Sustainable production of Cellulose-based products and additives to be used in SMEs and rural areas
Funded from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101007733.

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CELISE Mid-Term Meeting Symposium

Experimental assays and simulation of a second-generation ethanol facility based on brewery spent grains

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University of Cantabria - UC

25th July, 2023

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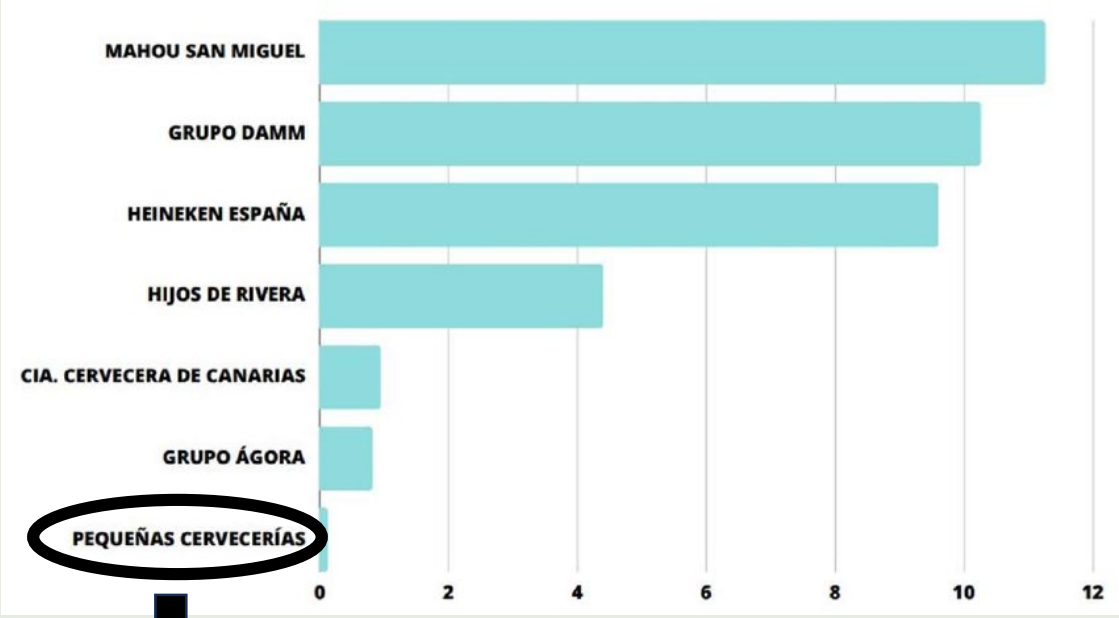
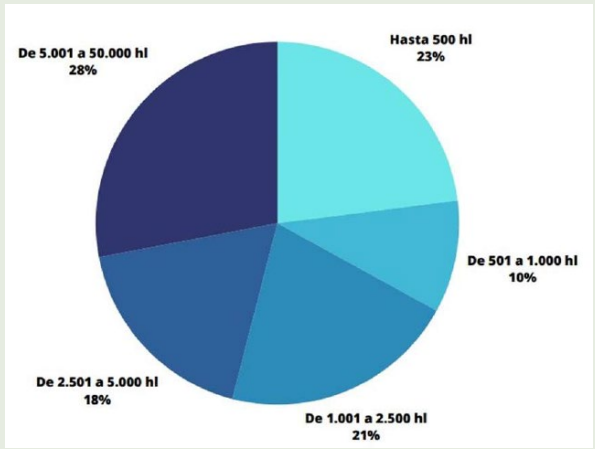
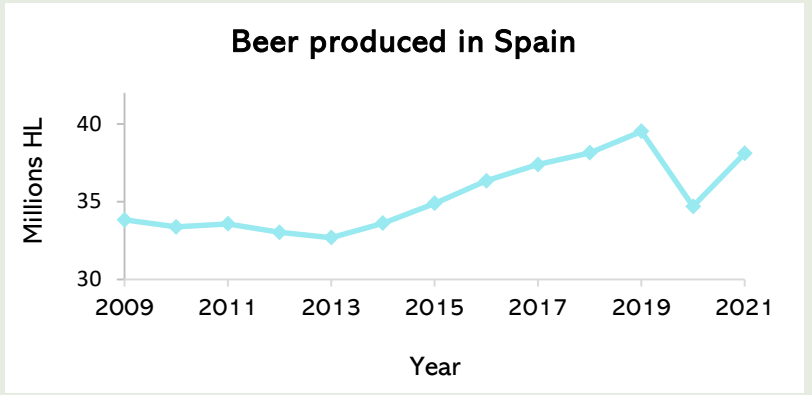
Introduction





- In 2021 $38.1 \cdot 10^6$ HL were produced in Spain. In general beer production has been increasing year by year in both large/small scale level



- Artisan beer of small factories producing lower than 50,000 HL only represents 0.34 % of the total Spanish production
- Heterogeneity among artisan beer manufacturers and plant capacities is so big

