Pre-treatments effect on the enhance of the biogas production from rice straw anaerobic digestion

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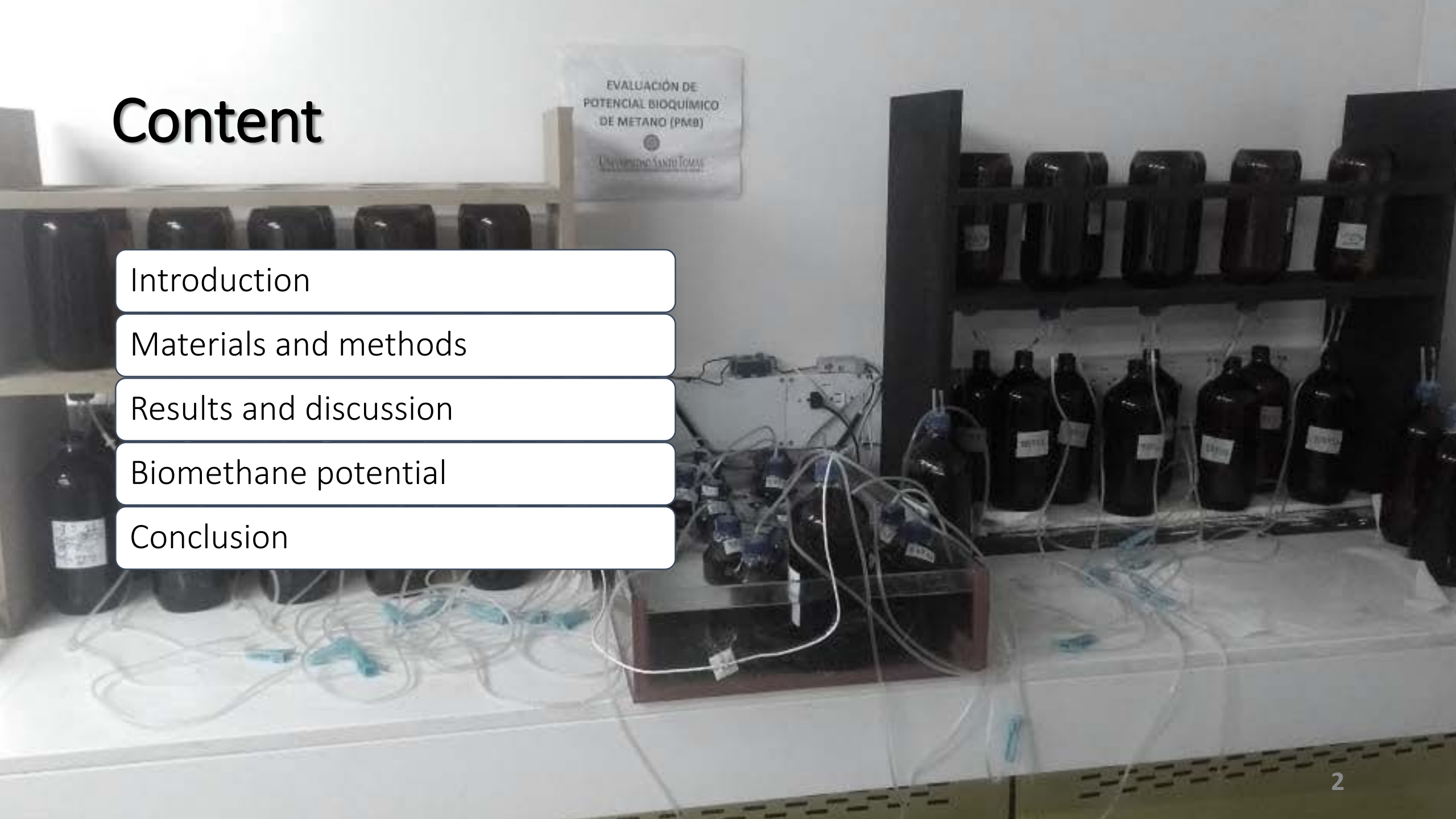
Content



