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ENSILING AGROINDUSTRIAL WASTE PRIOR TO ANAEROBIC DIGESTION: A SOLUTION FOR LONG TERM STORAGE

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EXECUTIVE SUMMARY

In the current context of waste recovering, production of renewable energy and reduction of greenhouse gases emission, anaerobic digestion (AD) is a technology receiving increasing interest. AD is a biological process, which allows the degradation of organic waste, related to human activity, producing a biogas storable and recoverable in the form of energy. Substrates are often selected according to their biodegradability and availability. Therefore, crop residues, such as wheat straws, are interesting because of their high abundance and low cost. However the low biodegradability of such lignocellulosic materials must to be considered. Similarly, agroindustrial organic waste are interesting due to their fast degradation, but the preservation of this seasonal waste might become problematic when considering the feeding of continuous AD reactors throughout the year. Silage represents an interesting storage technology but, difficult to be applied on agroindustrial organic waste because of their high water content. The use of a co-substrate having high solid contents, such as wheat straw, could be an innovative solution by reducing the water content of the waste mixture. Indeed, silage or anaerobic fermentation might be a way to maintain the methane potential of agroindustrial organic waste while pre-treating lignocellulosic materials due to the acidification of the silage process. The aim of this study is to evaluate the potential of ensiling a mixture of fresh seasonal agroindustrial waste with wheat straw for long term storage prior to AD process. Furthermore, the effect of the initial substrate mixtures on the metabolic pathways followed was investigated. Anaerobic fermentation was performed at laboratory-scale in batch tests. A mixture of beet leaves and wheat straw was carried out to obtain a Total Solid (TS) of 35%. This mixture was introduced in 50 plastic vacuum-packed bags and stored in a dark room at ambient temperature. Three bags were analysed periodically in triplicates at 10 different storage times from 0 to 180 days. Different analyses were performed: biogas production and composition, concentrations of nitrogen, carbon, soluble sugars and metabolites, as well as a monitoring of the microbial communities by 16S rRNA sequencing (MiSeq). Finally, the methane potential was assessed in order to evaluate the effectiveness of the storage. As results, beet leaves contained initially soluble sugars (25.5g Glucose/gTS ; 45g Xylose/gTS) and microbial metabolites (30.9g Lactate/gTS ; 27 g Acetate/gTS). The presence of lactic acid indicates that the fermentation process partially occurred before the start of the experiment. During the storage step, sugars were consumed and a succession of metabolic pathways was clearly observed. Interestingly, a lactic fermentation pathway was followed by butyric fermentation, homoacetogenesis and then methanogenesis. Microbial community characterization by New Generation Sequencing is under progress. These results will provide better understanding of the fermentation process with the succession of metabolic pathways. These different pathways did not affect the methane potential during the storage. Even though no improvement of the biodegradability of wheat straw was observed, mixing wheat straw with beet leaves was successful to store fresh waste. To determine the effect of more specifics substrate characteristics (e.g. sugar content) on the metabolic pathways followed, experiments are currently in progress. Moreover, inoculation with lactic acid bacteria is also investigated to redirect the process towards lactic acid fermentation. To conclude, this study has shown that anaerobic storage is a relevant solution to long term storage of fresh biodegradable biomass prior to anaerobic digestion.