Sustainable production of Cellulose-based products and additives to be used in SMEs and rural areas
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CELISE Mid-Term Meeting
WP1: Biomass processing

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24th July, 2023

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Objectives

- Transfer of knowledge about sustainable lignocellulosic processing
  - To obtain cellulose pulp, biochar and fibres from biomass residues. In addition, energy production in rural areas obtained from the rest of fractions (lignin, hemicellulose) will be also studied.
  - The best characterisation methods will be also analysed.
  - In addition, two workshops about pretreatment methods and novel fibre production in SMEs and applications will be carried out, mainly for younger researchers.

- Create knowledge about
  - (i) novel characterisation methods of lignocellulosic materials by HPLC and FTIR;
  - (ii) novel hydrolysis and biochar production processes using deep eutectic solvents and hydrothermal processes;
  - (iii) joining processes for second-generation of ethanol production; and
  - (iv) new fibre bio-products from cellulose materials and natural additives.

- Skill development for biomass processing and characterisation in SMEs and rural areas.

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Tasks and secondments done

- **Task 1.1. Characterisation methods and residues.**

  (Leading by LS-IWC) M03-M11

  Secondments related to this task:

  Oskars Bikovens from LS-IWC to UCC

  Juan Carlos Colmenares from IChF to UCC

  Jakub Klaban from Inocure to LSIWC

  Alberto Coz from UC to Inocure

  Tamara Llano from UC to Inocure

  Rodrigo Leonardi from FICH-UNL to UC

  Tamara Llano from UC to FICH-UNL

  Summary of tasks:

  - Waste materials: (i) cocoa production waste (cocoa pod husk, mucilage and bean shell, cocoa tree pruning) available in rural and vulnerable areas, (ii) coffee production waste (coffee pod husk, mucilage, and bean shell, coffee silverskin) available in rural and vulnerable areas, (iii) brewer spent grains from small enterprises, (iv) waste from corn in rural areas, (v) waste from soya in rural areas.
  - Best characterisation methods: a summary of all of them is presented in D1.1

Tasks and secondments done

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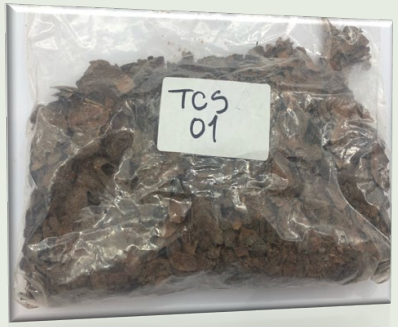
Samples by F. Colmenares, Universidad Cooperativa de Colombia and J.C. Colmenares, Poland



Cocoa wastes

Coffee wastes

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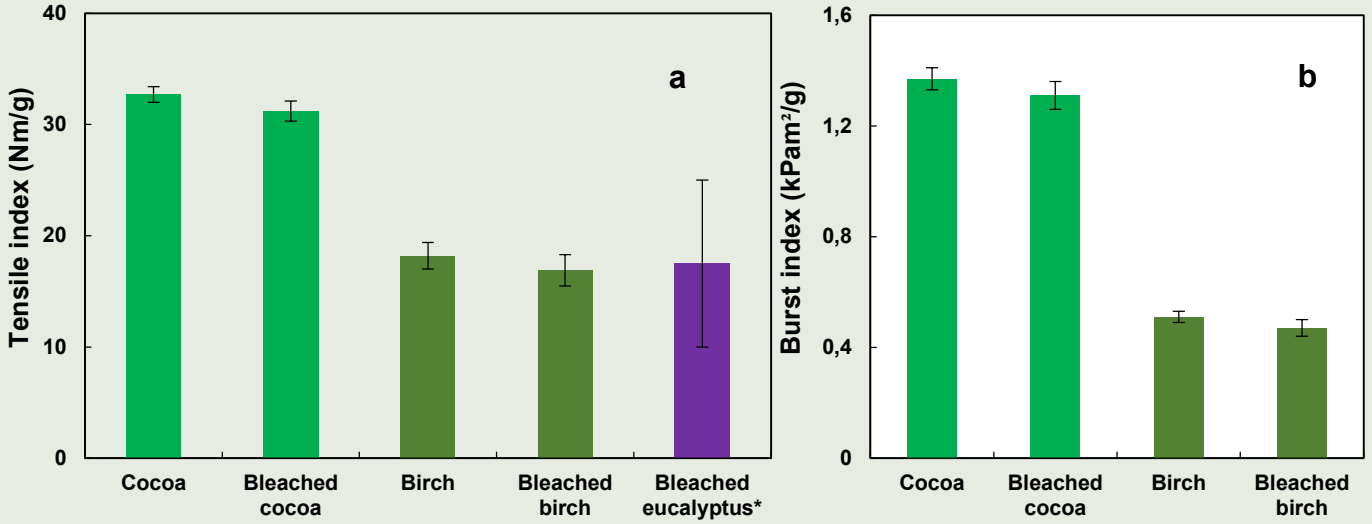
Tasks and secondments done

