Thermal and acidic pre-treatments applied to cow manure: effects on pathogenic bacteria persistence and on biogas production during thermophilic anaerobic digestion

C. Delmon, A. Prorot, C. Maftah, M. Casellas-Français
Anaerobic digestion
H. Salsali et al. (2006); H. Salsali et al. (2008); Scaglia et al. (2014); Orzi et al. (2015); Liu et al. (2019)

« Green » energy

Agricultural anaerobic digestion

Biogas

Digestate
Introduction

Materials and Methods

Results and Discussion

Conclusion

Anaerobic digestion

H. Salsali et al. (2006); H. Salsali et al. (2008); Scaglia et al. (2014); Orzi et al. (2015); Liu et al. (2019)

Hygienization

but

Pathogenic bacteria persistence

Pre-treatments

Acidic pre-treatment

Thermal pre-treatment

Combination between 2 pre-treatments
Objectives

Evaluate impact of pre-treatments on cow manure

1) Ability to reduce pathogen survival

2) Impact on biogas production
### Types of pre-treatments and bacteria enumeration

<table>
<thead>
<tr>
<th>Pre-treatments</th>
<th>Acidic pre-treatments</th>
<th>Thermal pre-treatment</th>
<th>Acido-thermal pre-treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.5 g/L</td>
<td>1 hour at 70°C</td>
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Acidic pre-treatments: equimolar mixture of acetic, propionic and butyric acids

Cow manure

- **Clostridium perfringens** (spores)
- **Enterococcus sp. and Escherichia coli**
Biochemical methane potential (BMP) production assessment

**Materials and Methods**

- **Inoculum** = agricultural anaerobic digester
- **Substrate** = cow manure
- **Thermophilic conditions** (55°C)
- **4/5 inoculum** (Volatile Solids basis)
- **1/5 substrate** (Volatile Solids basis)
**Introduction**

**Materials and Methods**

**Results and Discussion**

**Conclusion**

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**Acidic pre-treatments**

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<th>Bacteria</th>
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<td>1-log reduction at 6 g/L</td>
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<td>Pre-treated (1.5 g/L) cow manure</td>
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Bacteria Acidic pre-treatments

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Faecal contamination indicators

- Influence of matrix type
- Sporulating bacteria
- Only acid: no effect

Ease the anaerobic digestion’s first step
### Thermal pre-treatment

#### Bacteria

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<td><em>Escherichia coli</em></td>
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#### Substrate

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<td>No real influence</td>
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**Bacteria** | **Thermal pre-treatment** | **Substrate** | **Influence on overall CH4 production**
---|---|---|---
*Escherichia coli* | 2-log reduction | Thermal pre-treated cow manure | No real influence
*Enterococcus sp.* |  |  |  
*Clostridium perfringens* spores | No influence ? |  |  

**Faecal contamination indicators**

- « Jumbled matrix »
- Not a pure culture
- Sporulating bacteria
- Weak effect on spores

**Organic matter solubilisation**
**Acido-thermal pre-treatments**

H. Salsali *et al.* (2008)

- **Bacteria**
  - *Escherichia coli*
    - Acido-thermal pre-treatment (1.5 g/L): 2-log reduction
    - Acido-thermal pre-treatment (3 g/L): 4-log reduction
    - Acido-thermal pre-treatment (6 g/L): total reduction
  - *Enterococcus sp.*
    - Acido-thermal pre-treatment (1.5 g/L): 1.5-log reduction
    - Acido-thermal pre-treatment (3 g/L): 1.6-log reduction
    - Acido-thermal pre-treatment (6 g/L): 1.7-log reduction
  - *Clostridium perfringens* spores
    - High standard deviation

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**Faecal contamination indicators**

- **Sporulating bacteria**
  - *Clostridium perfringens*
    - Synergistic effect
      - Effect on *C. perfringens* but both vegetative and spores
Acido-thermal pre-treatments

F. Passos et al. (2017)

Substrate Influence on overall CH4 production

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<td>Acido-thermal (1.5 g/L + 1 hour at 70°C) pre-treated cow manure</td>
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<td>Acido-thermal (3 g/L + 1 hour at 70°C) pre-treated cow manure</td>
<td>Lower methane production</td>
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<td>Acido-thermal (6 g/L + 1 hour at 70°C) pre-treated cow manure</td>
<td>Higher methane production F. Passos et al. (2017)</td>
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Reduce pathogen survival

Deep impact on *Escherichia coli* and *Enterococcus sp.*

No real impact on spores

Synergistic effects between two pre-treatments

Impact on biogas production

Lower methane production with acido-thermal pre-treatments

How could we explain persistence of spores?

Why a lower methane production?
Thank you for your attention
Bibliography


