# Unifying ammonia inhibitory limits in anaerobic digestion: link with operational conditions and microbial communities

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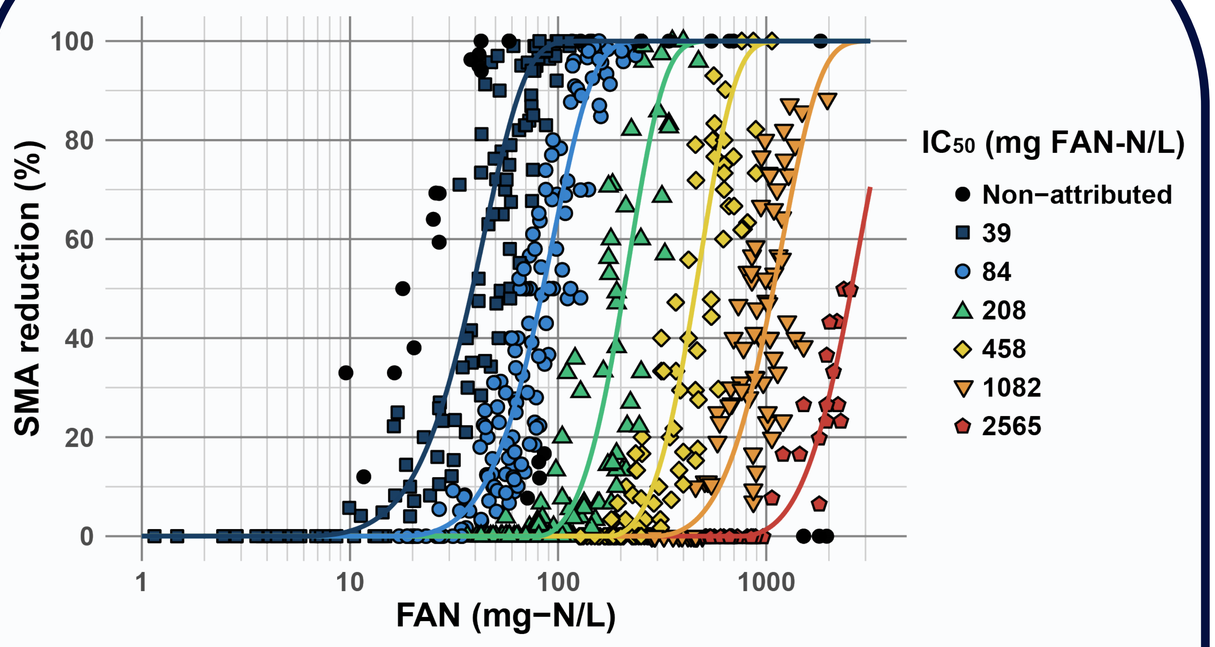
## Introduction

- Free ammonia nitrogen (FAN) is a major inhibitor in anaerobic digestion processes
- There is no current agreement in the literature regarding inhibitory limits
- Data from literature was used to unify inhibitory limits and link inhibition resilience to operational parameters and archaeal populations