Introduction

Agro-industrial activities in bioconversion processes

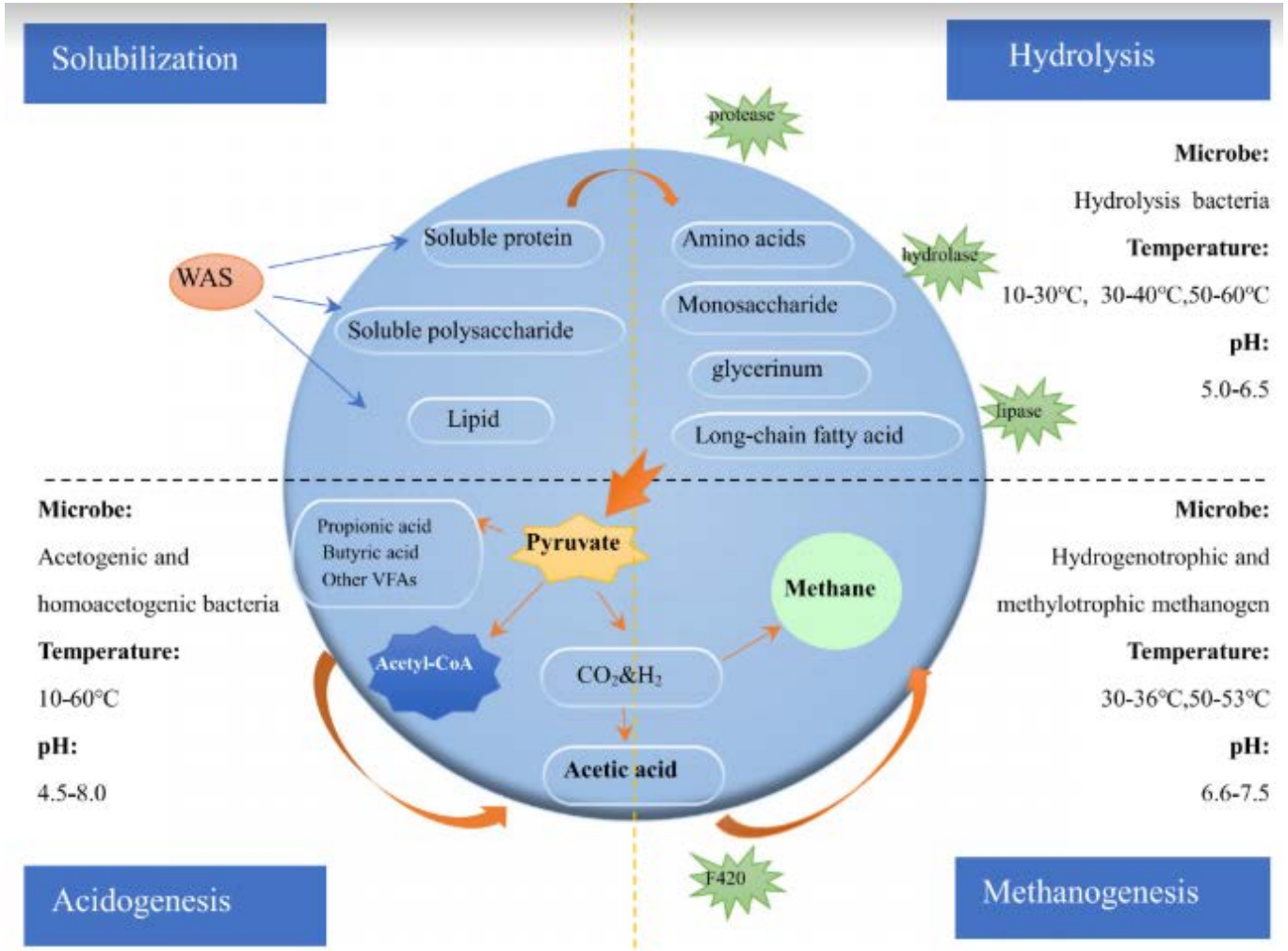
Colombia is the third producer of rice in Latin America, with approximately 2 million tonnes, with CH4 emissions about 0.24 tonnes of CH4 per hectare [1].

