Fuel suitability of fast pyrolysis bio-oils from citric acid–leached sugarcane residues

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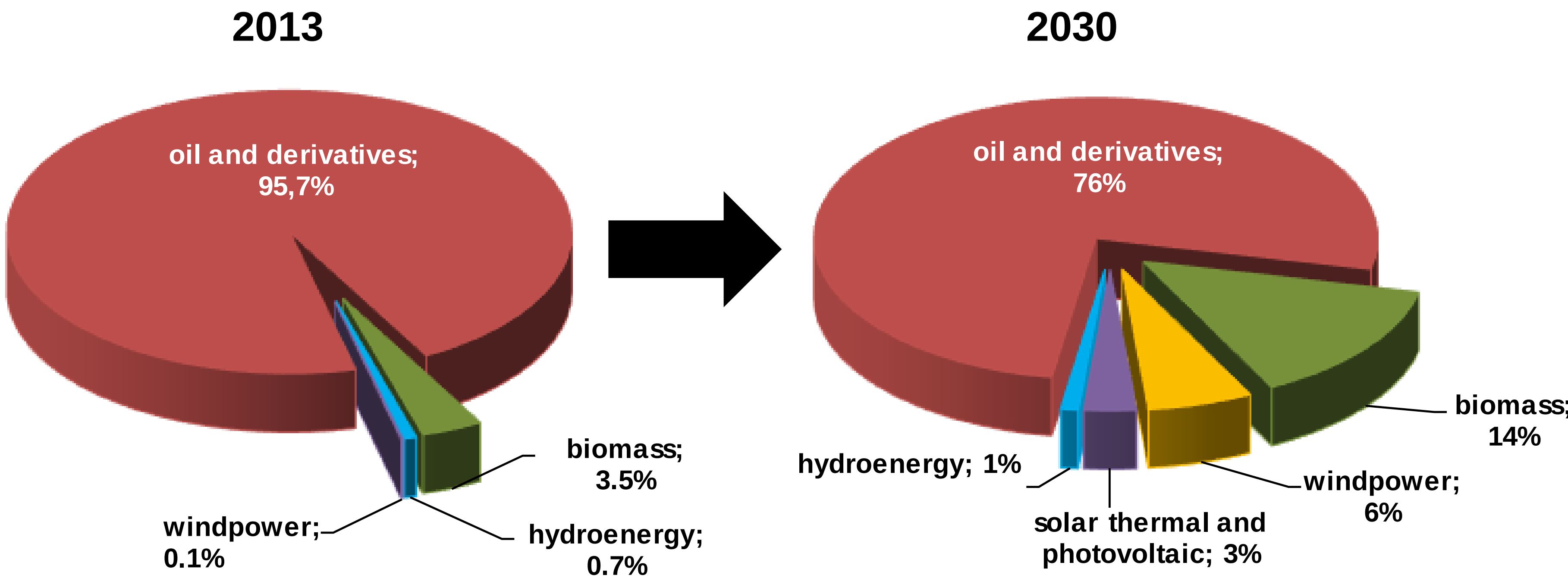
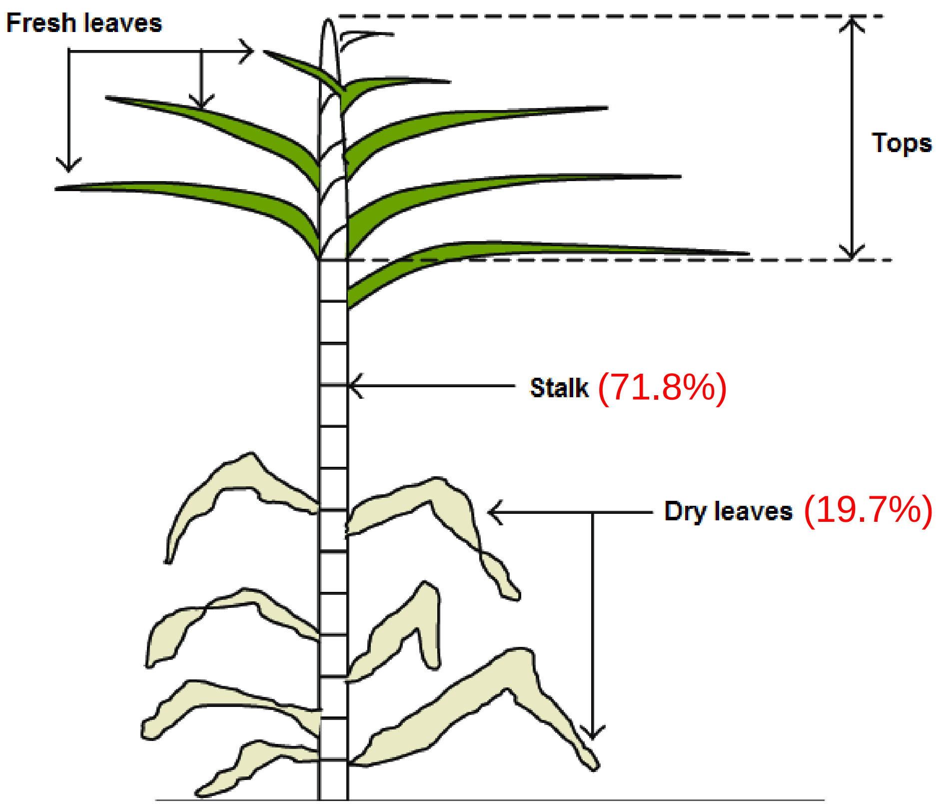
Distribution of energy supply by sources: projected growth in Cuba