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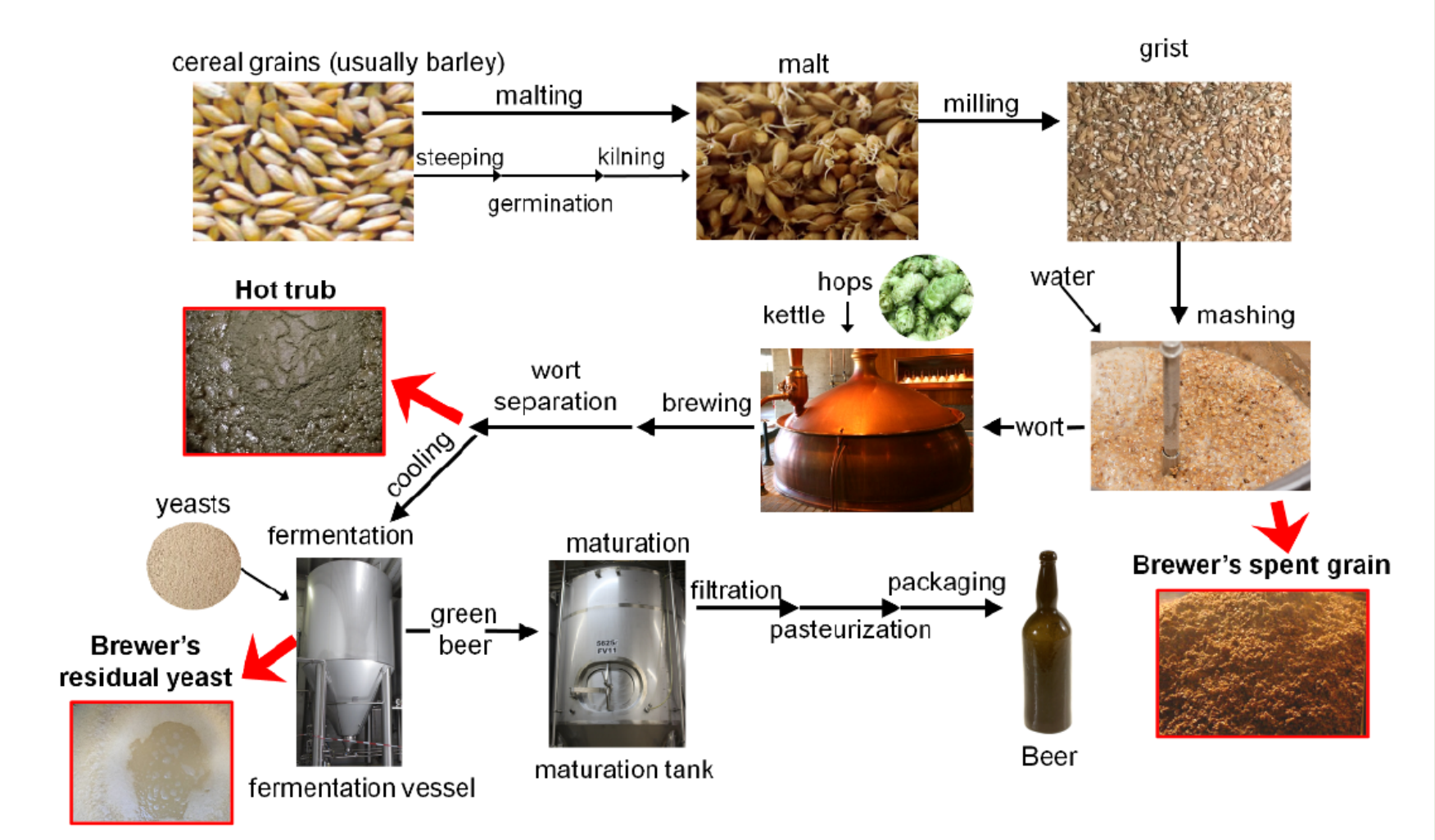
Introduction



Source: Rachwal et al. (2020) *Utilization of brewery waste in food industry.*

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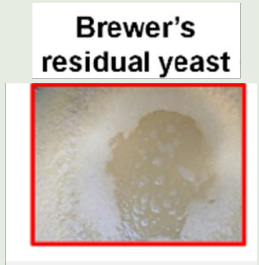
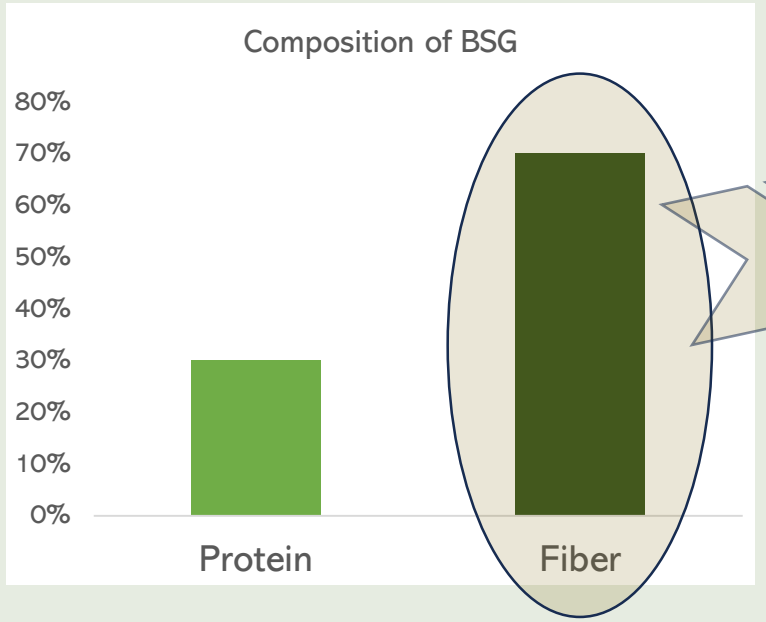
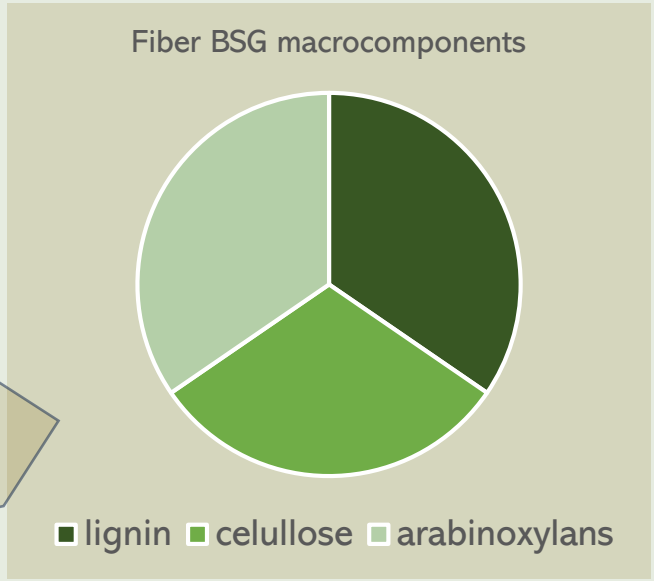
Introduction

