Effect of Cow Dung Inoculum on Biogas Generation from Anaerobic Digestion of Organic Fraction of Municipal Solid Waste - A Case Study of India

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What are we going to learn today?

- Motivation for this study
- Objectives
- Materials and methods
- Key results
- Conclusions
Motivation for this study

• One-third of total world food production gets wasted every year.
• Most of the organic wastes meets with the traditional disposal techniques.
• Scarcity of suitable land for landfilling.
• Stringent regulations.
• Potent renewable energy source.
• Reduce the environmental impacts.

Fig. 1: Anaerobic digestion process
Objectives

• To identify the optimum combination of OFMSW and CM for efficient anaerobic digestion.
Materials and methods

• **Feedstock materials**
  
  • Leftover food waste and other degradable wet organic waste.
  
  • The co-digestion substrate was cow dung (CM) collected from a farm.

• **Reactor Set-up**

  • Aspirator glass bottles of capacity 1000 mL with bottom sampling port were used.
  
  • The experiments were performed in batch.
Fig. 2: Experimental set-up of the anaerobic batch reactor
**Reactor Set-up (Continue..)**

- The reactors were filled with four different substrate to inoculum ratio (0.5, 0.63, 0.75 and 1.0) based on VS contents.
- The inoculum and substrate were thoroughly mixed in the blender before being added to the reactor.
- All the reactors were operated at mesophilic temperature (35 ± 1 °C).
- Water displacement method was used for biogas production measurement at a fixed time every day.
- The other end of silicone tube was inserted in an inverted 50 ml graduated measuring cylinder filled with water, whereas in duplicate it was 1.5 N NaOH solution.
- The reactors were terminated at the end of 30th day.
Analytical methods

• The Characteristics of the collected samples were analysed in the laboratory.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OFMSW</th>
<th>CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content (%)</td>
<td>81.2</td>
<td>84.4</td>
</tr>
<tr>
<td>pH</td>
<td>5.3</td>
<td>7.4</td>
</tr>
<tr>
<td>Total Solid (TS) (%)</td>
<td>18.8</td>
<td>15.6</td>
</tr>
<tr>
<td>Volatile Solid (VS) (% d.b.)</td>
<td>90</td>
<td>79.3</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>79800</td>
<td>19600</td>
</tr>
<tr>
<td>Carbon, C (% d.b.)</td>
<td>45.12</td>
<td>37.34</td>
</tr>
<tr>
<td>Nitrogen, N (% d.b.)</td>
<td>1.58</td>
<td>3.03</td>
</tr>
<tr>
<td>C/N ratio</td>
<td>28.56</td>
<td>12.32</td>
</tr>
</tbody>
</table>
Reactor mixing ratio of OFMSW and CM (on VS basis)

<table>
<thead>
<tr>
<th>Mixing ratio of OFMSW and CM (on VS basis)</th>
<th>OFMSW (g VS/L)</th>
<th>CM (g VS/L)</th>
<th>Organic loading (g VS/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>-</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>R2</td>
<td>0.50</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>R3</td>
<td>0.63</td>
<td>6.3</td>
<td>10</td>
</tr>
<tr>
<td>R4</td>
<td>0.75</td>
<td>7.5</td>
<td>10</td>
</tr>
<tr>
<td>R5</td>
<td>1.00</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2: Combinations of feedstock in batch reactors
Key results

**Variation of pH in the reactors**

- During hydrolysis, the substrates get converted into amino acids and fatty acids which lead to accumulation of volatile fatty acids (VFA) resulting in a decrease in pH of the reactor.
- Till 12-15 days the pH in all the reactors gradually decreases.
- Due to CM as a co-substrate, the pH of the reactors again increases which creates favourable environment for the methanogenic bacteria.

![Variation of pH of the reactors](image_url)
**Biogas generation**

• The maximum biogas production was found in reactor R2.

• The percentage of methane in the generated biogas was 62%.

![Fig. 4: Biogas generated in the reactors](image-url)
• The biogas production of 1594 mL at S/I ratio of 0.5, followed by 1301 mL at 0.63, 1152 mL at 0.75 and 1037 mL at 1.0.

• The biogas generation was very less from mono-digestion of CM (R1).

Fig. 5: Cumulative biogas generation
Conclusions

• The biogas yield in the different reactors are not very encouraging.
• The maximum biogas yield of 106.27 mL/g VS was observed in reactor R2.
• The order of biogas yield in all the reactors are R2>R3>R4>R5>R1.
• The reason for lesser biogas production in all the reactors was due to the drop in pH of the reactors at initial stage of the reaction.
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Thank You

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Questions?