- ↑ % imported oil
- Biomass: thermal power - 872 MW
- Biomass source: sugarcane bagasse

Adapted from: **National Office of Statistics (Cuba) (2020) and National Electrical Union of Cuba (2015)**

Sugarcane (*Saccharum officinarum*)



Adapted from: **León-Martínez, T. S., *et al.* (2013)**

Lignocellulosic residues from sugarcane

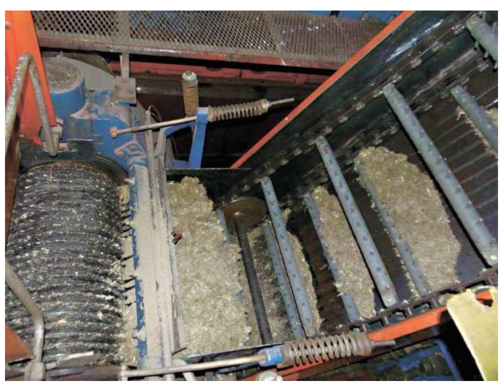
Leaves and cane tops

Mechanical harvesting (80%)

Manual harvesting (20%)

Sugarcane trash (SCT)

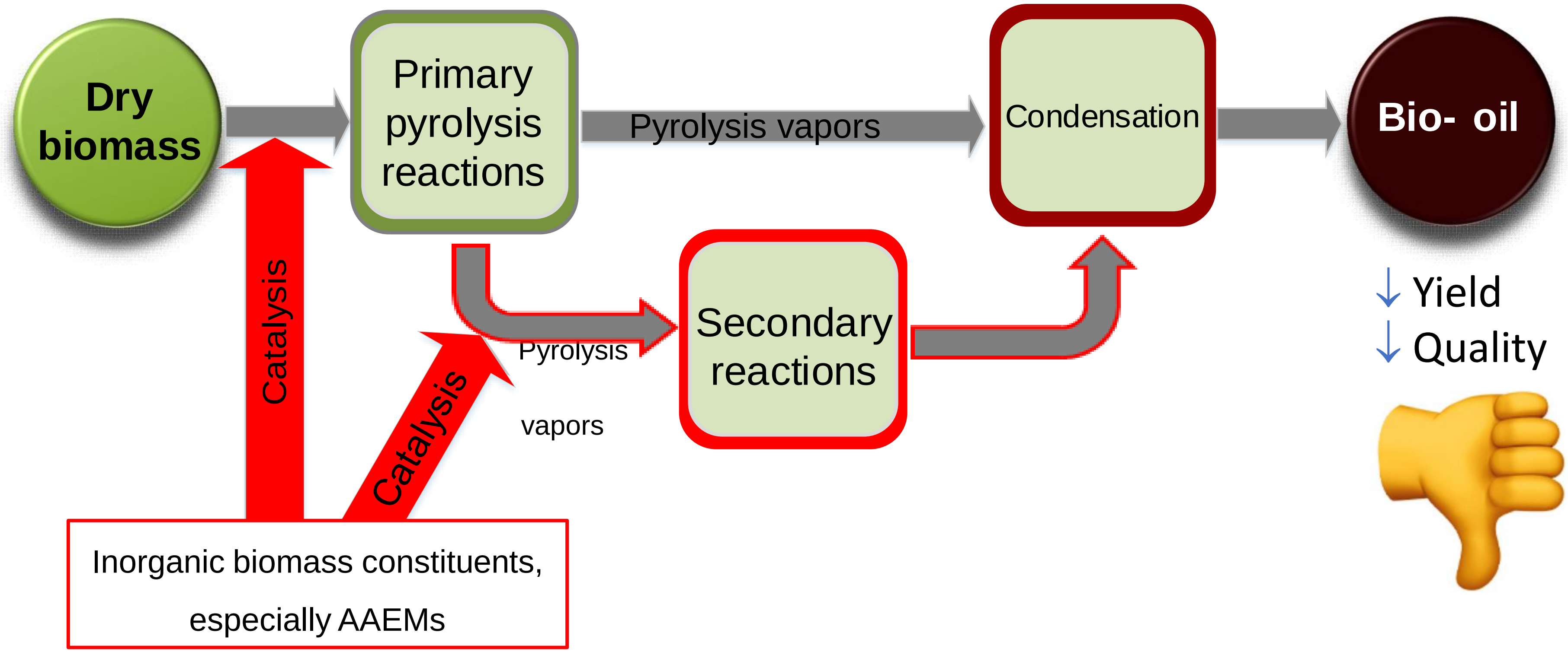
Plant stalk



Extraction of the juice

Sugarcane bagasse (SCB)