Among the solid residues generated in a brewery **the BSG** is the main solid residue **representing 85 % w/w** of the total wastes







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Objective

- Valorization of BSG fermentable sugars within a biorefinery concept

(i) Characterization and pretreatment experimental assays
(ii) Kinetic study of diluted acid hydrolysis
(ii) Simulation of a second-generation ethanol facility based on BSG

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Methodology

BSG collection from a local company

BSG washing, drying, and milling

BSG characterization

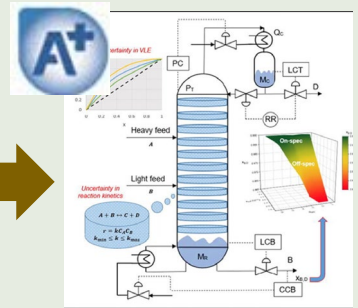
20 µL 5mM H2SO4 mobile phase 0.5 mL/min SHODEX SH1011 column

11.3 ±2.43 % lignin
20.9 ± 2.43 % cellulose
51.4 ± 8.22 % holocellulose

BSG diluted-acid hydrolysis

3 % v/v H_2SO_4, 1 bar
3 different temperatures (20 °C, 70 °C 120 °C) from 1 min to 60 min

2G ethanol plant simulation



Aspen Plus v11simulation tool

$$\text{Polymers (POL)} \xrightarrow{1} \text{Final products (FP)}$$

$$(-R_{POL}) = r_1$$

$$r_i = -k_i \cdot C_j^n \qquad k_i = k_{0i} \cdot e^{-\frac{Ea_i}{RT}}$$

$$\ln\left[C_j(t)\right] = \ln\left[C_{j,0}\right] - k_i\left(t_i - t_0\right)$$

Llano et al. (2017). *Sugar, acid and furfural quantification in a sulphite pulp mill: feedstock, product and hydrolysate analysis by HPLC/RID*. DOI: 10.1016/j.btre.2017.06.006

Llano et al. (2015). *Evolution of lignocellulosic macrocomponents in the wastewater streams of a sulphite pulp mill: A preliminary biorefining approach.* DOI: 10.1155/2015/102534