The production of rice generates 2% of the gross domestic product and is the economic support of up to 500.000 families of 21.800 rice farms [2].

The paddy rice production has reduced competitiveness due to the use of/* traditional farming, which leads to health and environmental impacts [3].

Anaerobic digestion

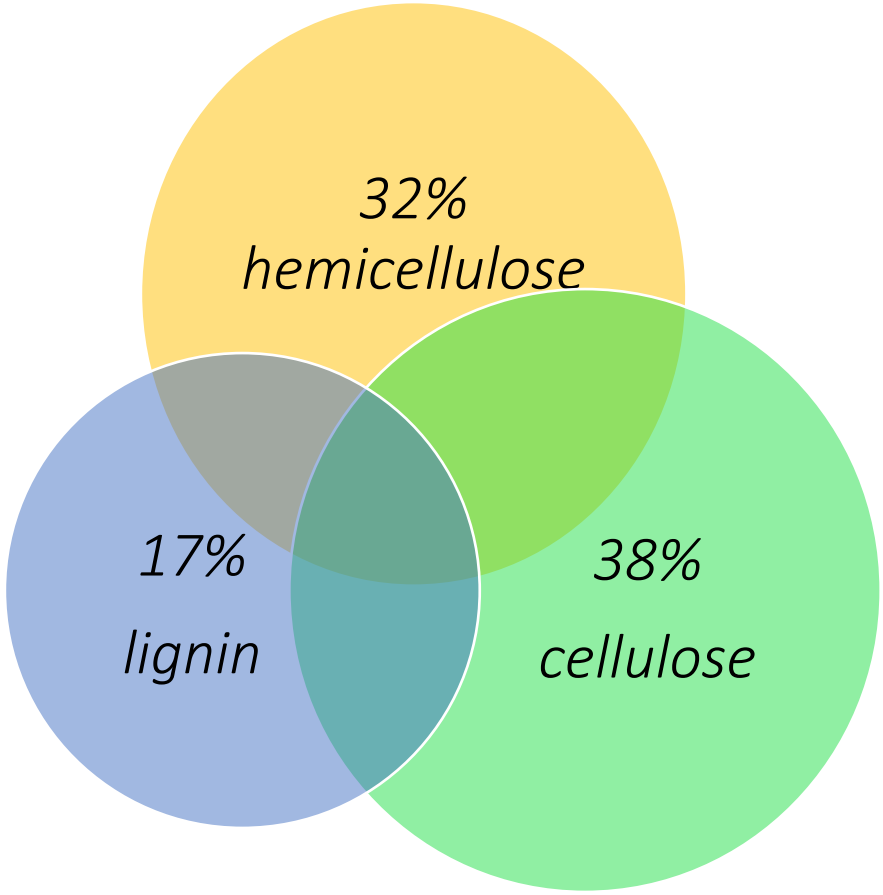
The anaerobic digestion comprises the conversion of organic carbon to usable products such as alcohols, volatile fatty acids and gases, through redox reactions, in which microorganisms interact in the absence of oxygen [4].



FuenteYuan, Y., et al. (2019) [5].

Lignocellulosic biomass

Biomass characteristics



Pre-treatments

- Physic
- Chemical
- Biologic
- Physicochemical

Materials and Methods

Rice straw

A 60°C for 24h dry

Particle size reduction

Biocultivos®
Agricultura sostenible

Inoculum

alpina

Pre-treatments

Alkaline hydrol

- 10 g l^{-1} NaOH in a relation 10:1 liquid:solid.
- Autoclaved for 60 minutes at 102 ºC

