Development of a thermophilic and cellulolytic consortium to improve anaerobic digestion of lignocellulosic biomass.

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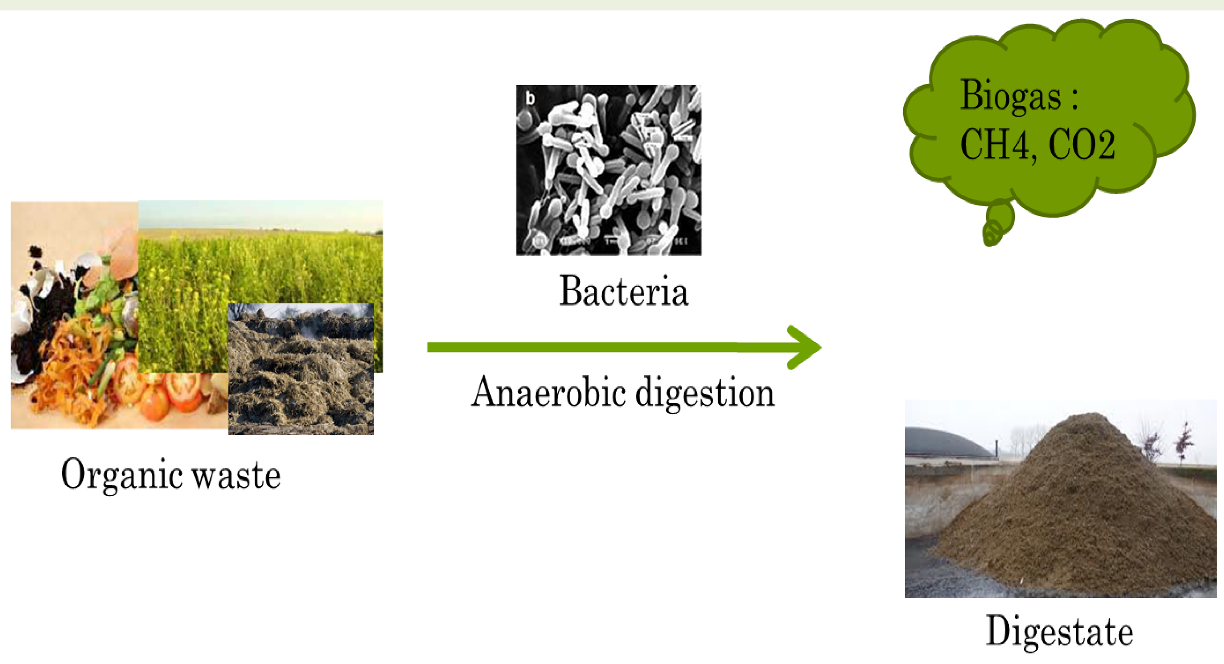
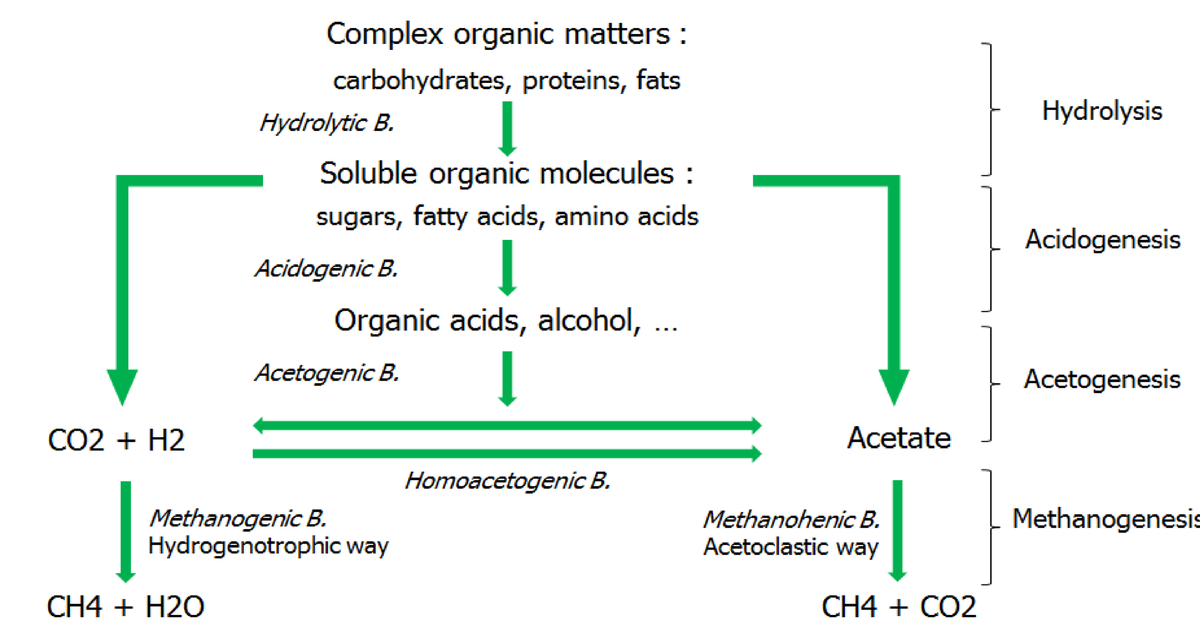
Context and objectives