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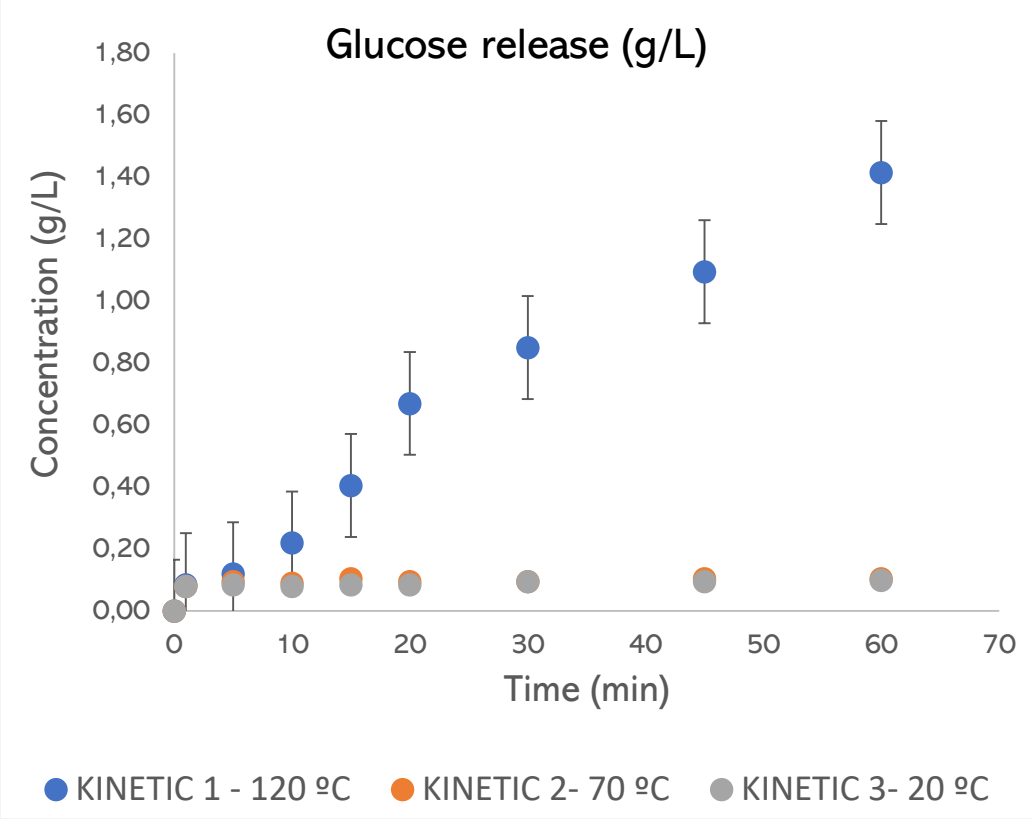
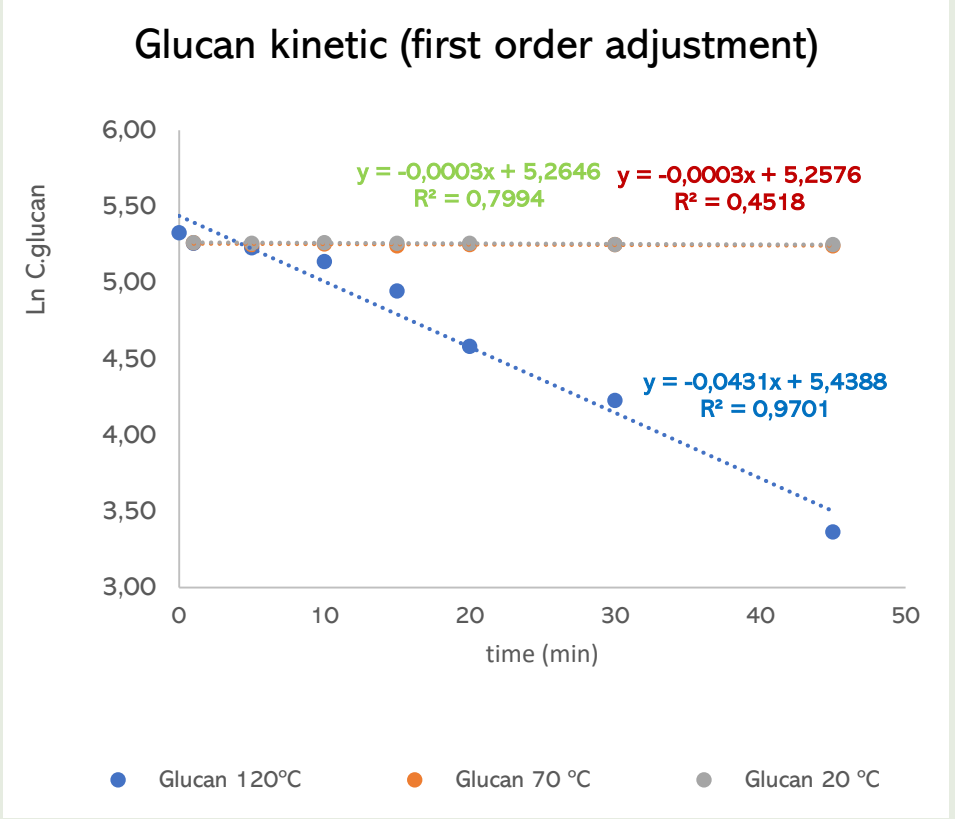
Results