Influence of inorganic biomass constituents on pyrolysis results



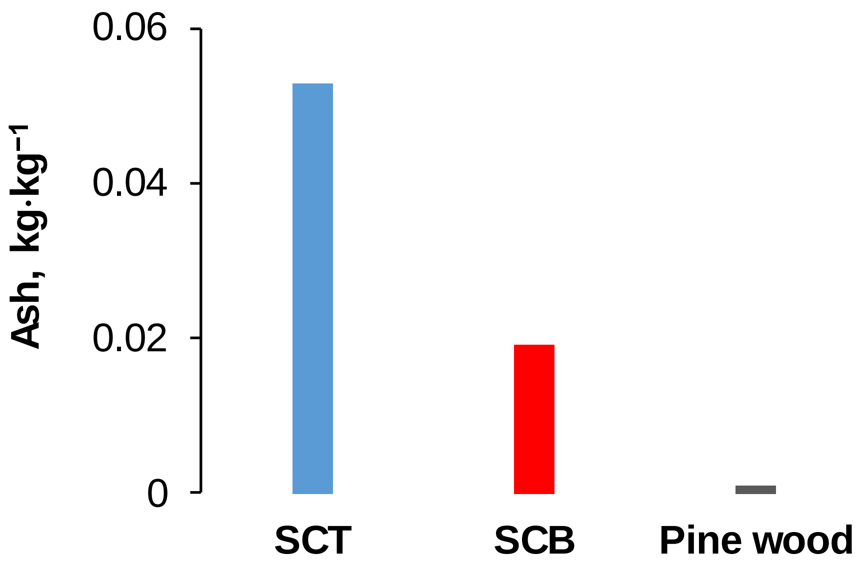
AAEMs: alkali and alkaline earth metals

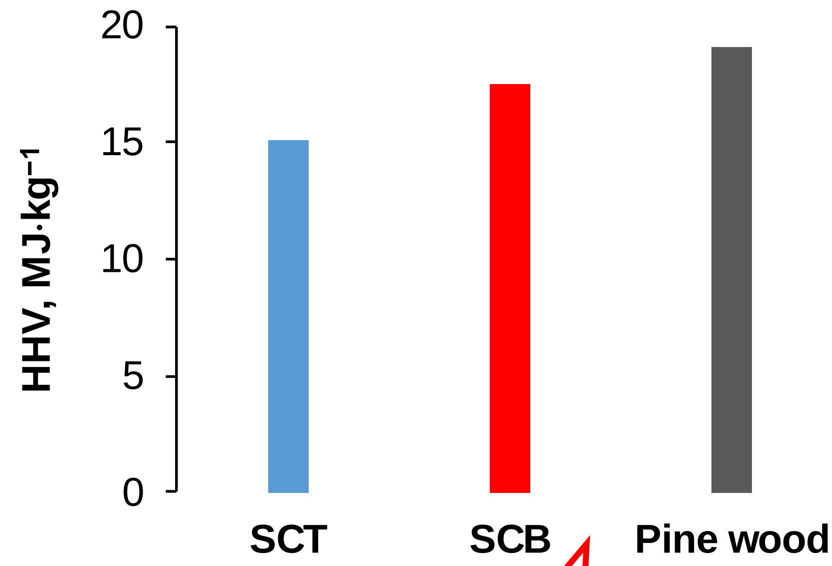
Adapted from: Eom et al. **(2012)**

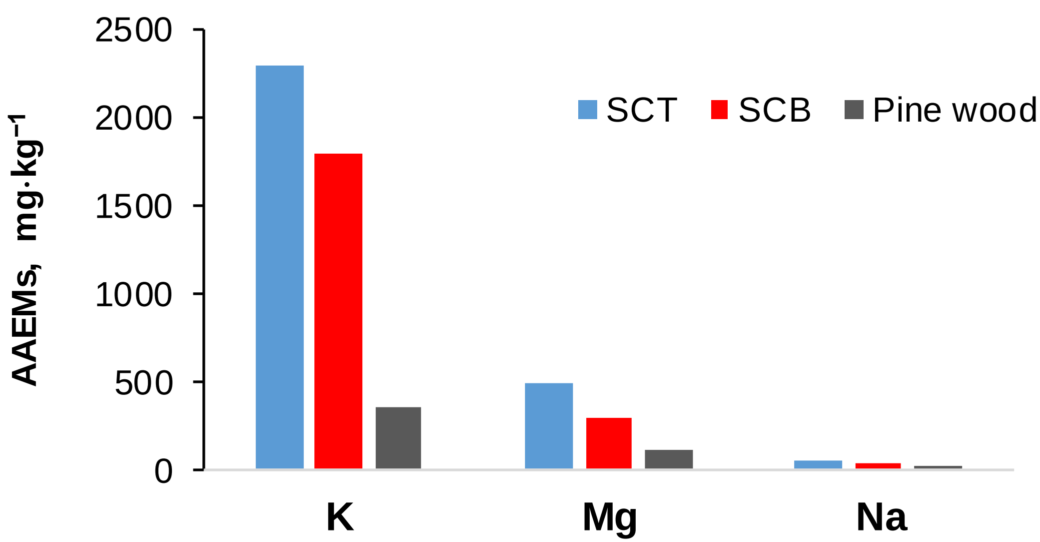
General objective

Suitability of bio-oil from citric acid (CA)-pretreated sugarcane residues as a fuel is assessed. This also includes assessing the stability of the bio-oil upon ageing.

Compositional analysis of raw materials







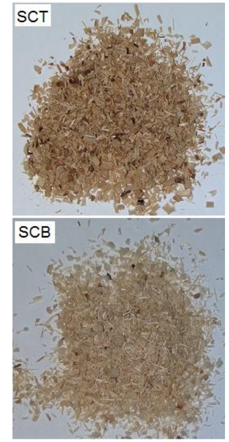
SCT
low quality
biomass

Experimental strategy

SCB/SCT

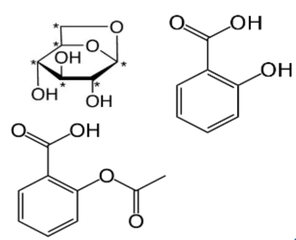
Pretreatment Leaching

Citric acid (CA)