Hydrolysis of cellulosic substrate = Limiting step

Development of an anaerobic cellulolytic consortium to improve methane production



Method

Isolation of the enriched microbial consortium :

Figure 1 : Enrichment method to obtain a cellulolytic, anaerobic and thermophilic consortium from compost. Transfer after 5 days growth at 55°C and in anaerobic static conditions. Scale-up in the fourth transfer.

➢ **Enrichment method:**

-Compost as microbial inoculum (10%)

-Anaerobia, 55°C, static

-Filter paper 1% (w/v)

-Transfer after 5 days growth

➢ **Degradation potential (one week, 10 g/l of substrate) :**

-Filter paper → 99%

-Microcrystalline cellulose → 98%

Results

Impact of cellulolytic microbial consortium on biogas production

➢ Cellulosic substrate

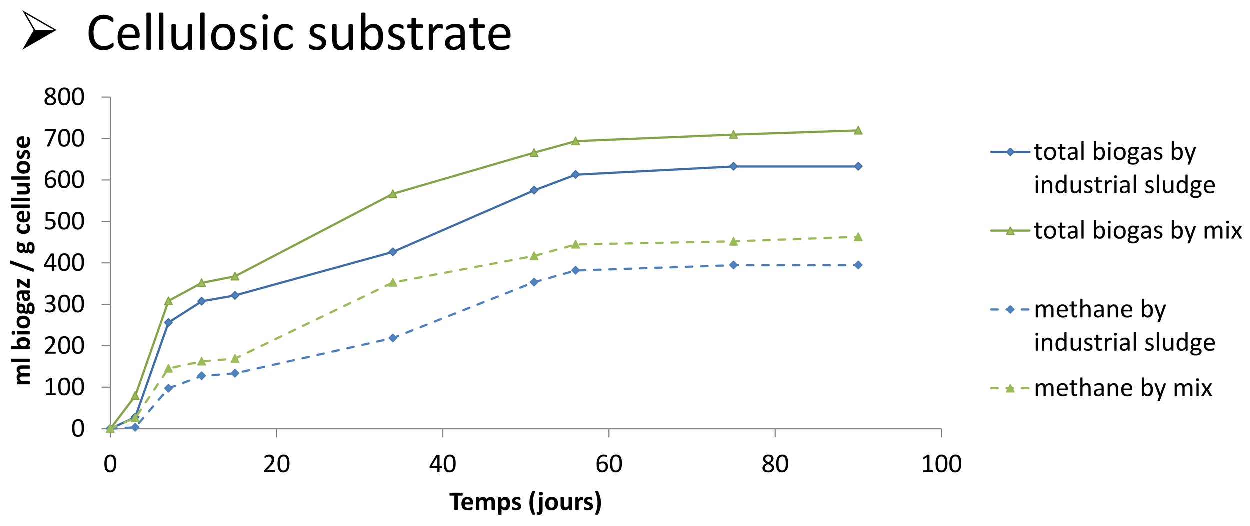


Figure 2 : Evolution of maximal total biogas and methane production (ml/g cellulose) during anaerobic and thermophilic (55°C) digestion of a cellulosic substrate (10 g/l filter paper) by (1) industrial digester sludge (10% v/v) and (2) mix 1:1 of digester sludge and isolated consortium (10% v/v).

