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Anaerobic Digestion of Green Wastes at Different Solids Concentrations and Temperatures to Enhance Methane Generation

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Abstract : Two major categories of green waste are fruit and vegetable (FV) waste and garden and yard (GY) waste. Although, anaerobic digestions (AD) is able to manage FV waste; there is less confidence in the conditions for AD to handle GY wastes (grass, leaves, trees and bush trimmings); mainly because GY contains lignin and other recalcitrant organics. GY in the dry state (TS ≥ 15 %) can be digested at mesophilic temperatures; however, little methane data has been reported under thermophilic conditions, where conceivably better methane yields could be achieved. In addition, it is suspected that at lower solids concentrations, the methane yield could be increased. As such, the aim of this research is to find the temperature and solids concentration conditions that produce the most methane; under two different temperature regimes (mesophilic, thermophilic) and three solids states (i.e. 'dry', 'semi-dry' and 'wet'). Twenty liters of GY waste was collected from a public park located in the northern district in Tehran. The clippings consisted of freshly cut grass as well as dry branches and leaves. The GY waste was chopped before being fed into a mechanical blender that reduced it to a paste-like consistency. An initial TS concentration of approximately 38 % was achieved. Four hundred mL of anaerobic inoculum (average total solids (TS) concentration of 2.03 ± 0.131 % of which 73.4% were volatile solid (VS), soluble chemical oxygen demand (sCOD) of 4.59 ± 0.3 g/L) was mixed with the GY waste substrate paste (along with distilled water) to achieve a TS content of approximately 20 %. For comparative purposes, approximately 20 liters of FV waste was ground in the same manner as the GY waste. Since FV waste has a much higher natural water content than GY, it was dewatered to obtain a starting TS concentration in the dry solid-state range (TS ≥ 15 %). Three samples were dewatered to an average starting TS concentration of 32.71 %. The inoculum was added (along with distilled water) to dilute the initial FV TS concentrations down to semi-dry conditions (10-15 %) and wet conditions (below 10 %). Twelve 1-L batch bioreactors were loaded simultaneously with either GY or FV waste at TS solid concentrations ranging from 3.85 ± 1.22 % to 20.11 ± 1.23 %. The reactors were sealed and were operated for 30 days while being immersed in water baths to maintain a constant temperature of 37 ± 0.5 °C (mesophilic) or 55 ± 0.5 °C (thermophilic). A maximum methane yield of 115.42 (L methane/ kg VS added) was obtained for the GY thermophilic-wet AD combination. Methane yield was enhanced by 240 % compared to the GY waste mesophilic-dry condition. The results confirm that high temperature regimes and small solids concentrations are conditions that enhance methane yield from GY waste. A similar trend was observed for the anaerobic digestion of FV waste. Furthermore, a maximum value of VS (53 %) and sCOD (84 %) reduction was achieved during the AD of GY waste under the thermophilic-wet condition.

Keywords : anaerobic digestion, thermophilic, mesophilic, total solids concentration
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