Py-reactor µg-scale

GC/MS



Products analysis

Scaling up experiments

Bench-scale pyrolysis
kg-scale

Lab-scale pyrolysis
g-scale

Analytical Py-GC/MS
µg-Scale

Effect of leaching on organic product distribution

Analytical Py-GC/MS
µg-Scale

↓

Lab-scale pyrolysis
g-scale

↓

CA–leached SCT and SCB yield organics close to those from strong acids

Levoglucosan major constituent in organics

↓

Bench-scale pyrolysis
kg-scale

Pretreatment conditions for 10 dm^3 scale

Leaching setup 10 dm^3 scale

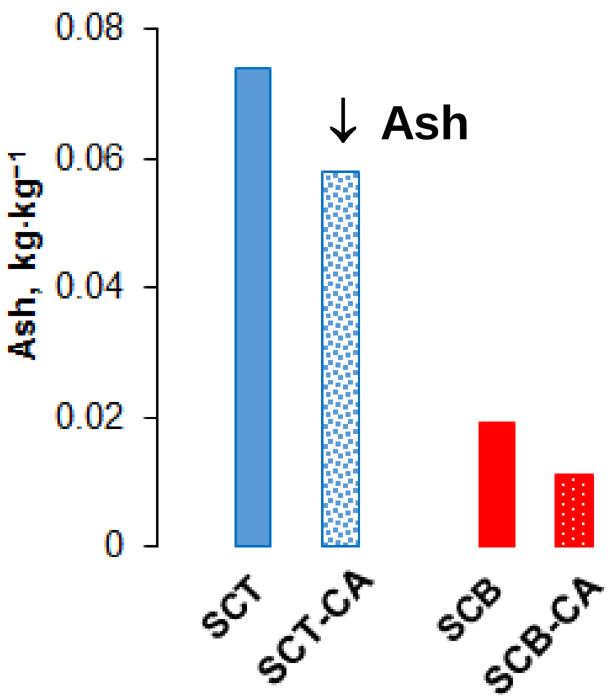
Leaching time: 1 h

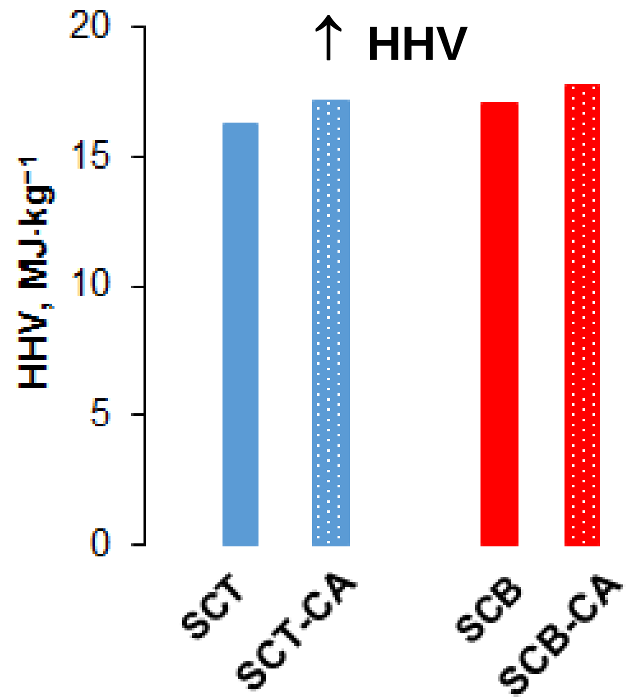
Leaching temperature: 25 °C

Stirrer speed: 350 and 470 min^{-1} for SCB and SCT

Leaching solution: citric acid in an aqueous concentration of 0.096 kg·dm^{-3}

Compositional analysis of CA-leached SCB and SCT



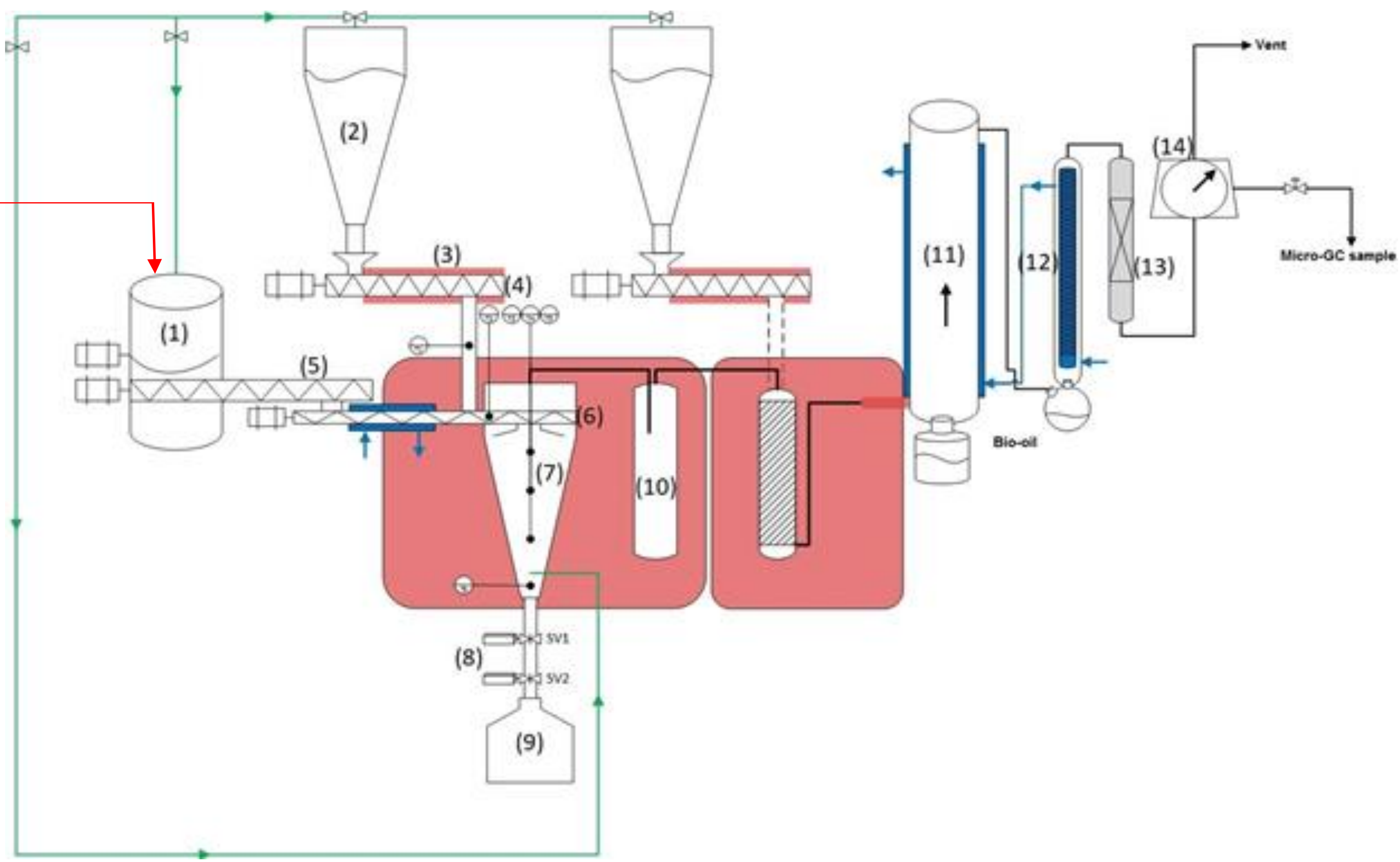


Small differences can be found between biomasses leached with CA obtained on a 10 dm^3 scale with those processed on a 0.25 dm^3

