Methanosarcina sp. as key archaea to avoid acidification in dry anaerobic digestion of food waste

Gabriel Capson-Tojo, Maxime Rouez, Marion Crest, Eric Trably, Jean-Philippe Steyer, Jean Philippe Delgenes, Renaud Escudié

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G. Capson-Tojo*,, M. Rouez**, M. Crest**, E. Trably*, J.-P. Steyer*, J.-P. Delgenès*, R. Escudié***

* LBE, INRA, Univ. Montpellier, 102 avenue des Etangs, 11100, Narbonne, France

** Suez, CIRSEE, 38 rue du Président Wilson, 78230, Le Pecq, France

INTRODUCTION

- **Food waste** (FW) is a highly biodegradable substrate rich in nitrogen [1]. These characteristics often lead to accumulation of volatile fatty acids (**VFAs**) and free ammonia nitrogen (**FAN**), causing low methane yields and even AD failure [2,3]. It is then critical to have well-adapted resilient **archaeal communities** in the reactors, resistant to these common inhibitors (such as mixotrophic archaea [4])
- **Objective**: assess influence of the composition of the archaeal communities of different inocula on the methane production from FW and cardboard (CB) at different working conditions (*i.e.* **total solid** (TS) contents, **co-digestion proportions** and **substrate loads**)