Kaft pulp of Cocoa branches compared with traditional pulp wood in paper industry



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Tasks and secondments done

- **Task 1.2. Novel and sustainable hydrolysis processes as pre-treatment.**

  (Leading by UC) M03-M17

  Secondments related to this task:

  Carlos Burgos from UNACH to UC 2022

  Alberto Coz from UC to FICH-UNL

  Jakub Klaban from Inocure to LSIWC

  Alberto Coz from UC to Inocure

  Tamara Llano from UC to Inocure

  Rodrigo Leonardi from FICH-UNL to UC

  Tamara Llano from UC to FICH-UNL

  Summary of tasks:

  - Acid hydrolysis
  - Alkaline hydrolysis
  - Deep eutectic solvents
  - Autohydrolysis
  - Steam explosion (SE) autohydrolysis
  - Techno-economical evaluation of methods

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Tasks and secondments done

- Integrated biorefinery for the valorization of wastes
- Mild acid, autohydrolysis and organosolv pretreatment towards the isolation of biomass components (cellulose, hemicellulose, lignin)
- Production of nanocellulose and valorization of hemicellulose and lignin streams

Tasks and secondments done

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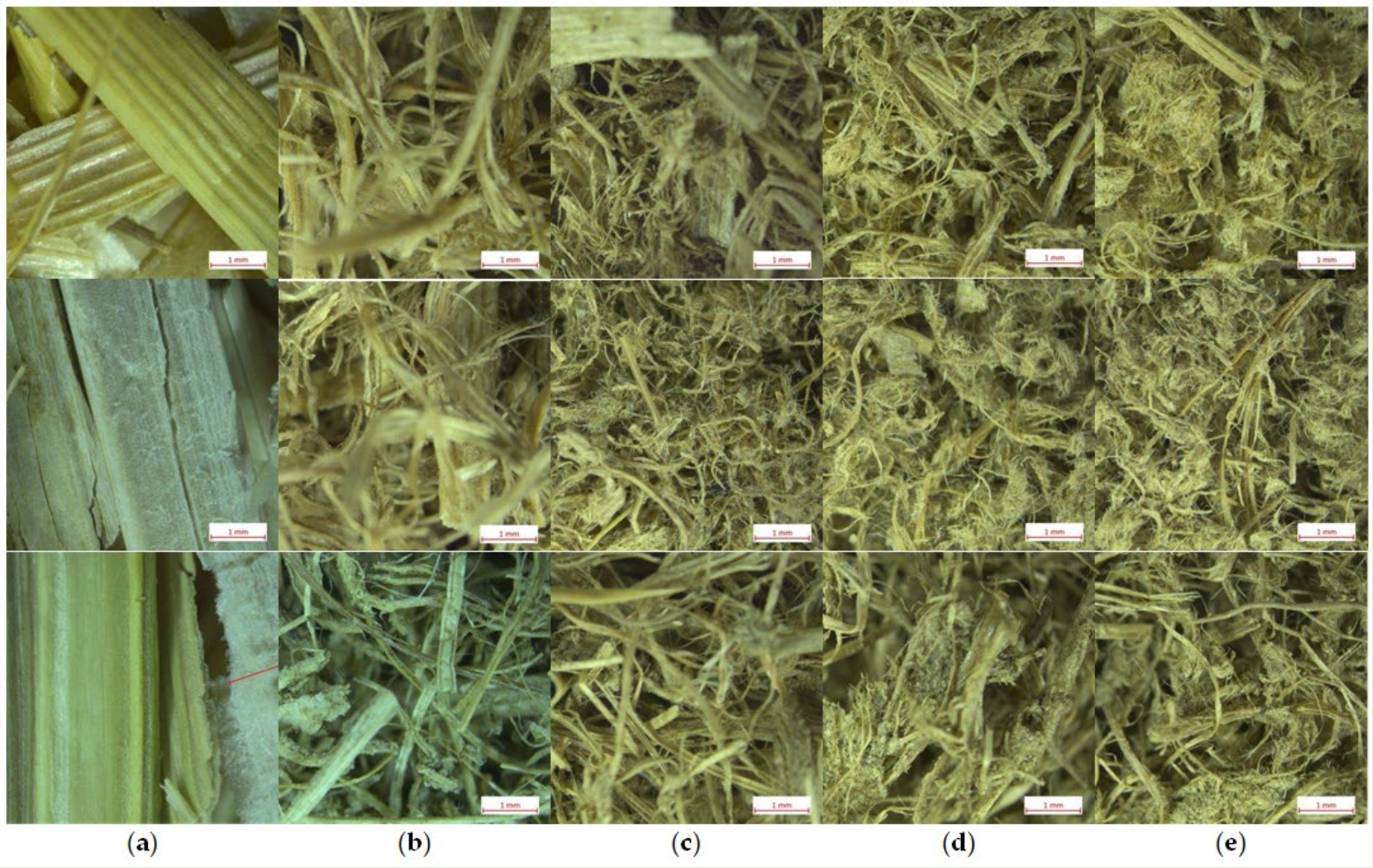

Microscopica l surface view (0.63×, scale bars 1 mm) of wheat straw (**above**), reed (**middle**) and corn stalk samples (**bottom**): (**a**) Raw and steam-exploded at 230 °C after (**b**) 15 s, (**c**) 30 s, (**d**) 40 s and (**e**) 50 s.

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Tasks and secondments done

- **Task 1.3. Energy production in rural areas.**

  (Leading by SGGW) M04-M23

  Secondments related to this task:

  Fernando Colmenares from UCC to UC

  Alberto Coz from UC to FICH-UNL

  Rodrigo Leonardi from FICH-UNL to UC

  Summary of tasks:

  - To study fermentation process for lignocellulose materials
  - To study energy demand and biomass energy production possibilities in rural areas.
  - To study the production of bioethanol from waste biomass

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Tasks and secondments done

- **Task 1.4. Production of biochar and applications.**

  (Leading by LUT) M08-M24

  Secondments related to this task:

  Juan Carlos Colmenares from IChF to UCC

  Summary of tasks:

  - Carbon-based materials from coffee residues
  - Slow pyrolysis from coffee residues (A collaboration between WUT and UC).

Tasks and secondments done

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- **Task 1.4. Production of biochar and applications.**

  (Leading by LUT) M08-M24

  Secondments related to this task:

  Juan Carlos Colmenares from IChF to UCC

  Summary of tasks:

  - Carbon-based materials from coffee residues
  - Slow pyrolysis from coffee residues (A collaboration between WUT and UC).

