Improved degradation and anaerobic digestion of maize silage by the natural hydrolytic consortia

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INTRODUCTION

Degradation and anaerobic digestion of lignocellulosic biomass is a very common and promising application in agricultural biogas plants. Lignocelullosic biomass (maize silage) is widely used as an attractive source of renewable energy. The main limitations associated with the use of substrates are related to their biodegrability or digestability. Degradation of maize silage during anaerobic digestion was determined by a wide spectrum of hydrolytic microorganisms. Hydrolytic microorganisms and their enzymes are responsible for the organic matter degradation, which may have an effect on an overall biogas production. In this study was used novel artificial microbial hydrolytic consortium for degradation of lignocellulosic biomass .

OBJECTIVES

The main aims of this study were: (i) selection of natural cellulose-degrading consortia from sewage sludge treatment plants (OS), hydrolyser of agricultural biogas plant (BH), cattle slurry (GB), and (ii) investigate the effect of bioaugmentation of selected natural hydrolytic consortia on biogas production from maize silage during anaerobic digestion.

MATERIALS & METHODS

- The selection experiment was performed in lab-scale bioreactors of working volume 500 mL. The lab-scale hydrolyzers were supplied with: 0.5% (v/v) of total solid (TS) of the aforementioned samples, 3% (v/v) of TS maize silage and spring low-mineral water.
- Selection were carried out during 10 passages. Hydrolysis of maize silage in each passage lasted for 72 hours and was performed in 30 ° C.
- Anaerobic digestion was performed in 1L lab-scale bioreactor at 37 ° C for 21 days.
- The bioreactors were supplied with the inoculum (18 gvs L-1) and maize silage (9,6 gVs L-1), and supplemented 100 mL of selected consortia.
- Analytical methods: volume of biogas production, methane concentration, volatile fatty acids (VFAs), soluble chemical oxygen demand (sCOD), total solids (TS), volatile solids (VS).
- Daily biogas production was measured by Milligascounter MGC-1 (Ritter).
- Methane content was analysed by gas chromatography GC/MS (Agillent)
- Microbial community structure: 16S rRNA gene amplicon library

RESULTS

The conducted analyses showed that:

❖ Selected consortia are stable and contain dominant bacteria with the family: *Clostridiaceae, Lactobacillacea, Prevotellaceae, Acetobacteraceae, Veillonellaceae* (Fig. 1).

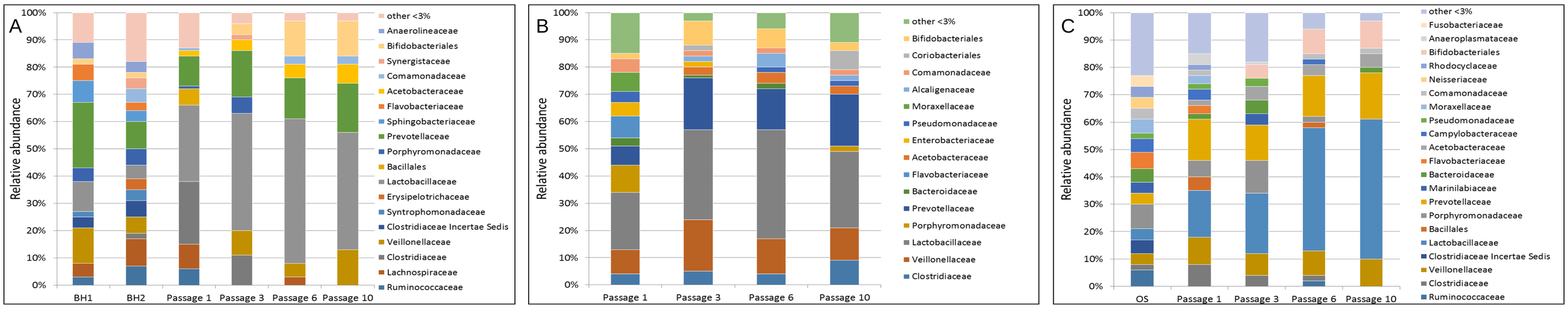

Fig. 1. Microbial community analyzed by 16S rRNA gene amplicon libraries. Hydrolutic consortia selected from: **A)** hydrolyser of agricultural biogas plant, **B)** cattle slurry and **C)** sewage sludge treatment plant.