Scheme of the Bench-scale pyrolysis system

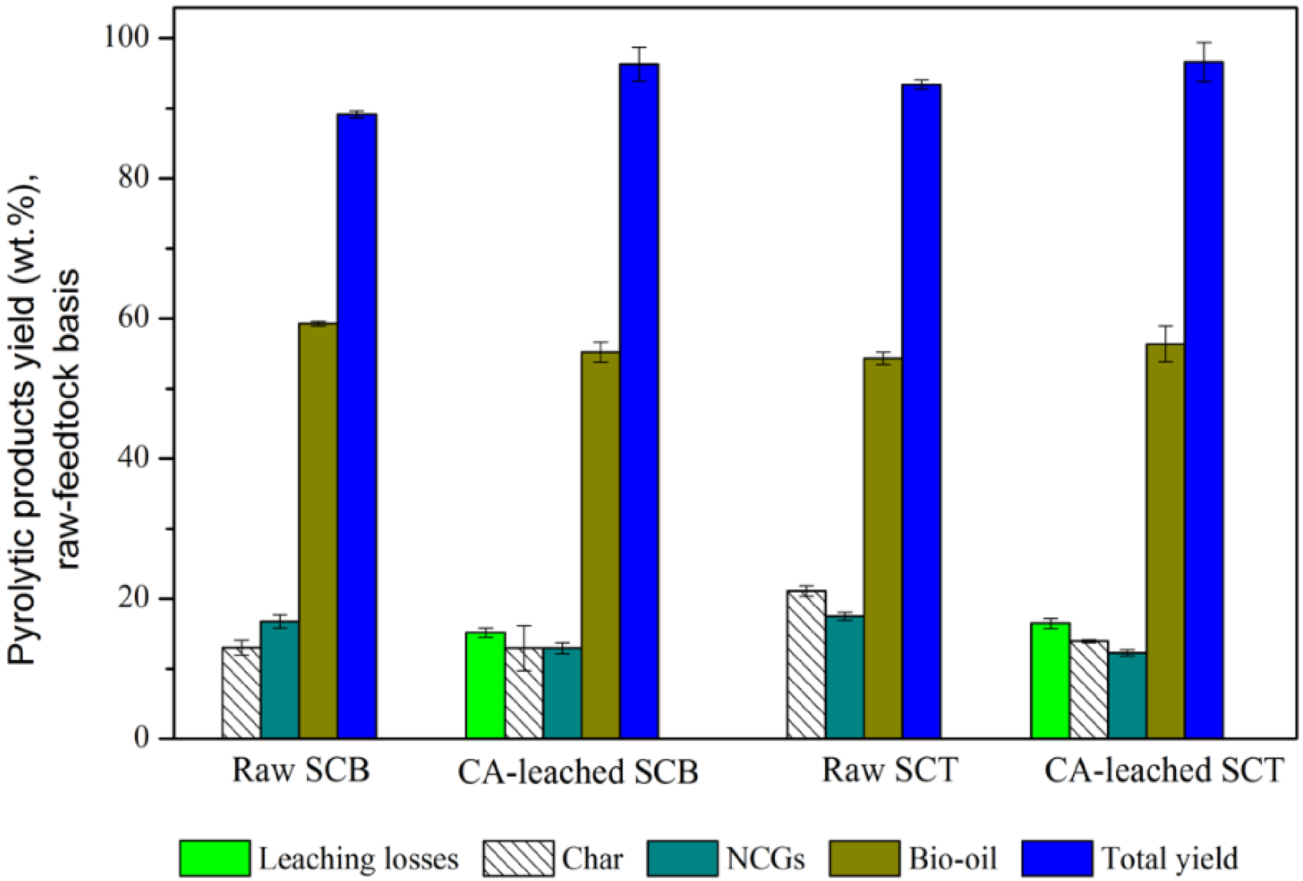
Raw or CA-leached

SCT or SCB



YILDIZ, G. **2015**. Catalytic fast pyrolysis of biomass (Doctoral dissertation). Ghent University, Ghent, Belgium, 214 p.

Average yields of pyrolysis products*



* raw and pretreated (25 °C and 1 h) sugarcane materials pyrolyzed at 500 °C

Physical and chemical properties of bio-oil from pyrolysis (500 °C)

Characteristics	SCT			SCB	
	Raw		CA–leached	Raw	CA–leached
	AP	OP			
Water content (wt %)	59.1	17.8	26.8	34.9	33.5
Solids content (wt %)	0.02	2.0	1.9	0.9	0.9
pH	3.3		2.9	2.5	2.4
HHV ($MJ \cdot kg^{-1}$)	8.6	18.2	12.8	12.0	13.2
Viscosity	ND	High	Medium	Low	Medium
Stability	ND	ND	Low	High	Low