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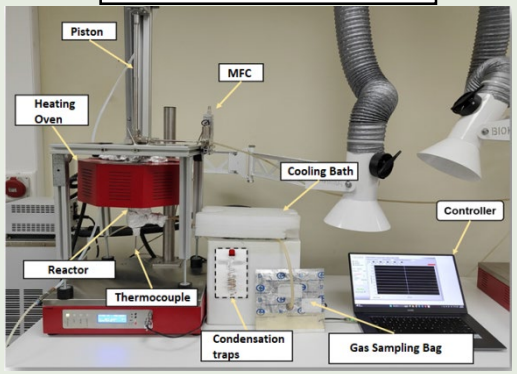
Tasks and secondments done

- AUTH is involved in the biomass/waste pyrolysis, towards value added products, using a fixed bed lab scale reactor and micro pilot unit

Biomass (e.g., Cocoa bean shell)

Pyrolysis



Bio-oil GC-MS, NMR, Karl-Fisher

Gases GC-FID

Char

Activation

Characterization

Elemental, ATR, XRD, BET, SEM, TGA

Adsorption/purification applications

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Tasks and secondments done

- **Task 1.5. Production of fibres and applications.**

  (Leading by INOCURE) M08-M39

  Secondments related to this task:

  Oskars Bikovens from LS-IWC to UCC

  Juan Carlos Colmenares from IChF to UCC

  Muhammad Yasir from Inocure to UC

  Velta Fridrihsone from LS-IWC to Inocure

  Dominika Hanusova from Inocure to LS-IWC

  Alberto Coz from UC to Inocure

  Tamara Llano from UC to Inocure

  Kim Standfield from VoCATE to UCC

  Summary of tasks:

  - Lignin fibers from coffee waste for carbon-based materials and new aromatic-based intermediates (biofarmacy)
  - Nanocellulose from lignocellulosic biomass (cocoa tree pruning) to be used for treatment of emerging contaminants by electrospinning
  - Use of coffee silverskin fibers as pre-treatment of protein samples for nanofibers biosensors.
  - Modified nanocellulose obtained by microfluidizer incorporation into a PVA or PLA polymer matrix by electrospinning.
  - Evaluation of the nanocellulose influence on parameters of obtained polymer material. Microscopic characterization of samples.
  - To study the stakeholders needs for technology commercialisation based on QFD (Quality Function Deployment) and Design Thinking approaches.