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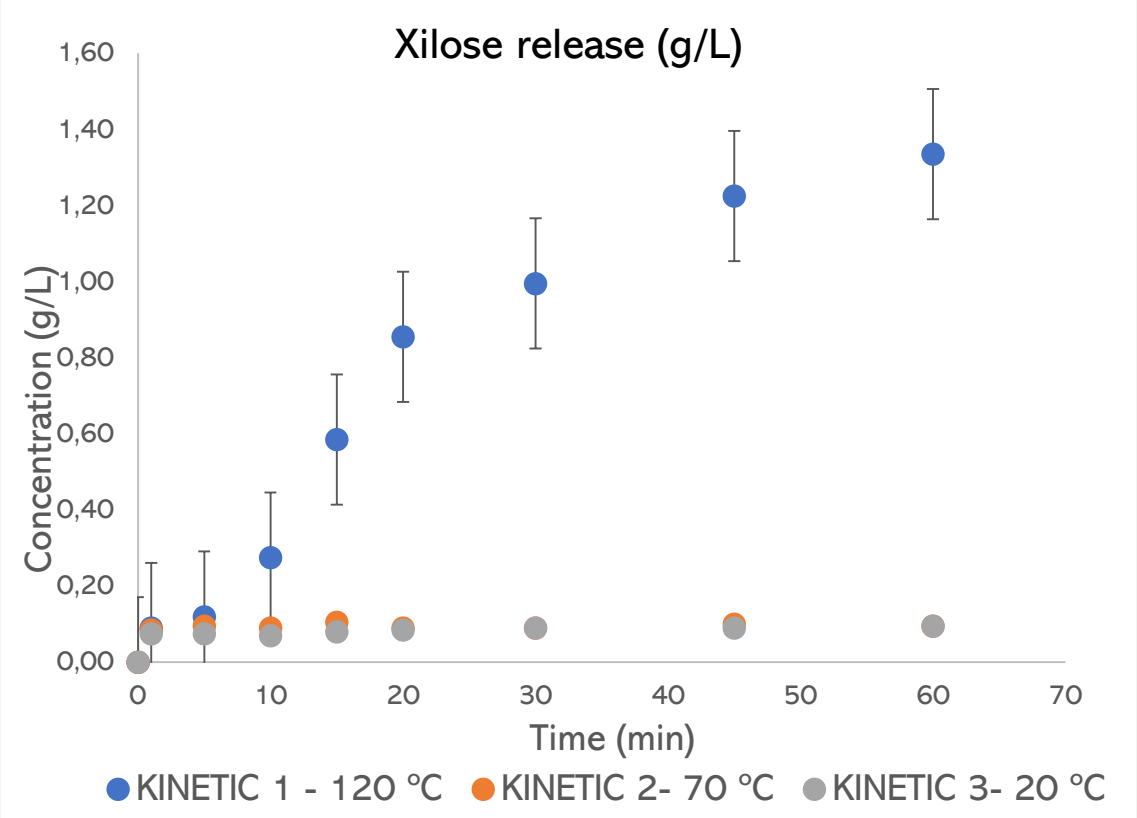
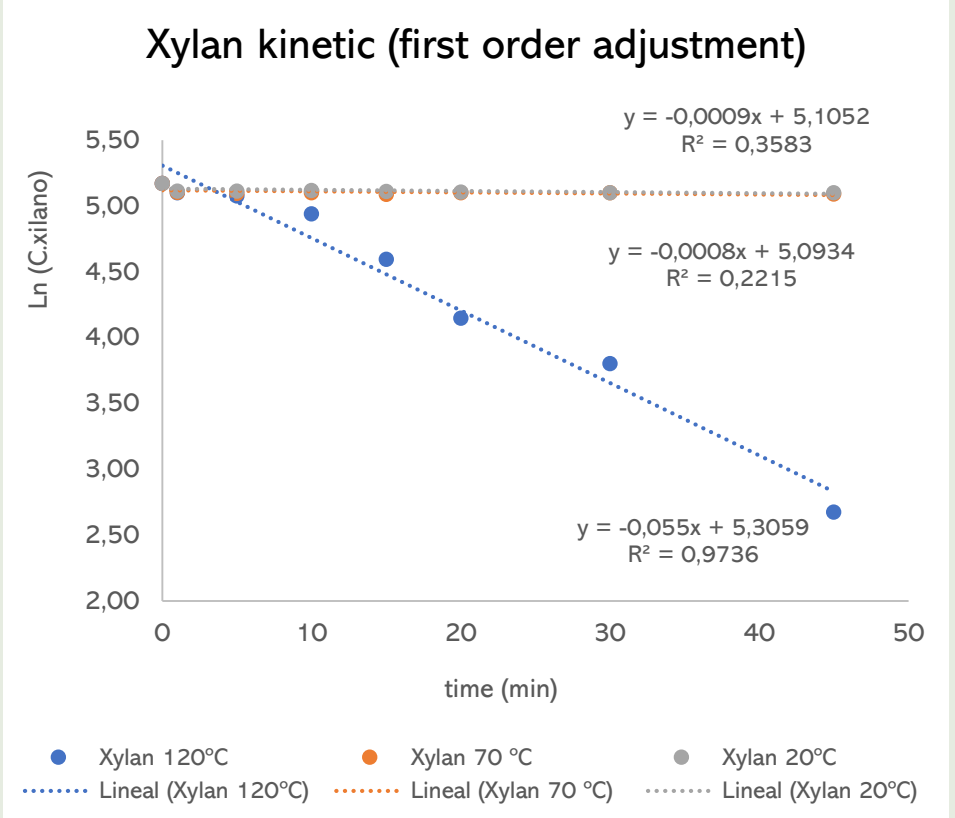
Results