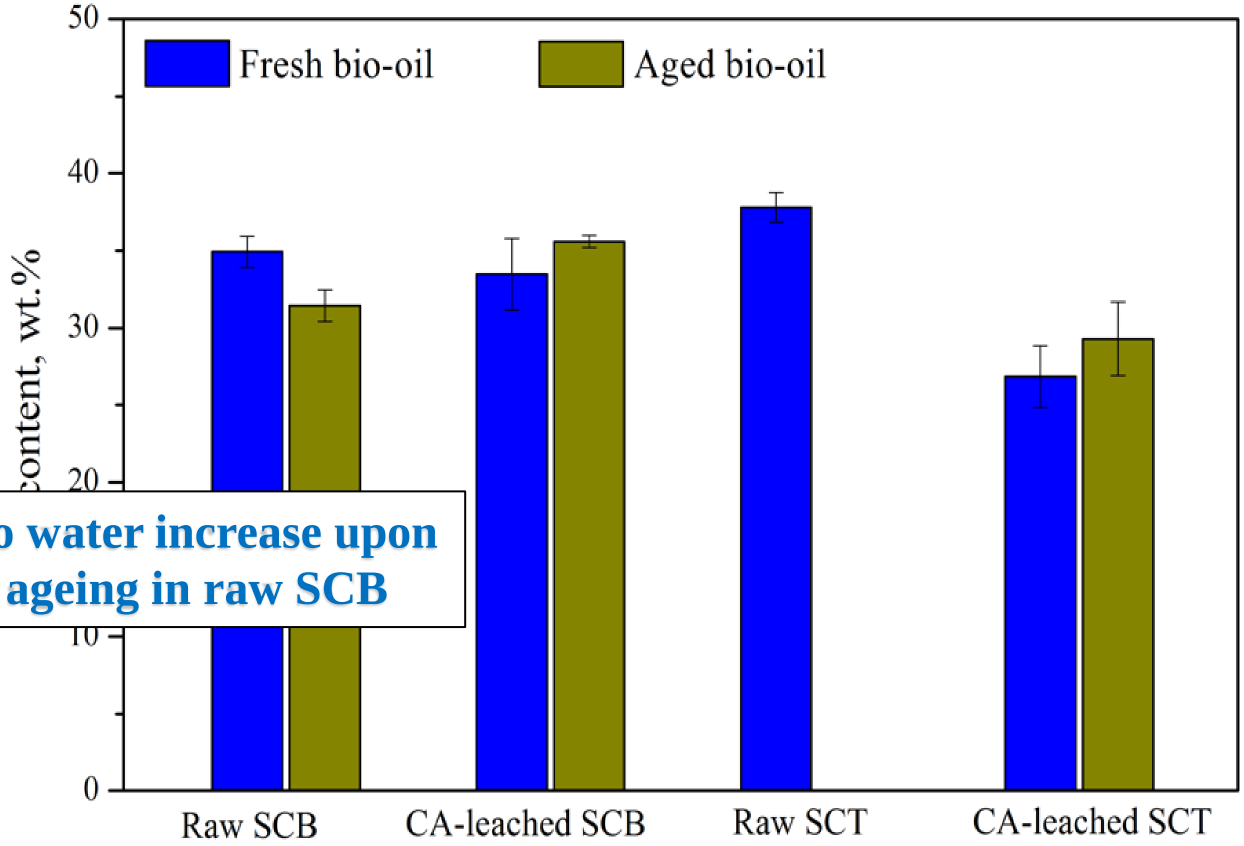
ND: not determined

Phase separation

AP: aqueous phase

OP: organic phase

Water content of fresh and aged bio-oil*



No water increase upon ageing in raw SCB

* fast pyrolysis (500 °C)

Effect of citric acid leaching on bio-oil production

Findings!!!

- Considering the organic yield, CA demonstrated to perform similarly to mineral acids.

- Bio-oil from **raw** sugarcane trash has low quality as a fuel and as a building block.

General conclusions

- Citric acid can be used for biomass pretreatment prior to pyrolysis.
- Sugarcane trash can be considered as a valuable feedstock for fast pyrolysis.
- The significant increase in levoglucosan in the bio-oils could open up new opportunities for the production of marketable products.
- Bio-oils obtained from raw sugarcane residues has low potential to be used as fuel or chemical platform.

TCCB

Perspectives

- Implementation of alternative harvester designs to collect more trash.
- Reuse or disposal of the spent leaching agent must be studied.
- To consider the recovery and use of minerals from the spent leaching solution.
- To study the production of specialty chemicals from CA-leached sugar cane residues bio-oils.
- To analyze alternatives for citric acid production in order to reduce costs.

TCCB

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Thank you!

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