➢ Lignocellulosic substrate

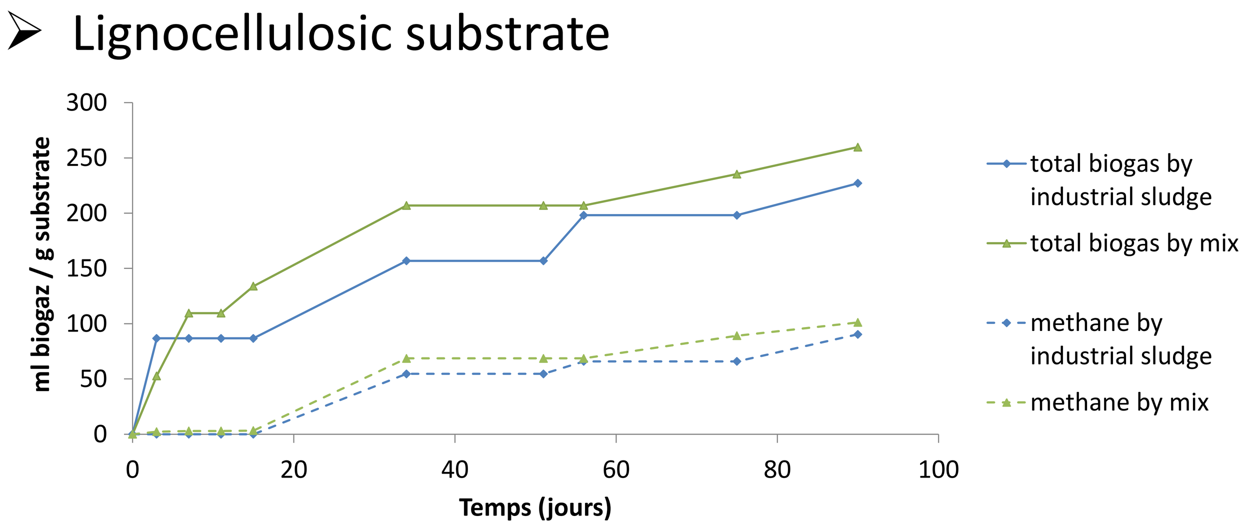


Figure 3 : Evolution of maximal total biogas and methane production (ml/g cellulose) during anaerobic and thermophilic (55°C) digestion of a lignocellulosic substrate (10 g/l mechanical pulp paper) by (1) industrial digester sludge (10% v/v) and (2) mix 1:1 of digester sludge and isolated consortium (10% v/v).

→ positive effect of the isolated consortium on biogas and methane production by industrial sludge

→ gain of 14% in both cases for biogas production and respectively 20% and 12% for methane

Characterization of isolated consortium

➢ ***Cellulose degradation kinetics***

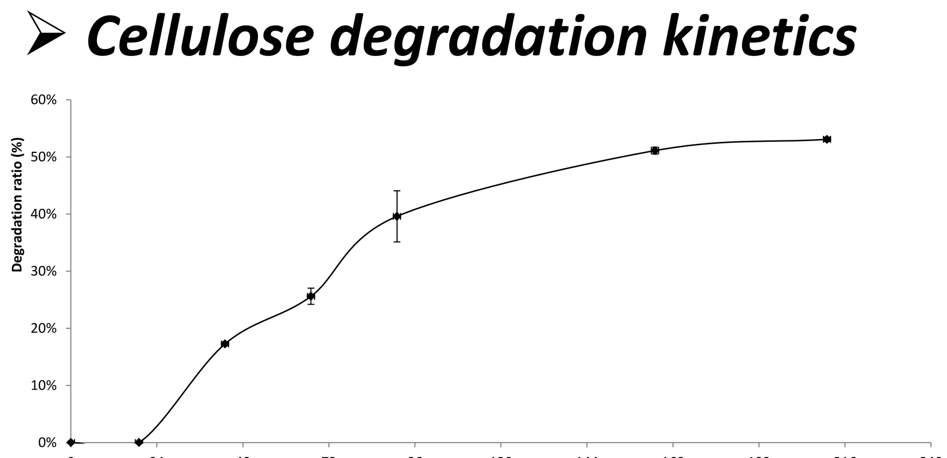


Figure 4 : kinetics of filter paper (1% w/v) degradation by consortium (10% v/v). Experiments under thermophilic (55°C) and anaerobic static conditions.