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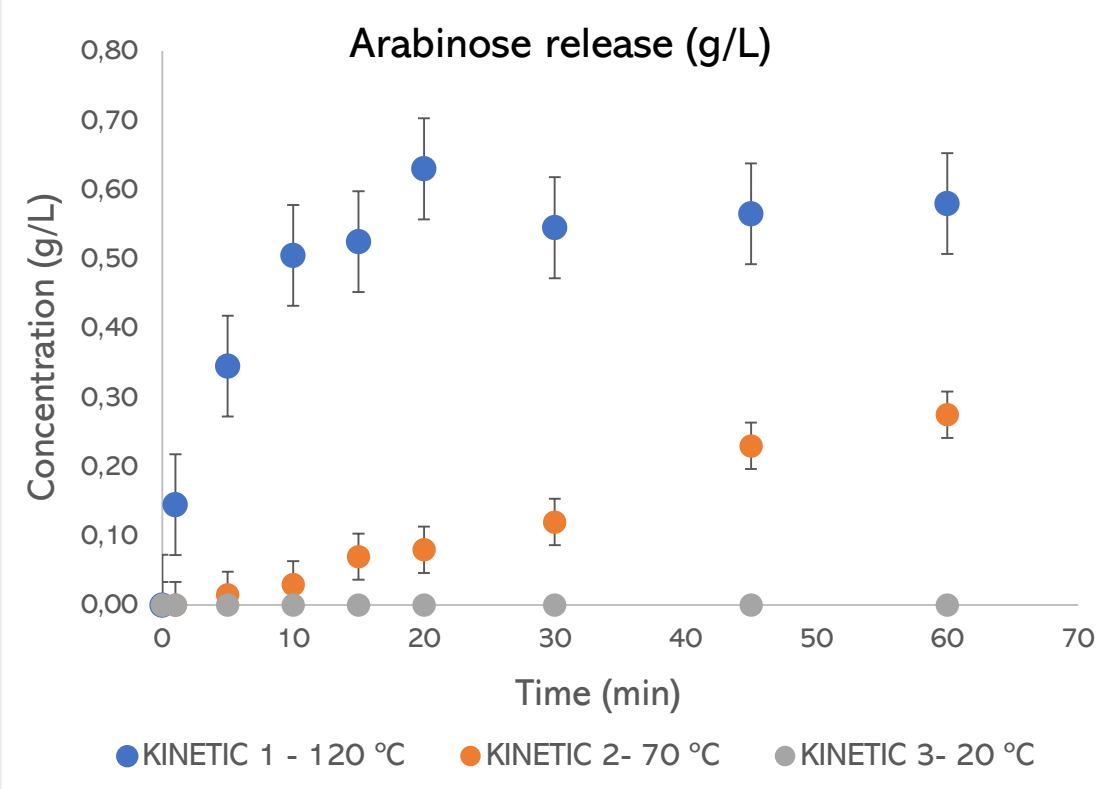
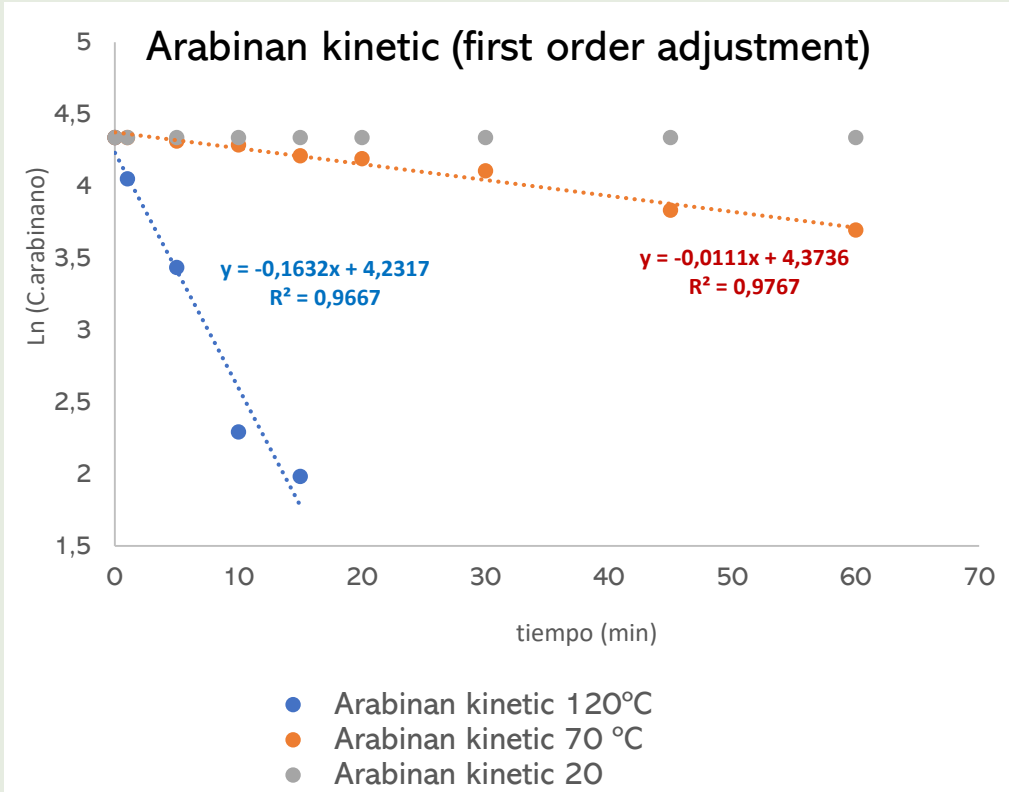
Results





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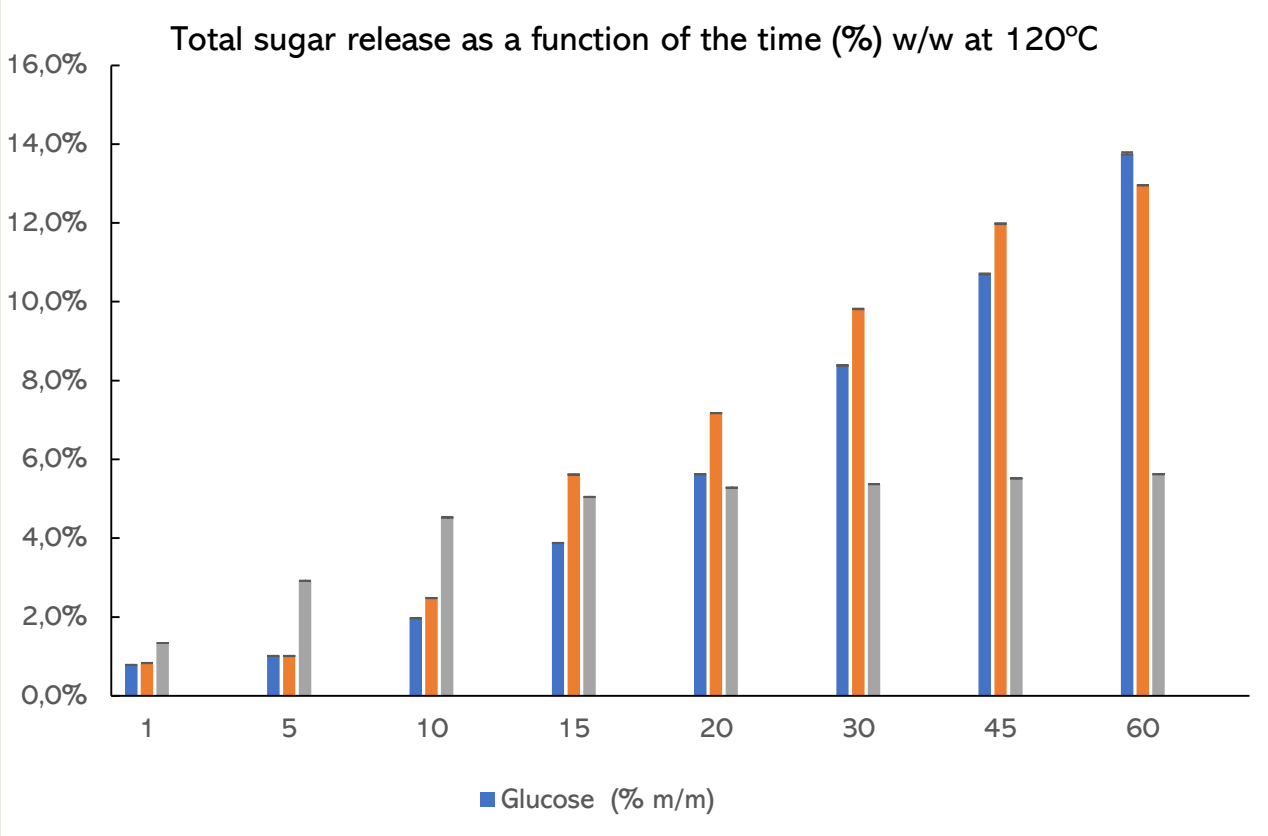