te pH of 9

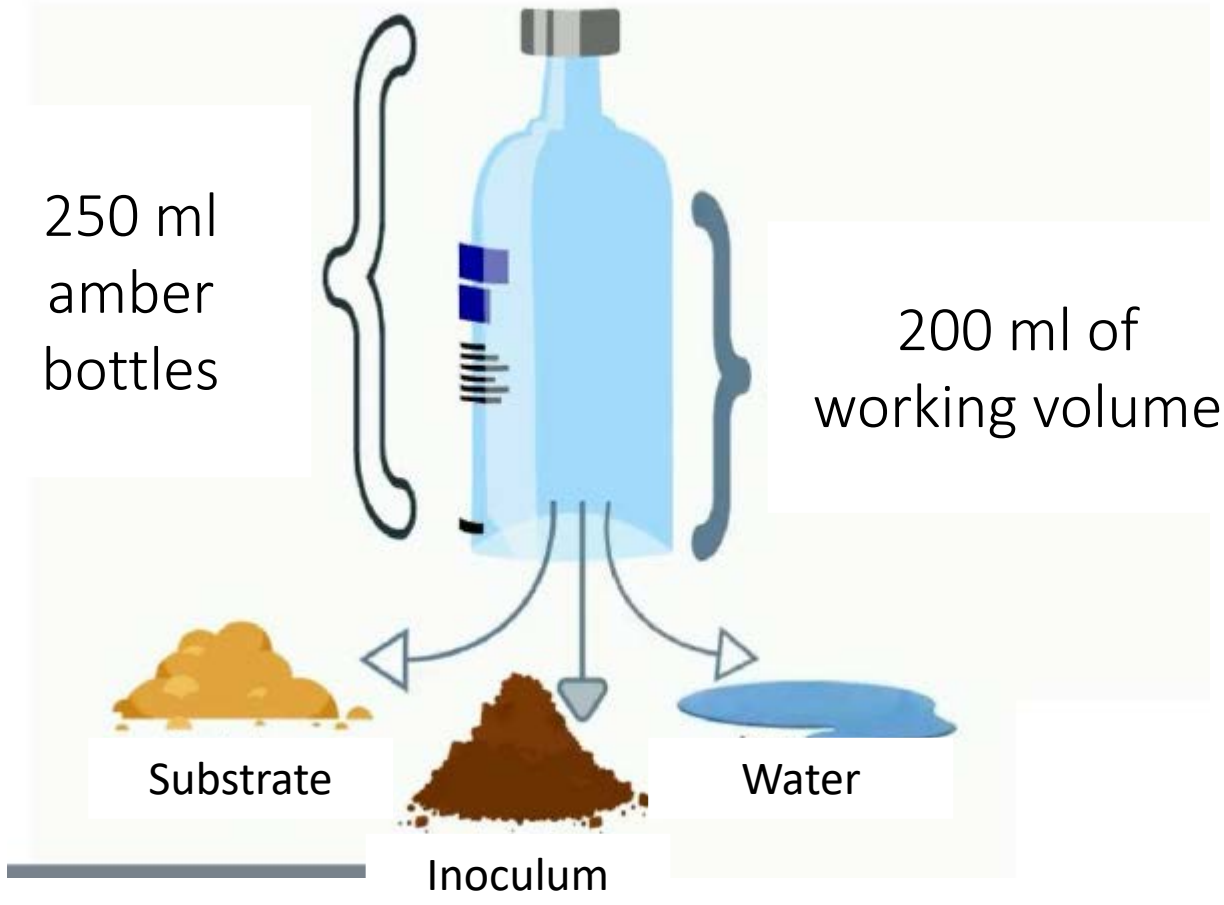
Thermal hydr

atio

No pre-treatment test

The evaluation of the pre-treatments was based on the initial characterization of the substrate; the organic load varied between 10 and 20 grams of volatile solids, and an inoculum to substrate ratio of 3 was used.

Experimental procedure



24 assays

Organic load:

- *10 g VS/L*
- *20 g VS/L*

Three scenarios:

- *2 pre-treatments*
- *1 with no pre-treatment*

Mesophilic conditions (35 ± 1 ◦ C) for 21 consecutive days.

