by the BMP value is important when evaluating potential substrates and for optimising the design and functioning of an anaerobic digester (Raposo et al., 2011a).

Anaerobic co-digestion of organic solid substrates, defined as the anaerobic treatment of a mixture of at least two types of substrates, is increasingly popular in Europe (Alvarez et al., 2010). It indeed offers several advantages in terms of biogas yield as well as the diversity of substrates treated. The feasibility of adding new co-substrates in an already established process have been tested for many kind of substrates such as meat waste (Buendia et al., 2009), fat, oil and grease waste (Long et al., 2011), municipal solid waste (Hartman and Ahring, 2005), fruits and vegetables (Callaghan et al., 2002), household waste, sludge and manure (Angelidaki and Ahring, 1997), etc.

Because of the wide range of BMP values of the different substrates considered in anaerobic co-digestion projects, the knowledge of the BMP value of a new substrate is crucial before its addition in an existing process or for the design of the industrial plant for its treatment.

However, the BMP test is time consuming (30–50 days) and expensive, making the current protocol non-adapted for industrial plant management and optimisation. New technologies providing fast determination of BMP become thus necessary. Several biochemical models have already been developed to predict faster the BMP value (reviewed in Lesteur et al., 2010). Although a relatively good estimation of the BMP value is obtained in a shorter time with these models, time consuming laboratory experiments remain necessary.

Alternative methods have been studied. It has been demonstrated that near infrared spectroscopy (NIRS) is a suitable method for fast prediction of a wide range of organic parameters for plant

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