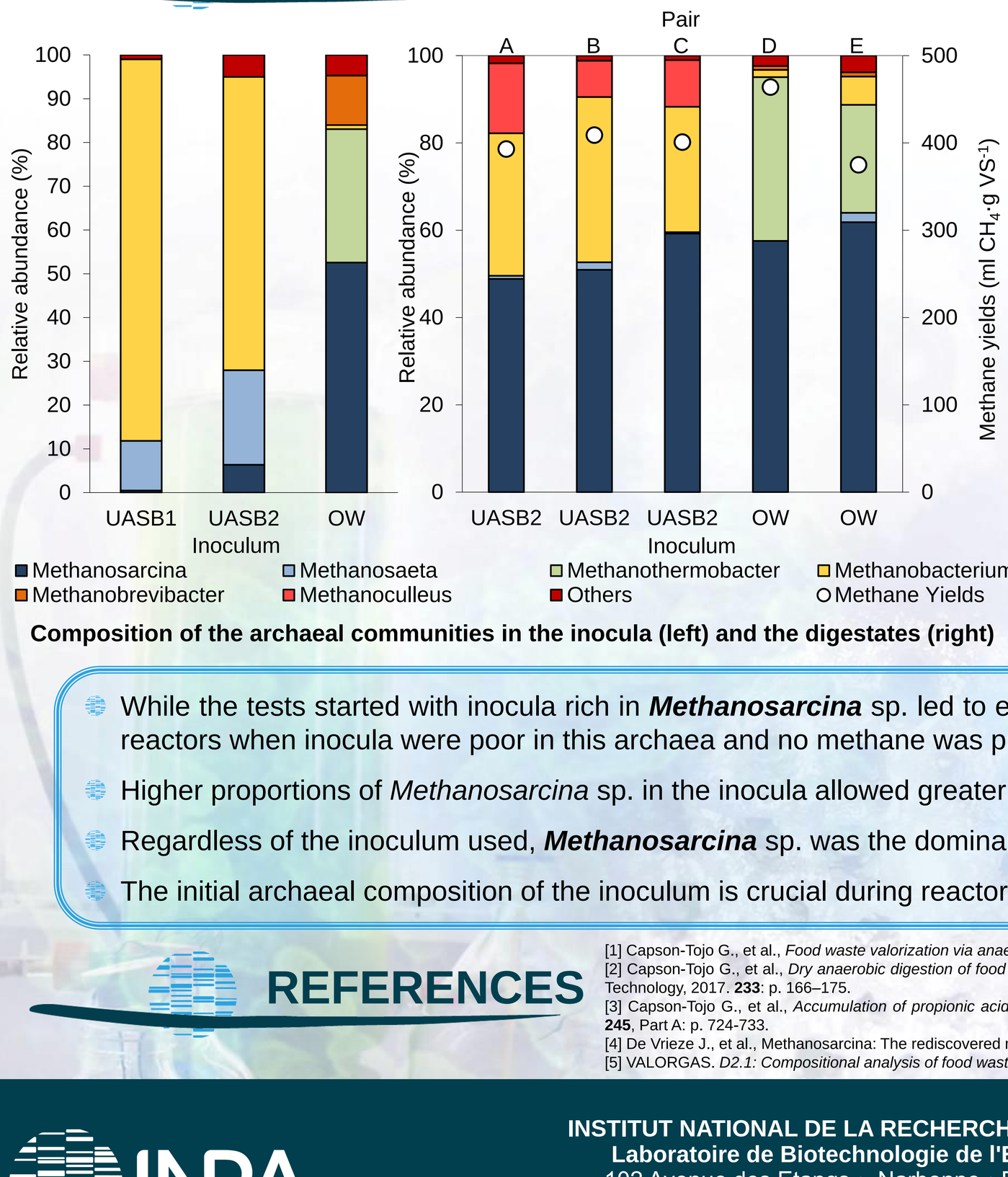
MATERIALS & METHODS

- Model FW (VALORGAS report [5]) and compact CB as substrates
- Three different inocula: UASB1 (high TS, low TAN), UASB2 (high TS, low TAN), OW (low TS, high TAN)
- 5 pairs of comparable experiments at different co-digestion proportions (1.00-4.00), substrate to inoculum (S/X) ratios (0.25-1.00 g VS·g VS^{-1}) and initial TS contents (20-30 %)
- Follow-up of methane production and analysis of concentration of TAN, VFAs and archaeal composition in inocula and digestates

Operational conditions of the batch experiments and obtained methane yields

Pair	Inoculum	Substrate	S/X (g VS·g VS^{-1})	Co-dig. ratio (g TS FW·g TS CB^{-1})	Initial TS (%)	Methane yield (ml CH_4·g VS^{-1})
A	UASB2	FW+CB	0.25	1.00	27.5	393±9.0
	UASB1	FW+CB	0.25	1.00	30.0	7.9±1.9
B	UASB2	FW+CB	0.25	1.86	27.5	409±11
	UASB1	FW+CB	0.25	1.75	30.0	11±2.7
C	UASB2	FW+CB	0.25	1.00	35.0	401±16
	UASB1	FW+CB	0.25	1.00	35.0	17±2.3
D	OW	FW	0.25	-	20.0	464±14
	UASB1	FW	0.25	-	20.0	0.7±0.9*
E	OW	FW	1.00	-	20.0	375±17
	UASB2	FW+CB	1.00	4.00	27.5	0±0

MAIN RESULTS



Composition of the archaeal communities in the inocula (left) and the digestates (right)

- High TAN and transient VFA concentrations in the reactors (up to 5 g·l^{-1} and 23 g COD·l^{-1}, respectively)
- One reactor of each pair produced methane efficiently and the other was acidified due to VFA accumulation at the beginning of the batch AD process
- No methane with UASB1; with UABS2, only at an S/X ratio of 0.25 g VS·g VS^{-1}; OW worked at high loads
- In UASB1: no ***Methanosarcina*** sp. initially; in UASB2, minority initially; in OW: predominant methanogen
- In all reactors producing methane: ***Methanosarcina*** sp. as main methanogen
- No *Methanosaeta* sp. in digestates due to inhibition

Take-Home Message

- While the tests started with inocula rich in ***Methanosarcina*** sp. led to efficient methane production, VFAs accumulated in the reactors when inocula were poor in this archaea and no methane was produced
- Higher proportions of *Methanosarcina* sp. in the inocula allowed greater substrate loads
- Regardless of the inoculum used, ***Methanosarcina*** sp. was the dominant methanogen in the **methane-producing** reactors
- The initial archaeal composition of the inoculum is crucial during reactor start-up to achieve stable anaerobic digestion

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INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE
Laboratoire de Biotechnologie de l'Environnement
102 Avenue des Etangs • Narbonne • F-11100 • France
Tel : + 33 6 38 12 79 57
E-mail: gabriel.capson-tojo@supagro.inra.fr
www.montpellier.inra.fr/narbonne