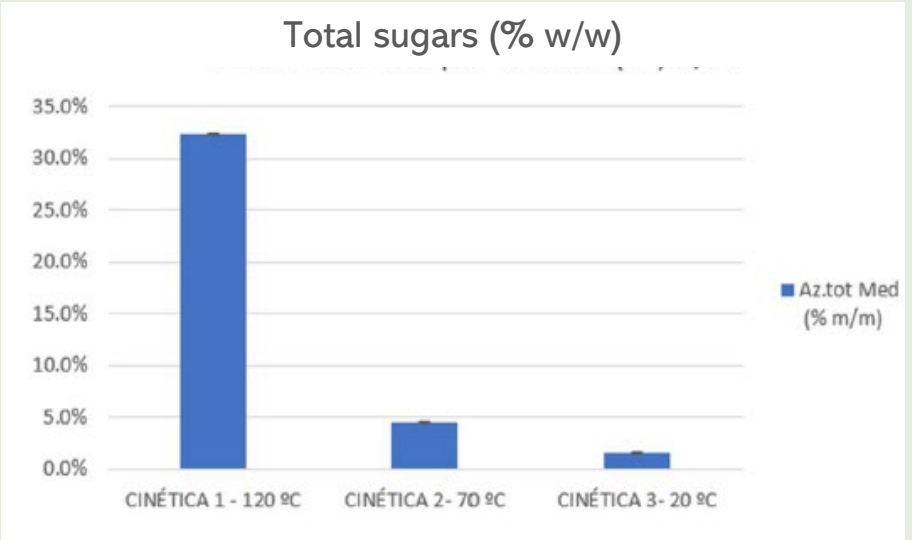

	T1 (ºC)	T2 (ºC)	ki,1 (mol·L^{-1}·min^{-1})	ki,2 (mol·L^{-1}·min^{-1})	ln (k1/k2)	(1/T1-1/T2)	Ea (cal/mol)	Ea (J/mol)
glucan	120	20	0,0431	0,0003	4,967	-0,042	236,9	991,2
xylan	120	20	0,055	0,0009	4,113	-0,042	196,1	820,6
arabinan	120	70	0,1632	0,0111	2,688	-0,006		

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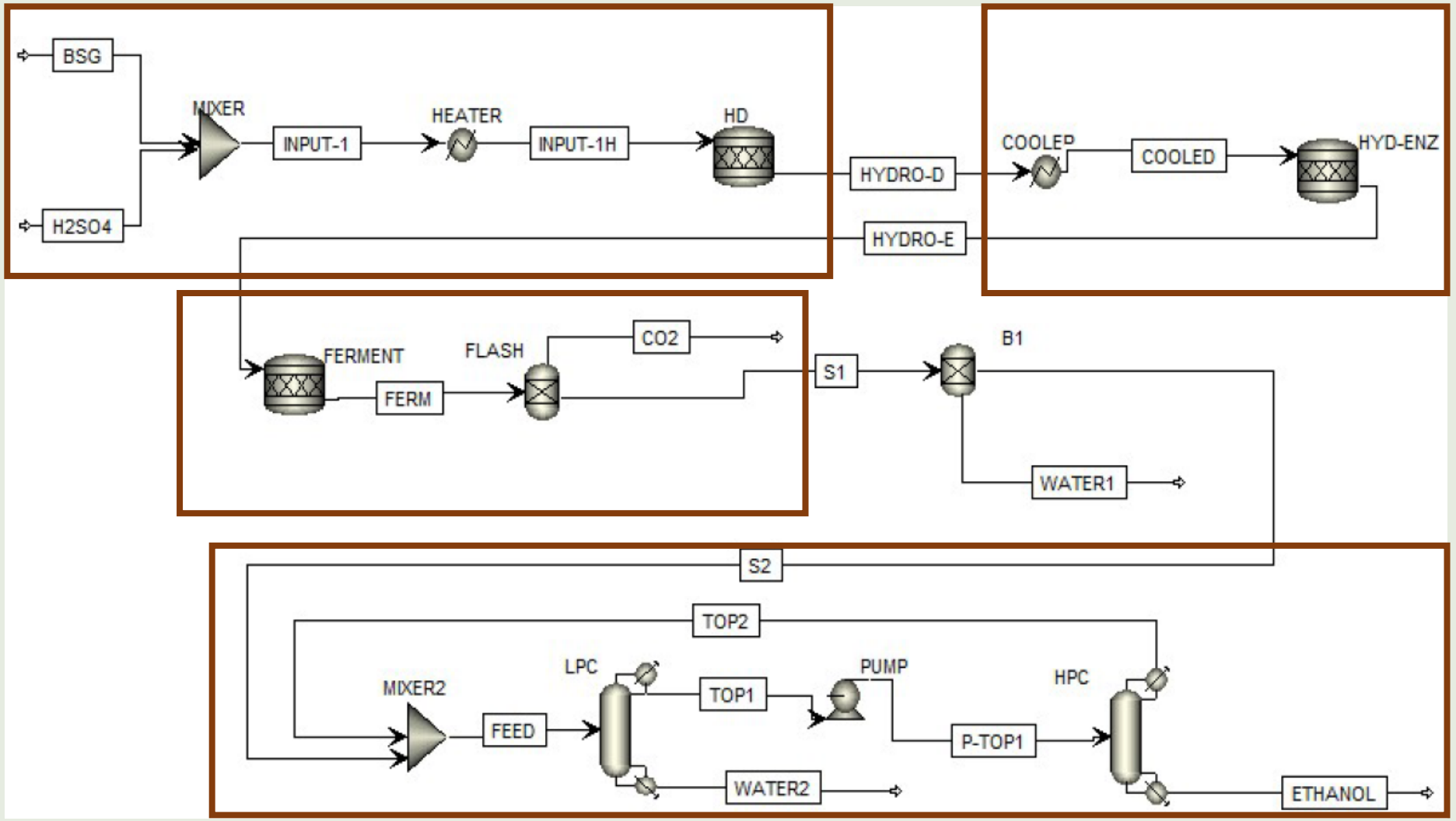
Results



