BIOMETHANE PRODUCTION FROM PHYTOREMEDIATION DERIVED MAIZE BIOMASS VIA ANAEROBIC DIGESTION

Ana M. S. Paulo[1], P.M.L. Castro[1], Ana P.G.C. Marques[1]

[1]CBQF – CENTRO DE BIOTECNOLOGIA E QUÍMICA FINA, ESCOLA SUPERIOR DE BIOTECNOLOGIA, CENTRO REGIONAL DO PORTO DA UNIVERSIDADE CATÓLICA PORTUGUESA, RUA ARQUITETO LOBÃO VITAL, 4200-072 PORTO, PORTUGAL

CATÓLICA FACULTY OF BIOTECHNOLOGY PORTO

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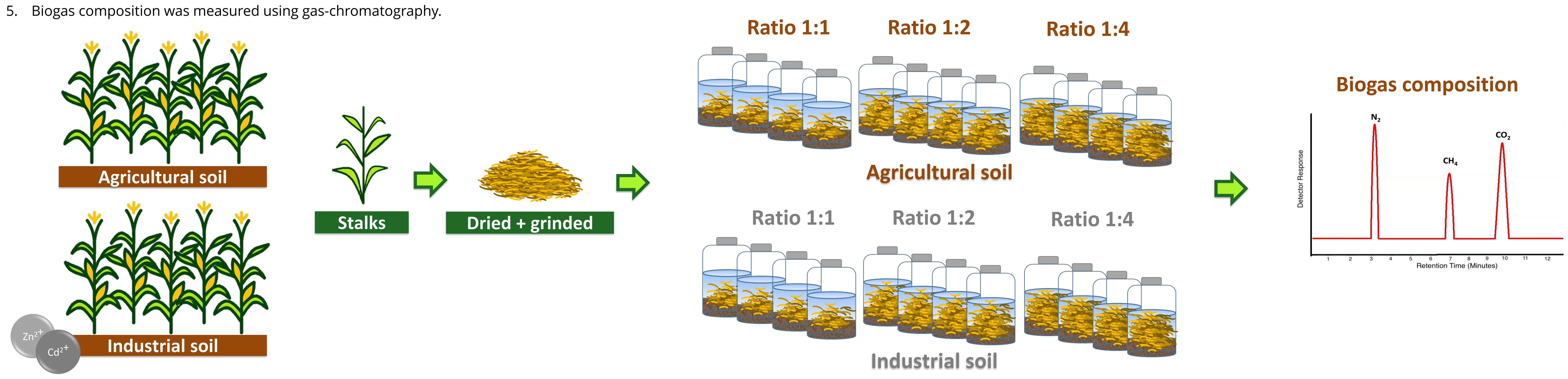
Introduction

Soils contaminated with heavy metals (HM) are widespread in Europe. Phytoremediation is a low cost biologically based technology attractive for soil requalification, which establishes a vegetation cover to stabilize the site, avoids the dispersion of contamination and simultaneously removes pollutants present in the brownfield [1]. However, the fate of harvested biomass can be an obstacle for its implementation. The use of biomass grown in degraded and abandoned soils, not involving agricultural soils for energy crop cultivation, may increase the sustainability of utilizing biomass for bioenergy generation, while it may allow for increasing the available agricultural soil through the consequent gradual decontamination of such brownfields. One possible solution is to use HM contaminated biomass for generating biogas. Although the information available in literature is still very scarce, this strategy presents a considerable degree of success. Anaerobic digestion (AD), is a process in which organic matter can be decomposed by microbiota with the production of biogas – methane rich renewable gas composed of 50 to 65% methane and 35 to 50% carbon dioxide. In this study, the main objective was to evaluate the potential of maize used in contaminated soil bioremediation for biogas production. For this, mayze plants were grown in industrial soil, contaminated with HM (e.g., cadmium and zinc), and in agricultural soil, used as control soil. This work presents a novel integrated strategy comprising the utilization of maize phytoremediation derived biomass for the generation of biogas.

Methods

1. Maize plants were grown (5 months) in contaminated (industrial) and non contaminated soils (agricultural);
2. Stalks were dried, grinded and used as substrate (carbon and energy source) for the biomethane assays (BMP);
3. Inoculum → Anaerobic granular sludge from a full scale EGSB (Expanded Granular Sludge Bed) reactor, treating wastewater from a beverage company was used as inoculum;
4. Different inoculum to substrate ratios (VS based) were tested → 1:1, 1:2 and 1:4;
5. Biogas composition was measured using gas-chromatography.