## Materials and methods

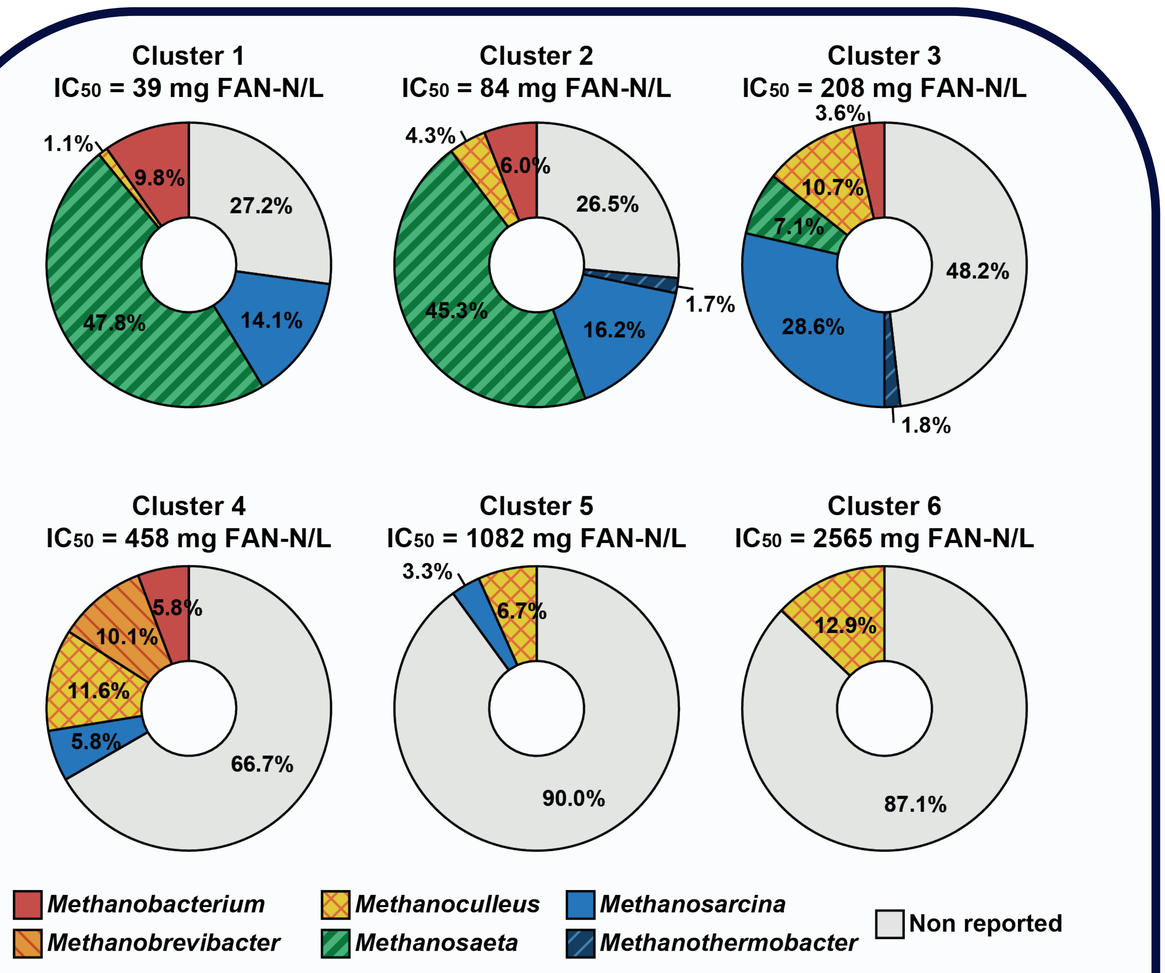
- A database containing 1,590 points was generated (from 50 articles)
- FAN concentrations were recalculated using a modified Davies equation to account for the ionic strength in N-rich media (Capson-Tojo *et al.*)
- The inhibitory constants ($IC_{50}$) were calculated using a threshold inhibition function (Astals *et al.*, 2018)
- An iterative clustering approach based on regression analysis over the inhibition function was used to obtain different $IC_{50}$ values

## Main results




**Reduction of the specific methanogenic activities (SMA) at different FAN concentrations.** The set of inhibition curves and $IC_{50}$ values resulting from the clustering approach are also shown.

- Six different inhibition curves were obtained, forming **six data clusters with increasing resilience to FAN** (higher $IC_{50}$ values)
- A **sensitivity analysis** verified that the cluster distribution was optimal according to defined criteria
- The median **temperatures and pH** of each cluster **increased with the $IC_{50}$**
- The total ammonia nitrogen (**TAN**) **and** the **$NH_4^+$ concentrations** were **not significantly different between clusters**




**Repartition of the main archaeal genus after anaerobic digestion for each resulting cluster.** Only the predominant genus (that with the highest percentage in relative abundance) was considered for the counting. "Non-reported" corresponds to studies in which the microbial communities were not analysed.

- Clusters with **low $IC_{50}$ values** were dominated by **acetoclastic** methanogens (mainly *Methanosaeta*)
- ***Methanosarcina*** (mixotroph) dominated at **low-intermediate $IC_{50}$ values**
- **Hydrogenotrophic** methanogens showed the **highest $IC_{50}$**

## Take home message

- **Resilience to FAN inhibition is affected by both the operational parameters and the archaeal composition**
- **The working pH and temperature, rather than the TAN content itself, are the main factors affecting FAN resilience**
- ***Methanosaeta*-dominated reactors presented lower inhibition limits when compared to mixotrophic and hydrogenotrophic systems**
- **More research must be carried out to study the microbial communities in nitrogen-rich systems at high FAN levels**

## References


Astals et al., (2018), Characterising and modelling free ammonia and ammonium inhibition in anaerobic systems. Water Res, 143:127–35
Capson-Tojo et al., Unraveling the literature chaos around free ammonia inhibition in anaerobic digestion. Submitted to Renewable & Sustainable Energy Reviews



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