200 kg BSG/day

0.20 kg EtOH/ Kg.BSG

98.9 % total sugars conversion

97.2 % molar purity (useful for being used as fuel)

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Conclusions

- Diluted acid hydrolysis using 3 % v/v H2SO4 at 120 °C and 60 min provided the highest sugar release reaching values of 13.8 % w/w of glucose, 13.0 % w/w of xylose, and 5.6 % w/w of arabinose
- From the processing of the experimental data, it is showed that the kinetics is of order 1 fits well in most of the cases.
- A second-generation ethanol plant of small capacity (200 kg/day) resulting in a production of 0.2 kg EtOH/kg BSG

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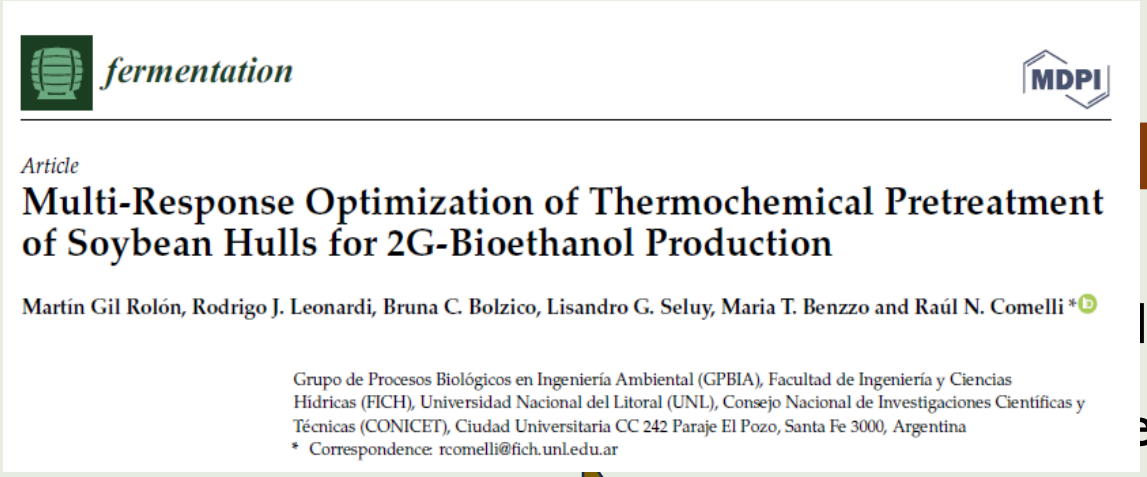
Future work

As a result of the UC secondments at the FICH-UNL



fermentation MDPI

Article

Multi-Response Optimization of Thermochemical Pretreatment of Soybean Hulls for 2G-Bioethanol Production

Martín Gil Rolón, Rodrigo J. Leonardi, Bruna C. Bolzico, Lisandro G. Seluy, Maria T. Benzzo and Raúl N. Comelli *

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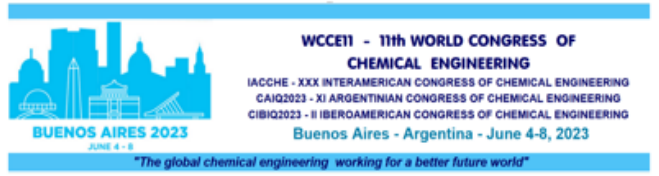
GPBIA Grupo de Procesos Biológicos en Ingeniería Ambiental — UNL UNIVERSIDAD NACIONAL DEL LITORAL

l GPBIA research groups

ess of Chemical Engineering (WCCE-11)

- The transfer of k wledge per
  enzymatic saccharifica fer
- Such transfer of knowledg will a
  ethanol process previously assay
  plant capacity from artisan to indu
- To apply multi-criteria analysis to



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CAIQ2023 - XI ARGENTINIAN CONGRESS OF CHEMICAL ENGINEERING
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BUENOS AIRES 2023 JUNE 4 - 8
Buenos Aires - Argentina - June 4-8, 2023
"The global chemical engineering working for a better future world"

"Comparison of different thermochemical processes for glucose release from soybean hulls".

Raul N. Comelli [1], Rodrigo J. Leonardi [1], Andres Gentile [1], Martin Gil Rolón [1], Tamara Llano Astuy [2], Alberto Coz Hernández [2]

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