→Kinetics similar to sigmoidal microbial growth curve

➢ ***Microbial community structure***

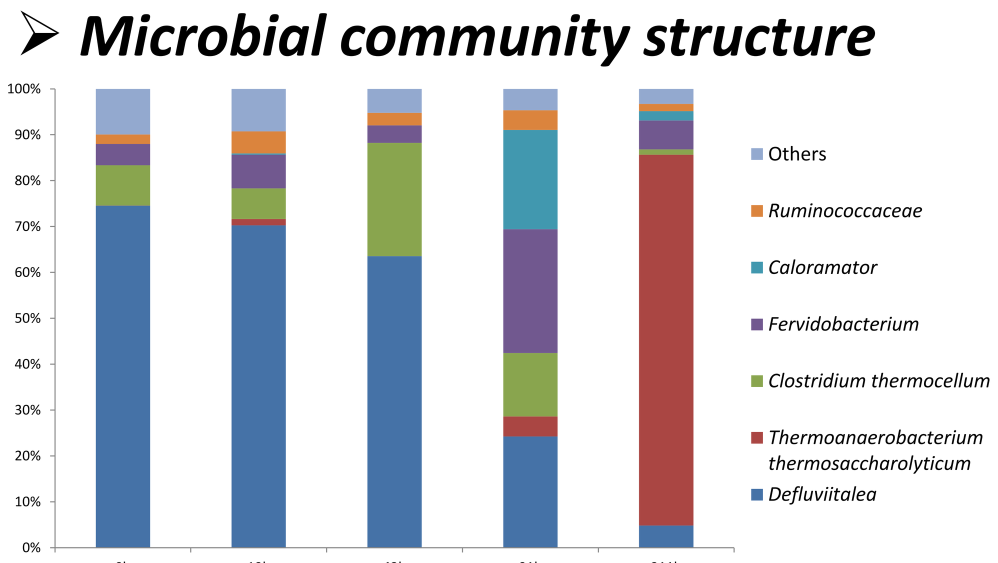


Figure 7 Population structure dynamic during anaerobic thermophilic (55°C) degradation of cellulose (filter paper 10 g/l) by isolated consortium (10% v/v).

→pH evolution induces population evolution

→Cellulose degrading species :

- ***Clostridium thermocellum***
- ***Thermoanaerobacterium thermosaccharolyticum***

➢ ***Metabolites of cellulose anaerobic degradation***

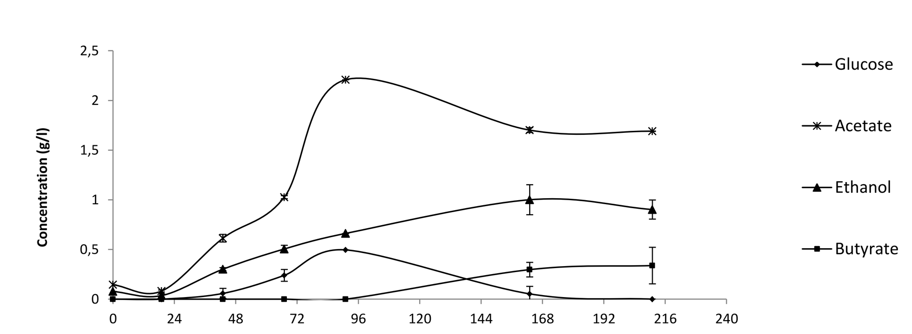


Figure 5 Metabolites' concentration (g/l) evolution during anaerobic thermophilic (55°C) cellulose (filter paper 10 g/l) degradation by isolated consortium (10% v/v).

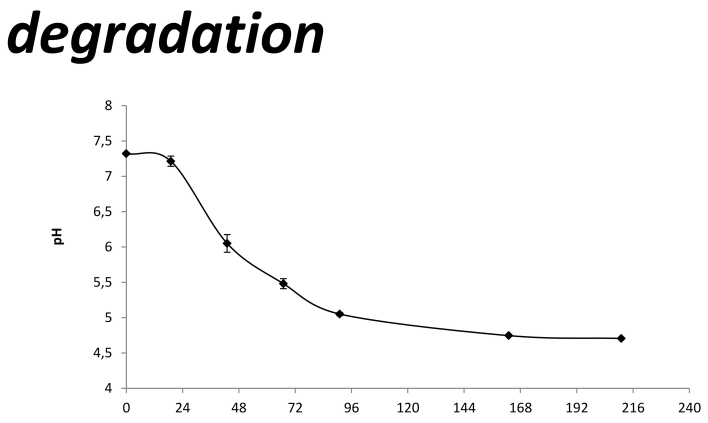


Figure 6 pH evolution during anaerobic thermophilic (55°C) cellulose (filter paper 10 g/l) degradation by isolated consortium (10% v/v).

→Glucose accumulation only during the first 91 hours

→Acetate and ethanol are predominant metabolites and are produced since the start

→Butyrate is measured from 163th hour

→pH decrease due to VFA accumulation

Conclusions

➢Enrichment method, with high temperature compost as microbial source, permitted to obtain an efficient cellulolytic anaerobic and thermophilic consortium

➢Positive impact of isolated consortium on biogas production.

➢Acetate and ethanol, are the prevailing metabolites produced during anaerobic cellulose degradation.

➢Medium parameters evolution induced important modification of the microbial community structure.

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