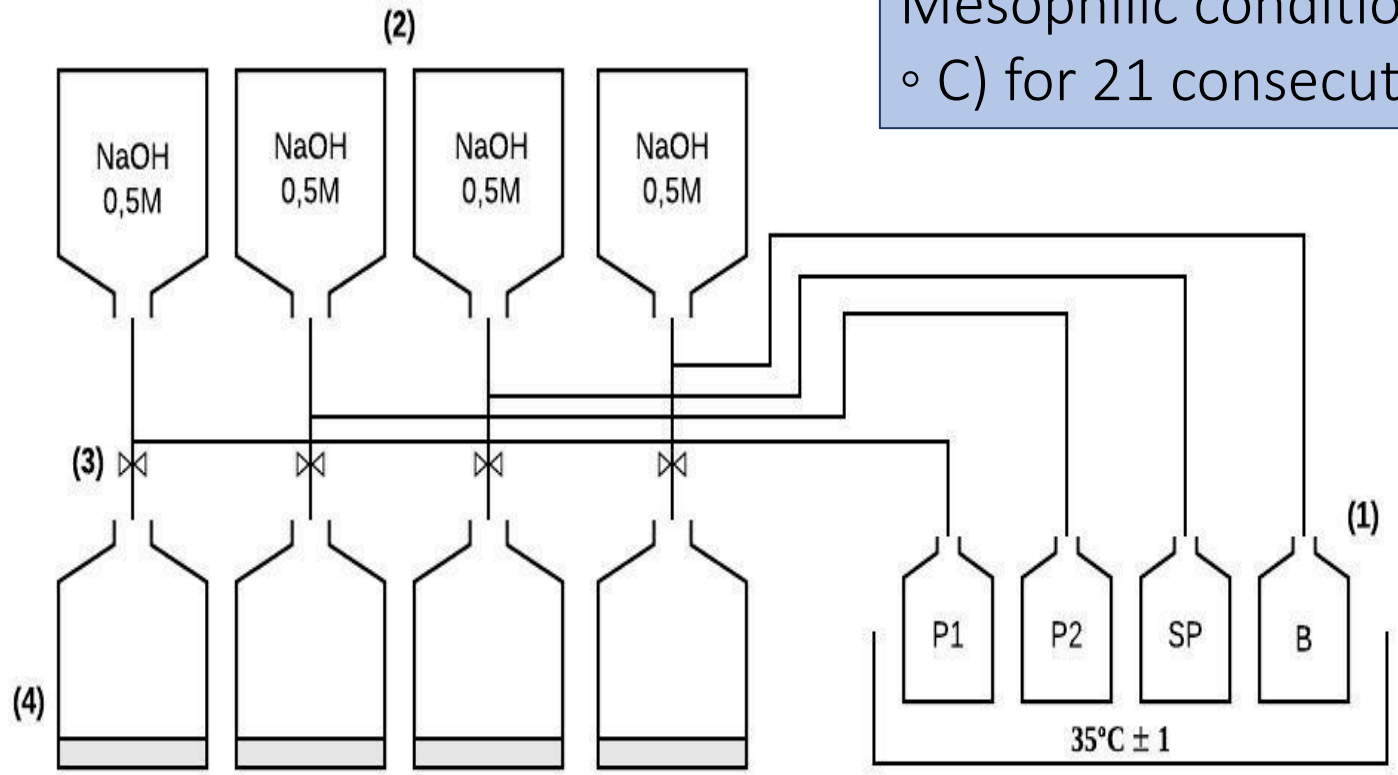


Figure 1. Experimental configuration, for anaerobic assessment; 1. reactors, 2. 0.5M NaOH solution, 3. silicone tubing, 4. compiler bottles.

