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Co-Smoldered Digestate Ash as Additive for Anaerobic Digestion of Berry Fruit Waste: Stability and Enhanced Production Rate

Authors : Arinze Ezieke, Antonio Serrano, William Clarke, Denys Villa-Gomez

Abstract : Berry cultivation results in discharge of high organic strength putrescible solid waste which potentially contributes to environmental degradation, making it imperative to assess options for its complete management. Anaerobic digestion (AD) could be an ideal option when the target is energy generation; however, due to berry fruit characteristics high carbohydrate composition, the technology could be limited by its high alkalinity requirement which suggests dosing of additives such as buffers and trace elements supplement. Overcoming this limitation in an economically viable way could entail replacement of synthetic additives with recycled by-product waste. Consequently, ash from co-smouldering of high COD characteristic AD digestate and coco-coir could be a promising material to be used to enhance the AD of berry fruit waste, given its characteristic high pH, alkalinity and metal concentrations which is typical of synthetic additives. Therefore, the aim of the research was to evaluate the stability and process performance from the AD of BFW when ash from co-smoldered digestate and coir are supplemented as alkalinity and trace elements (TEs) source. Series of batch experiments were performed to ascertain the necessity for alkalinity addition and to see whether the alkalinity and metals in the co-smouldered digestate ash can provide the necessary buffer and TEs for AD of berry fruit waste. Triplicate assays were performed in batch systems following I/S of 2 (in VS), using serum bottles (160 mL) sealed and placed in a heated room (35±0.5 °C), after creating anaerobic conditions. Control experiment contained inoculum and substrates only, and inoculum, substrate and NaHCO3 for optimal total alkalinity concentration and TEs assays, respectively. Total alkalinity concentration refers to alkalinity of inoculum and the additives. The alkalinity and TE potential of the ash were evaluated by supplementing ash (22.574 g/kg) of equivalent total alkalinity concentration to that of the pre-determined optimal from NaHCO3, and by dosing ash (0.012 – 7.574 g/kg) of varying concentrations of specific essential TEs (Co, Fe, Ni, Se), respectively. The result showed a stable process at all examined conditions. Supplementation of 745 mg/L CaCO3 NaHCO3 resulted to an optimum TAC of 2000 mg/L CaCO3. Equivalent ash supplementation of 22.574 g/kg allowed the achievement of this pre-determined optimum total alkalinity concentration, resulting to a stable process with a 92% increase in the methane production rate (323 versus 168 mL CH4/ (gVS.d)), but a 36% reduction in the cumulative methane production (103 versus 161 mL CH4/gVS). Addition of ashes at incremental dosage as TEs source resulted to a reduction in the Cumulative methane production, with the highest dosage of 7.574 g/kg having the highest effect of -23.5%; however, the seemingly immediate bioavailability of TE at this high dosage allowed for a +15% increase in the methane production rate. With an increased methane production rate, the results demonstrated that the ash at high dosages could be an effective supplementary material for either a buffered or none buffered berry fruit waste AD system.

Keywords : anaerobic digestion, alkalinity, co-smoldered digestate ash, trace elements
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