Tasks and secondments done

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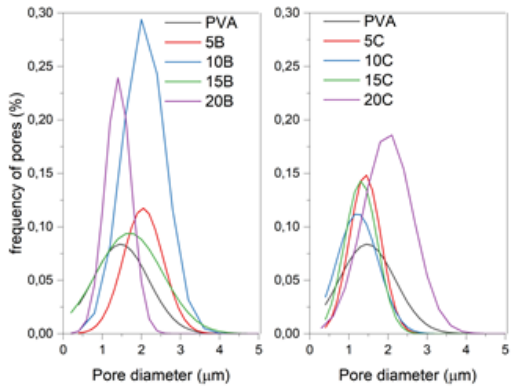
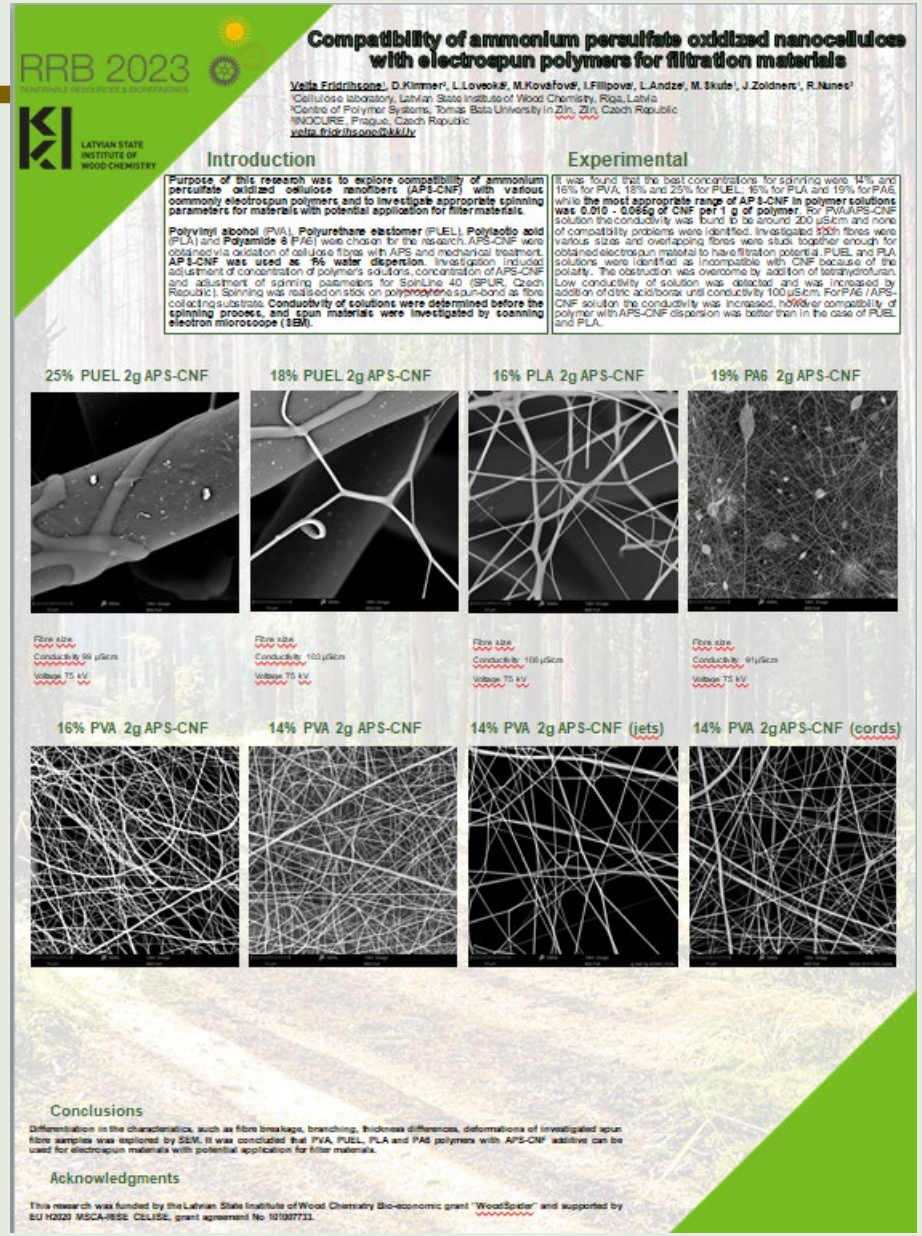
Electrospun PVA, PUEL, PLA samples with CNF

Porozimetry - ASTM F316 – 03





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Deliverables, Milestones and deadlines

Number	Title	Beneficiary	Type	Dissemination level	Deadline
D1.1	Recommendations about characterisation methods in lignocellulose biomass	LS-IWC	Report	Public	M11
D1.2	Pre-treatments of lignocellulosic residues to be used in SMEs and rural areas	UC	Report	Public	M17
D1.3	Production of cellulose fibres, biochar, biofuels and energy to be used in SMEs and rural areas	SGGW	Report	Public	M39

Number	Title	Beneficiary	Deadline
MS1	Fibre material prototypes	BANGOR	M39

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Deliverables, Milestones and deadlines

D1.1. Recommendations about characterisation methods in lignocellulose biomass

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Future work

- **First workshop about biomass pretreatment methods**
  - Online: 29th September
  - Organised by AUTH and Ecoresources
- **Completion of deliverable D1.2.**
- **Increase the open access publications for next year**
- **Next secondments in this WP:**
  - SGGW to FICH-UNL, and to UCC
  - LSIWC to UCC
  - BANGOR to FICH-UNL, and to UCC
  - AUTH to CCC, and to UCC
  - TWI to AUTH
  - Ecoresource to UC
  - UNACH to UC
  - Latitud to UC
  - FICH-UNL to UC