Analytical methods

The physicochemical characterization of rice straw and digested samples were carried out according to international standards; using as methods: 2540B APHA - SM for total solids (TS), ASTM D3174 for volatile solids (VS), ASTM D1426 for Total Kjeldhal Nitrogen (TKN) and ASTM D1252 for Chemical Oxygen Demand (COD). For TS, 1 g of solid sample was taken for the substrate and 25 ml of liquid sample for the inoculum, which were taken to an oven for 24 hours at 105ºC, dried and weighted. The VS were determined from the TS, where the samples were placed in an oven for 1 hour at 550ºC, dried and weighted. The TKN was found from samples of 1 g of substrate, 5 g of Kjeldahl catalyst and 15 ml of H_2SO_4, which were placed in the "Bloc-Digest" digestion unit, later it was taken to a "Pro-Nitro M" distiller where the extract of the digested sample is deposited in a 4% H_3BO_3 solution with an indicator, then resultant was titrated with HCl to determine the percentage of TKN. COD was measured with commercial vials HI 93752, with range of 0 to 150 mg l^{-1}.

Results and discussion

Substrate characteristics

Table 1. Initial physicochemical characterization of substrate and inoculum.

	Total solids (%)	Volatile solids (%)	Total Kjeldahl nitrogen (%)	C/N ratio
Rice straw[a]	92.35±0.02	72.93±0.03	1.06±0.15	43.21
Inoculum[b]	4.79±0.00	4.31±0.02		

[a] Sample on dry basis.
[b] Sample on wet basis.

