Improving anaerobic fermentative performance of food waste by Fe-modified biochar: FeBC synthesis and application in fermentation system

Room 1 Session IX
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Campus for Research Excellence and Technological Enterprise (CREATE)
## Background

### The Enormous Scale of Global Food Waste

Total annual household food waste produced in selected countries*

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Food Waste per Year (tonnes)</th>
<th>Estimated Food Waste per Capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>91,646,213</td>
<td>64</td>
</tr>
<tr>
<td>India</td>
<td>68,760,163</td>
<td>50</td>
</tr>
<tr>
<td>United States</td>
<td>19,359,951</td>
<td>59</td>
</tr>
<tr>
<td>Japan</td>
<td>8,159,891</td>
<td>64</td>
</tr>
<tr>
<td>Germany</td>
<td>6,263,775</td>
<td>75</td>
</tr>
<tr>
<td>France</td>
<td>5,522,358</td>
<td>85</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>5,199,825</td>
<td>77</td>
</tr>
<tr>
<td>Russia</td>
<td>4,868,564</td>
<td>33</td>
</tr>
<tr>
<td>Spain</td>
<td>3,613,954</td>
<td>77</td>
</tr>
<tr>
<td>Australia</td>
<td>2,563,110</td>
<td>102</td>
</tr>
</tbody>
</table>

* UNEP estimates with high or medium confidence

Source: UNEP Food Waste Index Report 2021

### Food Waste Is Becoming A Billion Tonne Problem

Estimated annual global food waste by sector (million tonnes)

- Household: 569
- Food Service: 244
- Retail: 118

Source: UNEP Food Waste Index
Background

Landfill

Incineration

Compost
Background
Background

→ Low complexity;
→ Simple parameter control;
→ all the microorganisms in a reactor;

→ higher organic loading rates;
→ condition adjustment for optimization phases;
→ reduction in the shocks due to organic loading;
→ Combination of reactors in different configurations.
Background

- Enhancing microbial growth
- Aggregating anaerobes
- Supplementing nutrients
- Promoting electron transfer
- Improving enzyme activity
- Buffering system pH
Challenges

• The efficiency of anaerobic fermentation of food waste to produce H₂/CH₄ needs to be improved

• Effect of Fe-modified biochar on anaerobic fermentation remains unclear

• The recyclability of iron-based biochar has not been studied well
Findings & Discussions
Findings & Discussions

<table>
<thead>
<tr>
<th>Groups</th>
<th>P  \text{ (mM)}</th>
<th>R_{\text{max}} \text{ (mM/h)}</th>
<th>\lambda \text{ (h)}</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>25.50</td>
<td>2.93</td>
<td>4.15</td>
<td>0.98</td>
</tr>
<tr>
<td>FeBC-treated</td>
<td>33.73</td>
<td>37.10</td>
<td>5.84</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Findings & Discussions
Summary

• For the first stage, $H_2$ production from FW was notably promoted by 32.3% with FeBC treatment.

• For the second stage, FeBC significantly improved methane production by 22.8%

• FeBC released iron slowly during fermentation and affects microbial community and EPS composition

Next: Optimizing FeBC preparation process for improving its recyclability
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Thank you!