Results and Conclusions

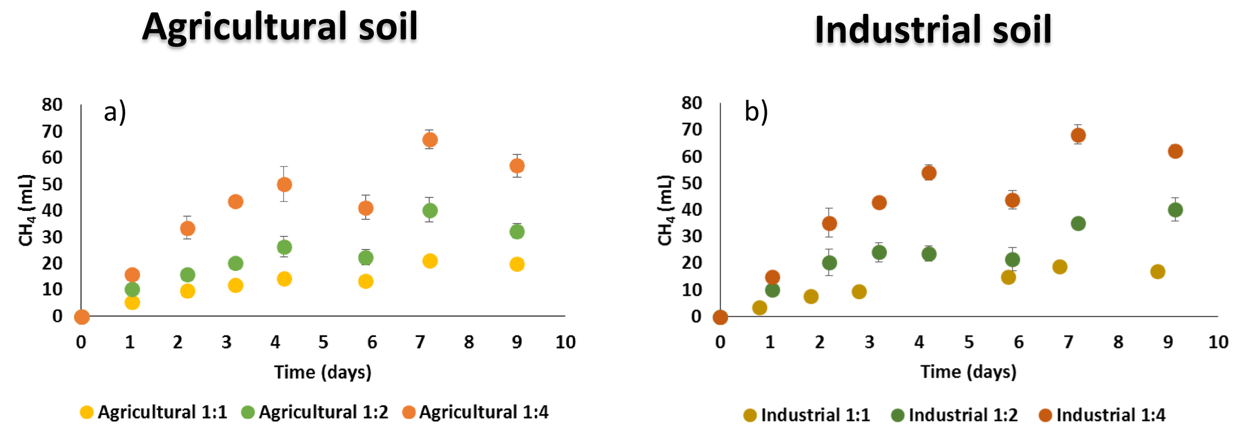


Figure 1. Methane production (mL/assay) from anaerobic digestion of maize stalks grown in agricultural soil a) and industrial soil b) comparison between ratios inoculum to substrate (g VSS/ g VS) of 1:1, 1:2 and 1:4.

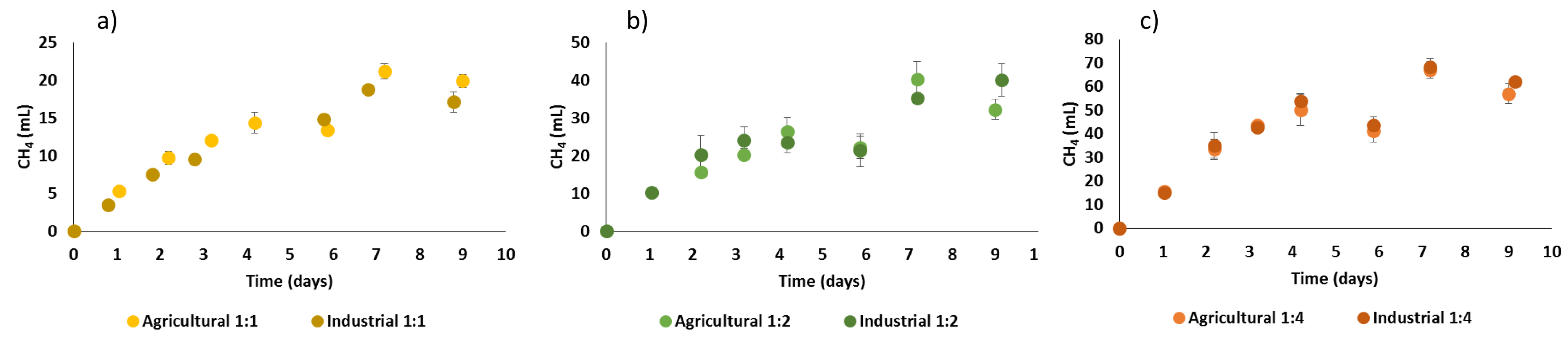


Figure 2. Methane production (mL/assay): comparison between ratios 1:1 a), 1:2 b) and 1:4 c) (inoculum to substrate (g VSS/ g VS)), for both soil conditions.

Table 1. Average values for maximum volume of methane (V_{max}) produced during the assays, initial methane production rate (MPR) and methane yield (MY), for ratios of 1:1, 1:2 and 1:4 (inoculum to substrate)

Parameter	Soil	Ratio inoculum to substrate		
		1:1	1:2	1:4
V_{max} (mL)	Agricultural	21	40	67
	Industrial	20	40	68
MPR (mL CH4 day^{-1})	Agricultural	3	4	15
	Industrial	4	5	14
MY (mL CH4 VS^{-1} day^{-1})	Agricultural	173	192	170
	Industrial	146	164	174

MPR – average values obtained between days 1 and 2; All values determined after blank subtraction

1. Stable methane production was reached after ca. 8 days of incubation, for all assays
2. More stalk, more methane → ratio 1:4 > ratio 1:2 > ratio 1:1
3. Initial methane production increased with increased substrate amount, independently from the soil condition, as well as final methane volume
4. This indicates that methane production is proportional to the amount of anaerobically degradable substrate
5. Maximum volume of methane, initial methane production rate and methane production yield were similar between mayze grown on agricultural and industrial soil

→ The anaerobic biodegradation of maize stalk was not significantly different after growth either on agricultural or industrial soil

→ Maize stalk used for metals phytoremediation is a potential bioenergy source

References

[1] Marques A.P.G.C., Rangel AOSS, Castro PML (2009) Remediation of heavy metal contaminated soils: phytoremediation as a potentially promising clean-up technology. Critical Reviews Environmental Science Technology 39:622-654.

Acknowledgements

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Phytoenergy (PTDC/BTA-BTA/28761/2017)

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