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Studies on Biogas Production from Salvinia molesta : An Aquatic Weed

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ABSTRACT
Biogas are produced from different feedstocks. *Salvinia,* a member of pteridophyta, is commonly known as water fan. It grows luxuriantly in stagnant water. Salvinia molesta is the world's worst weed known so far. Two tons of air dried *Salvinia*, therefore, can meet the fuel requirement of a small family of 3-5 months. Special advantage of using *Salvinia* is that unpleasant odors do not come out. This will certainly provide cheap and clean burning fuel and reduce the increasing pressure on forests.

Keywords: Biogas, . *Salvinia molesta,* feedstocks, cow dung, biogas tanks, gas stove,

1. INTRODUCTION

In 1976, for the first time, the Italian physicist, Volta, demonstrated methane in the marsh gas, generated from organic matter in bottom sediments of ponds and streams. Under anaerobic conditions, the organic materials are converted through microbial (microbiological) reactions into gases (fuel) and organic fertilizer (sludge). Biologically produced fuels are called biofuels. Biogas is a type of biofuel. Often biologically generated hydrogen, methane, ethanol, butanol and diesel are referred to as biohydrogen, biomethone, bioethanol,biobutanol and biodiesel respectively. Biogas is produced by anaerobic digestion of fermentation of biodegradient materials such as biomass, manure, sewage, municipal waste, green waste, plant material and energy crops. The mixture of gas is composed of 63% methane, 30% CO_2, 4% nitrogen and 1% hydrogen sulphide and traces of hydrogen, oxygen and carbon monoxide. Methane is the main constituent of biogas. The gases methane, hydrogen and carbon monoxide can be combusted or oxidized with oxygen. Air contains 21% oxygen. This energy release allows biogas to be used as a fuel. Biogas can be used as a low cost fuel in any country for any heating purpose, such as cooking.

Biogas are produced from different feedstocks. For example salvina, water Hyacinth, *Pistia*, *Glyricida* etc. Many factors include slurry, seeding, pH, temperature, nitrogen concentration, carbon ratio, creation of anaerobic condition, addition of algae etc.

Salvinia, a member of pteridophyta, is commonly known as water fan. It grows luxuriantly in stagnant water. Salvinia molesta is the world's worst weed known so far. It is originating from South America. Its common name is Giant *Salvinia* in English. The plant is an aquatic ornamental plant, as well as an aquarium plant.

Daily requirement of gas is 0.4 liter per captia. Two tons of air dried *Salvinia*, therefore, can meet the fuel requirement of a small family of 3-5 months. Special advantage of using *Salvinia* is that unpleasant odors do not come out. This will certainly provide cheap and clean burning fuel and reduce the increasing pressure on forests.

2. MATERIAL AND METHODS

Salvinia molesta, *Pistia*, *Eichhornia*, cow dung, bio gas tank made of synthetic fibre, water, gas stove for biogas, pH meter.

2.1 Methods

Biogas production from *Salvinia molesta* under different conditions could be understood by different experiments. The experiments are initiated with cow dung and double quantity of water. For this experiment 5 biogas tanks could be used.

Diameter of the tank	-	60 cm
Diameter of the dome	-	56 cm
Diameter of the tube	-	7 cm
Diameter of the tube mouth	-	13 cm

Salvinia collected from the fresh water bodies in the vicinity of S.N. college Cherthala, other Plant materials, cow dung, pH metre, fibre made biogas tanks (dome model), water, gas stove were the materials involved in the present investigation. Cow dung was used to initiate the process of methanogenesis.

We have evaluated different parameters like:

1. Substrate loading rate,
2. Retention time,
3. Type and nature of substrate,
4. Atmospheric temperature and rainfall,
5. Stirring frequency of loaded matter,
6. pH and EC of slurry,
7. Surface area of fed substrate,
8. Presence of root biomass,
9. Evacuation of slurry,
10. Proportion of water with each substrate.

All the experiments had minimum 3 replicates at a time and were repeated at least 3 times.

2.2 Analysis

For the biochemical analysis of nature and content of the biogas produced the samples of different experiments were sent to the poluchem lab, Ernakulam. The analysis were done for quantity of Methane and CO_2 in percentage and CO in ppm.

2.3 Dry matter content of plant material

The substrate was dried in an oven at 100^0C for 24 hours. These dried materials were ashed in muffle Furnace at 500^0C. Volatile matter was arrived at by subtracting the ash content from the dry matter. pH and Electrical conductivity were checked in the slurry using portable pH meters.

3. RESULTS

Effect of volatile matter loading, retention time and temperature on biogas production:

3.1 Salvinia molesta

Data on biogas production at three different loading rates, three different retention time and two different seasons using Salvinia as the substrate for methanogenesis are given in Table I.