❖ Addition of the novel consortium could increase the efficiency of biogas production up to 16%, 30% and 10% for BH, GB and OS respectively (Fig. 2.)

- in the control – at the level of 128 dm^3 biogas/kg VS
- in the culture with BH, GB and OS – at level of 149, 166 and 141 dm^3 biogas/kg VS, respectively.

❖ Natural hydrolytic consortia enhance solubilization of organic compounds during of anaerobic digestion process (Table 1).

- Increase concentrations of VFAs (20% higher than control)
- Increase of sCOD (15% higher than control)

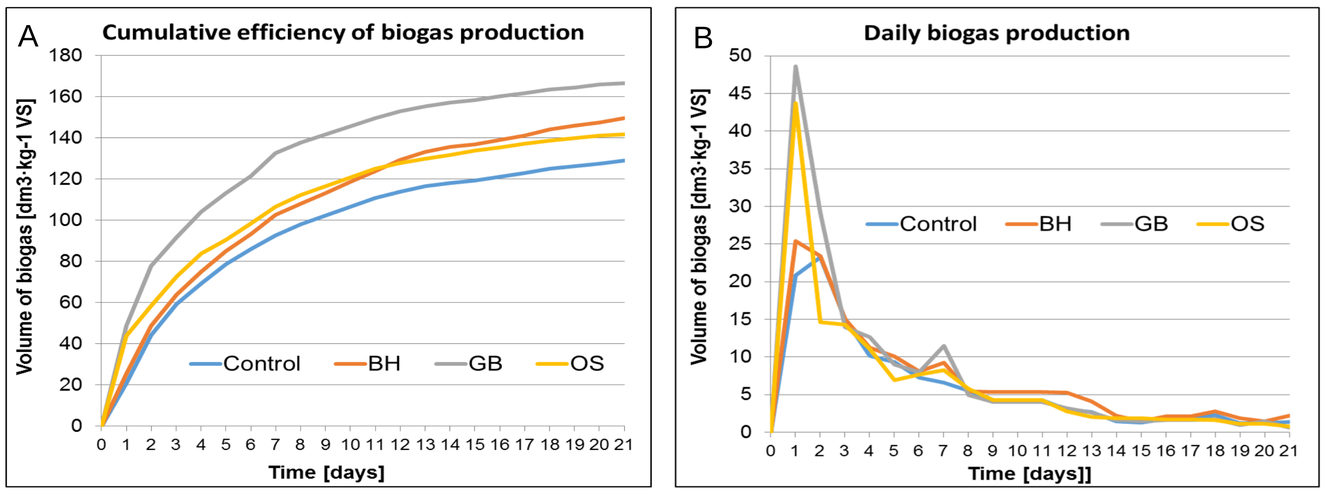

Fig. 2. The efficiency of biogas production during anaerobic digestion of sewage sludge: **A)** cumulative biogas production and **B)** daily biogas production.

❖ Supplementation of natural hydrolytic consortia can improves the quality of biogas of 16%, even up to 42-44% methane after 7 days (Fig. 2.).

Table 1 The physical - chemical characteristic of digester during anaerobic digestion (after 7 days) .

Parameters	**VFAs**		**sCOD**		**CH4**
Units	[g/L]		[g/L]		[%]
	0 days	7 days	0 days	7 days	7 days
Control	5.37±0.82	9.33±0.43	18.63±0.35	20.83±0.31	37.71±2.53
BH	5.88±0.19	10.29±0.74	18.43±0.55	22.50±0.70	44.03±2.92
GB	5.61±0.13	10.06±0.13	18.47±0.21	23.47±0.26	43.64±3.00
OS	6.12±0.11	10.11±0.46	18.47±0.53	23.20±0.21	42.62±0.55

CONCLUSIONS

The results indicated that the bioaugmentation of natural hydrolytic consortia could be a promising method for improving efficiency of degradation and biogas production during anaerobic digestion of maize silage.

This work was supported by the Research Project founded by National Centre for Research and Development and National Fund for Environmental Protection and Water Management [Project Number = No. 266405]