High VS/ST ratios are more appropriate for optimal methane production

Biomethane potential

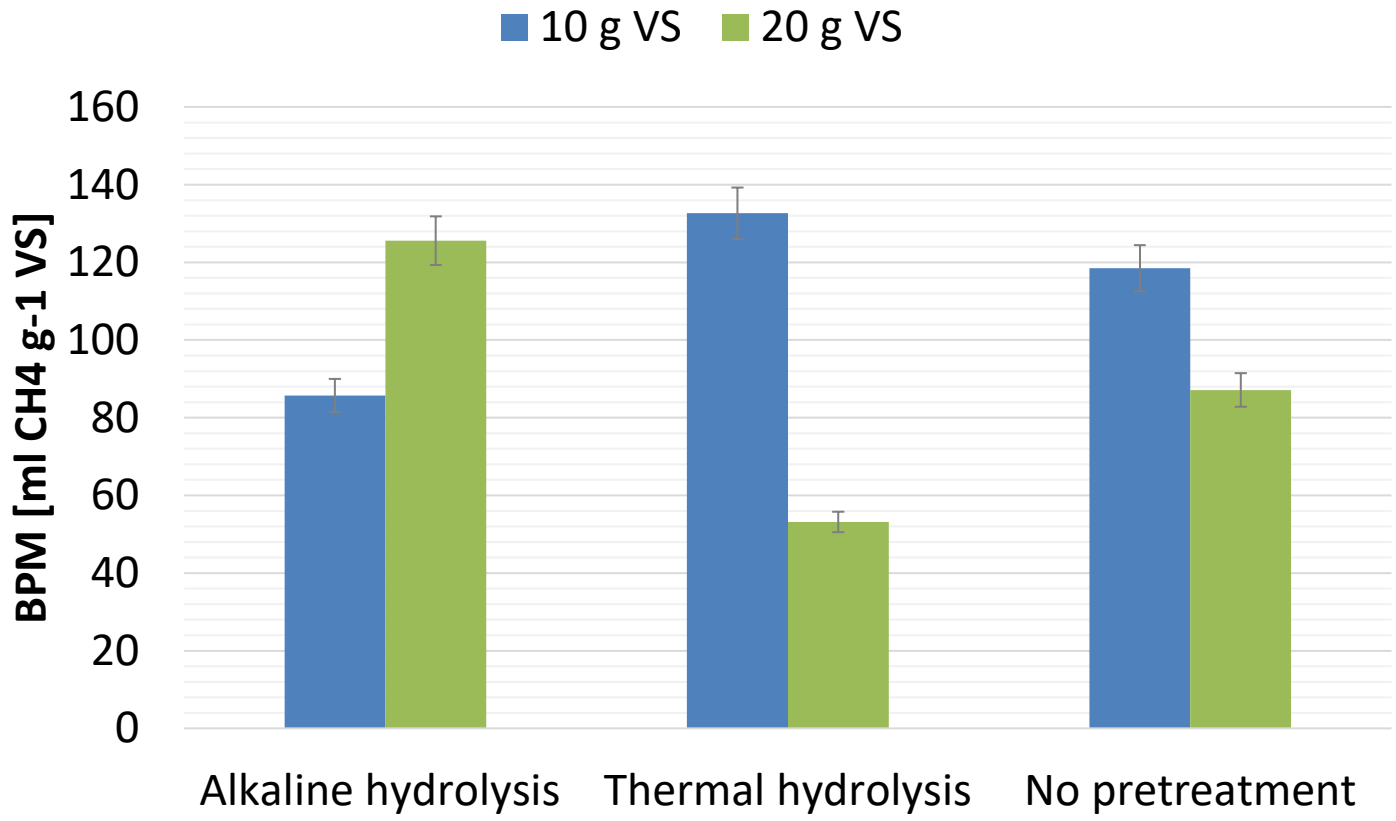
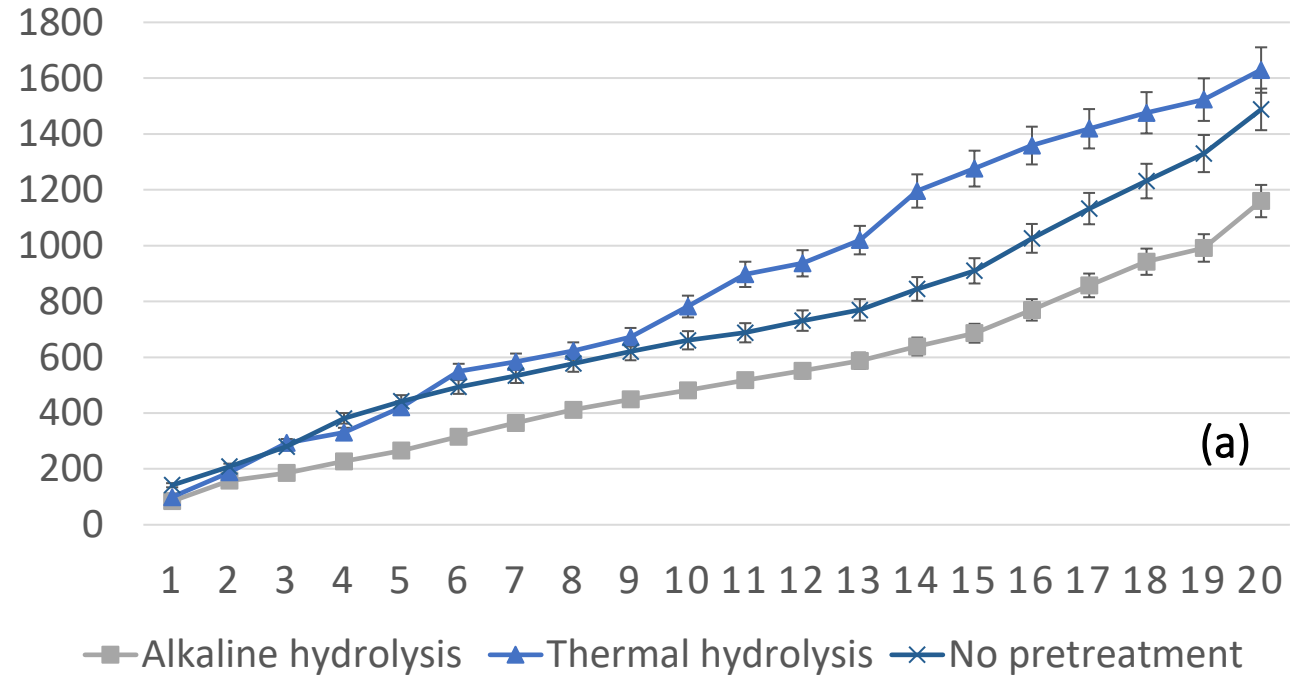


Figure 2. BMP for the raw rice straw, thermal and alkaline hydrolysis pre-treatments.



