INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Anaerobic Digestion of Terrestrial Weeds: Effect of Pre-Treatment and Co-Digestion on Biogas Production

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Parthenium hysterophorus, *Lantana camara* and *Ageratum conyzoides* are considered to be among the world's top ten worst terrestrial weeds due to their reproduction potential. They can grow within a few weeks and cover entire agricultural land (*Parthenium hysterophorus*), forest land (*Lantana camara*), and native vegetation (*Ageratum conyzoides*). *Parthenium hysterophorus*, *Lantana camara*, and *Ageratum conyzoides* are difficult to manage as they can re-grow miraculously even after they are completely eradicated. The availability of *Parthenium hysterophorus*, *Lantana camara*, and *Ageratum conyzoides* in abundance makes attractive feedstock through anaerobic digestion. India is a fast-growing country with a population of 1.21

billion people in 2011 with a growth rate of 17.64% from 2001 to 2011 (15th Indian Census 2011) next census will be taken in 2021. The energy demand of the country is increasing rapidly due to the increase in population and industrialization. Non-renewable conventional energy sources like coal, oil, and natural gas, etc., play a crucial role in maintaining the major energy demands of the country. India depends totally on oil imports to meet energy demand. It is reported that about 200 million rupees were spent on imports to meet the two-third of energy demand in 2000. India consumes 40.34 million tons of diesel, i.e., 43.2% of total consumption in 2000-2001 and it is noted that the annual energy demand of India will increases from 0.58 to 4.02% between 2017 to 2026. According to the literature, the energy source is on the verge of extinction. The world's oil reserves are estimated to get depleted by 2050. It is expected that total oil reserves in India will only last up to 6 years. Biogas production from *Parthenium hysterophorus*, *Lantana camara,* and *Ageratum conyzoides* can effectively manage terrestrial weeds as well as mitigate environmental pollution caused by fossil fuels.

In phase I, the BMP study of *Parthenium hysterophorus*, F/M ratio 2 shows the ideal combination followed by 2.5 and 1.5 respectively. In the BMP study of *Lantana camara*, the highest methane production was obtained from the F/M ratio of 1.5 followed by ratios 2 and 2.5 respectively. *Ageratum conyzoides*, BMP assay revealed that, F/M ratio 2 acquired maximum biogas production from the anaerobic digestion of *A. conyzoides* biomass with cow dung as the microorganism source.

During phase II, the various thermal pretreatment modes (hot air oven, microwave, autoclave, and hot water bath) were applied where temperature 60 to 220˚C and time (20 to 120 mins) study were conducted. In *Parthenium hysterophorus*, hot air oven showed the highest efficiency in the form of soluble chemical oxygen demand (sCOD) and volatile fatty acid (VFA), for *Lantana camara*, and *Ageratum conyzoides* autoclave pretreatment was found to be more efficient, followed by hot water bath, hot air oven and microwave pretreatments. During electrohydrolysis pretreatment, voltage (10 to 60 Voltage) and time (10 to 60 mins) were conducted. In Electrohydrolysis Pretreatment, *Parthenium hysterophorus* at 20V for 40 mins shows the highest sCOD and VFA, and for *Lantana camara* and *Ageratum conyzoides* at 30V for 20 mins shows the highest sCOD and VFA. During phase II, the various thermal pretreatment modes (hot air

oven, microwave, autoclave and hot water bath) were applied where temperature 60 to 220 ˚C and time (20 to 120 mins) study were observed.

Phase III, the co-digestion of *Parthenium hysterophorus* was performed not only with cow dung as inoculum but also with other organic wastes (i.e., food waste). In co-digestion during the BMP assay, a mixing ratio of 1.5 (165 mL CH_4 g^{-1} VS on the 17th day) was observed. In co-digestion (food waste) of BMP assay, mixing ratio 1.5 (211 mL CH_4 g^{-1} VS on 14th day) for *Lantana camara*. In co-digestion of the BMP mixing ratio of 2 (205 mL CH_4 g^{-1} VS on 13th day) for Ageratum conyzoides are observed to be ideal.

In phase IV, the continuous scale, anaerobic digester was operated for the time span of 50 days for the best F/M ratio and pretreatment technique obtained from BMP assay. Average biogas production for untreated *P. hysterophorus* was 3270 mL, *L. camara* was 3010 mL, and for *A. conyzoides was* 3150 mL, for pretreated *P. hysterophorus* is 6454 mL; *L. camara is* 6219 mL, and *A. conyzoides* is 6982 mL, and for co digestion of *P. hysterophorus* is 5984 mL; *L. camara* is 5218 mL and for *A. conyzoides* is 5765 mL.

In Phase V, Various bacteria were identified in microbial study. Euryarchaeota, Bacteroidetes and Proteobacteria were majorly observe in this study.

Keywords: *Parthenium hysterophorus; Lantana camara; Ageratum conyzoides;* Anaerobic digestion; Biochemical methane potential (BMP); F/M ratio; Pretreatment; Co-digestion; Continuous reactor; Microbial study.