A) Gas production during rainy season:

Results show that at a volatile matter loading of 1.55g/litre/day (retention time: 28 days) gas production per day and per kg volatile matter were 45 and 145 litres respectively. When volatile matter loading was doubled to 3.1g/litre/day (retention time:28 days), gas production per day increased by 24% although gas production per day per kg volatile matter has shown a 38% reduction, thus suggesting incomplete digestion of volatile matter loaded. When volatile matter loading was increased three times i.e. to 4.65g/litre/day (retention time: 28 days), the gas production per day increased by 60% and gas production per day per kg volatile matter decreased by 34 %. It seems that a retention time more than 28 days could have further increased gas production at the higher loading of volatile matter to some extent.

B) Gas production during hot season:

Gas production per day and per kg volatile matter at a volatile matter loading of 1.55g/litre/day (retention time: 28 days) were 65 and 210 litres respectively. Doubling the volatile matter loading with retention time of 14 days did not result in any increase in gas production per day. Gas production per day per kg volatile matter showed a drastic reduction of 50% suggesting that efficiency of digestion was negatively affected by doubling the volatile matter loading. This was similar to the situation during rainy season where gas production per day per kg volatile matter had shown a 54% reduction upon doubling the loading rate at 14 day retention time. However, when retention time was increased to 28 days with same loading rate of volatile matter (3.1g), a slight increase of 15 per cent was noticed in gas production per day, while gas production per day per kg volatile matter registered 43% reduction from the loading rate of 1.55 g volatile matter. When volatile matter loading was increased three times (4.65g/litre/day at retention time of 28 days), the gas production per day showed increase of 123 % and gas production per day per kg volatile matter showed 25% reduction.

A comparison of the experimental data showed that at a volatile matter loadings of 1.55, 3.10 and 4.65 g/litre/day, during hot season, gas production per day and gas production per day per kg volatile matter showed an increase of 44, 34 and 102 per cent respectively as compared with that during the rains when general atmospheric temperature average is below 30°C.

3.2 Cow dung

Experimental data on gas production at three loading rates during two seasons with apparent temperature difference using fresh cow dung as the feedstock are given in Table II.

A) Gas production during rainy season:

At a volatile matter loading of 1.6g/litre/day (retention time: 28 days) gas production was 7 litres per day and Gas production per day per kg volatile matter was 220 litres. Doubling the volatile matter loading with retention time of 14 days resulted in 17% increase in gas production per day. However, gas production per day per kg volatile matter showed a sharp 42% reduction suggestive of incomplete digestion of volatile matter loaded, similar to the observations using Salvinia as the feedstock during rainy season where gas production per day per kg volatile matter had shown a 38% reduction upon doubling the loading rate. Similarly, When volatile matter loading was increased three times gas production per day showed 65% increase and gas production per day per kg volatile matter registered a decline of 45 when volatile matter loading was increased three times i.e. to 4.8g/litre/day (retention time: 28 days).

B) Gas production at 35°C:

Results show that at a volatile matter loading of 1.6g/litre/day, during hot season, gas production per day and gas production per day per kg of volatile matter showed a marginal decrease (12%) from that of during rainy season. On doubling the loading rate during hot season, both gas production per day and gas production per day per kg of volatile matter have shown a 28% increase as compared to that obtained during the rains. When volatile matter loading was increased three times ie. 4.8g/litre/day, both gas production per day and gas production per day per kg volatile matter have shown a 26% increase during hot climate when compared to that of the performance in monsoon.

The results show that during hot season, cow dung digestion was slower and incomplete at loading rates of 3.2 and 4.8g/litre per day compared to that of Salvinia.

4. DISCUSSION

It could be observed from the results obtained that at 28 days retention time and at loading rate of 1.55g/litre/day, gas production litre/day/litre digester volume from Salvinia (0.225 litre) was lesser than that of cow dung (0.35 litre) by about 53%. A doubling of volatile matter loading resulted in a 17% increase in gas production per day from cow dung and a 24% increase in gas production per day from Salvinia. A three fold increase in volatile matter loading showed a similar increase in gas production per day from both cow dung (65% increase) and Salvinia (60% increase). The lower gas production from Salvinia biomass at increased loading rates as compared to cow dung, shows that digestion of cow dung is faster as compared to Salvinia. The lower rate of digestion of Salvinia biomass could due to its rigid and thick nature which does not make it easily amenable to quick digestion as compared to Eichhornia or Pistia.

The present work highlight the fact that already the recurring cost of biogas is far less than other fuels and use of abundantly available Salvinia will further bring down the fuel cost which will be a gain to lakhs of financially backward coir factory workers of Alappuzha and Cherthala.

5. CONCLUSIONS

The lower gas production from Salvinia biomass at increased loading rates as compared to cow dung, shows that digestion of cow dung is faster as compared to Salvinia. The lower rate of digestion of Salvinia biomass could due to its rigid and thick nature which does not make it easily amenable to quick digestion as compared to Eichhornia or Pistia.But the recurring cost of biogas is far less than other fuels and use of abundantly available Salvinia will further bring down the fuel cost which will be a gain to lakhs of financially backward coir factory workers of Alappuzha and Cherthala.

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