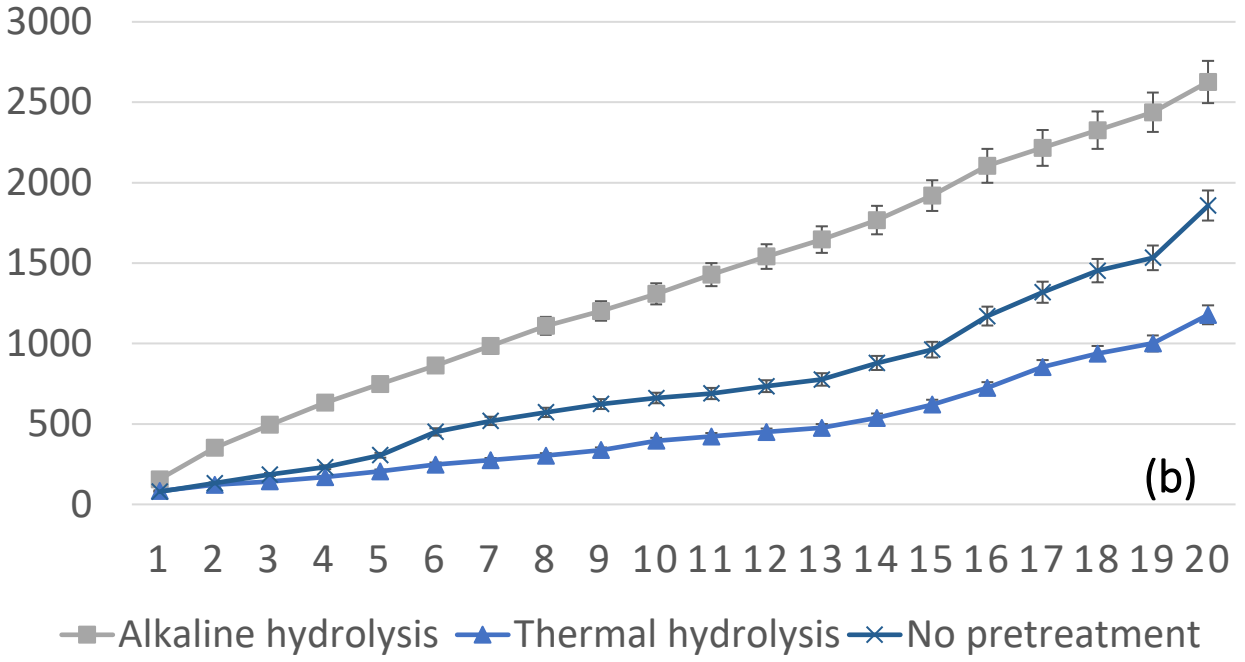


Figure 3. Biogas production performance for a retention time of 21 days; a) 10 g VS and b) 20 g VS.

Characterization of digestate

Table 3. Physicochemical characterization of digestate.

	10 g VS			20 g VS		
	Alkaline hydrolysis	Thermal hydrolysis	No pre-treatment	Alkaline hydrolysis	Thermal hydrolysis	No pre-treatment
TS (g ml^{-1})	1.48	3.83	3.62	1.597	4.834	5.113
VS (g ml^{-1})	0.349	0.684	0.68	0.412	0.887	1.008
COD (g l^{-1})	6.6	5.65	6.35	7	7.1	7.05

Conclusions

The initial evaluated pre-treatments seem to be suitable in the improvement of the biodegradability of rice straw, generating a significant increase in the biogas yields. The thermal hydrolysis treatment with an organic load of 10 g VS increased the biogas production by 11.9%, 39.64 ml CH_4 g^{-1} VS higher than the untreated one, while for alkaline hydrolysis is 11.9 ml CH_4 g^{-1} VS. The results obtained are interesting to assess possible codigestion processes taking as a starting point the yields of the rice straw pretreated. Although, the evaluation of other pre-treatments is needed to recommend a real-scale process.

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