

Enhancement of Anaerobic Digestion of Water Hyacinth Through Co-digestion and Potassium Hydroxide Pretreatment

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Abstract : Water hyacinth is a fast-growing plant that is considered invasive in many tropical areas due to its potential to clog waterways. The lignocellulosic structure of water hyacinth is the primary barrier to harvesting and efficiently producing bioenergy from degrading water hyacinth via anaerobic digestion. This study investigated anaerobic mono-digestion and co-digestion of water hyacinth and dairy manure using potassium hydroxide (KOH) pretreatment to break down the lignin prior to digestion. Water hyacinth was pretreated with KOH at 5%, 7.5%, and 10% based on volatile solids (VS) at 37°C for 24 h. The pre-treated samples were used directly for anaerobic digestion without washing or pH adjustment, with triplicate treatments tested after pre-treatment to assess the effects on the structural composition of the water hyacinth. Co-digestion experiments included 3:1, 1:1, and 1:3 ratios of water hyacinth to dairy manure based on VS. The inoculum-to-substrate ratio was set at 2:1 for all experiments. A total of seventeen experimental points were run in triplicate in 250 mL reactors. Results showed that with mono-digestion, the methane (CH₄) yields (296 mL CH₄/g VS) were achieved with 7.5% KOH pretreatment. Co-digestion at 1:3 increased energy production (390 mL CH₄/g VS), but co-digestion (1:1) with 5% KOH had the highest CH₄ yield (467 mL CH₄/g VS). KOH pretreatment reduced lignin content by 14.3 to 29.82% and increased cellulose content in the solid fraction by 72.0 to 104.6%, with the lowest increases at 5% and highest increases at 10% KOH. Pretreated at 7.5% exhibited a CH₄ yield increase of 18% and 36%, while those pretreated at 10% showed increases of 1% and 40% as the co-substrate ratio shifted from 3:1 to 1:3. These findings highlight the critical role of nutritional balance and alkalinity of dairy manure, which increased methanogenic activity. Even at 5% KOH pretreatment a 1:1 co-digestion ratio showed lignin degradation with co-digestion amplifying the effect of pretreatment. These results demonstrate a significant improvement in the digestion of water hyacinth through KOH pretreatment, with no washing or pH adjustment needed during digestion to achieve high yields. Use of these results could reduce pretreatment costs, avoid the loss of VS During pretreatment, we eliminate wastewater generation from pretreatment processing. Co-digestion of water hyacinth and dairy manure could be a viable industrial-scale application to create non-intermittent bioenergy in the form of biogas for electricity generation in rural areas while creating a value-added product from the invasive water hyacinth.

Keywords : alkaline, biogas, lignocellulosic, methane

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