



WORKSHOP

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BIOBASED MATERIALS RESEARCH:
ADVANCES FROM ECOFUNCO AND
BIONTOP EUROPEAN PROJECTS

ecofunco

biontop



Bio-based Industries
Consortium



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*Supercritical Carbon Dioxide : A
green and versatile technology for
both bio-additives extraction and new
biobased material functionalization*





Celabor : Belgian technological pilot platform for biomass refining and downstream processing





CELABOR scrI.

Is a Belgian private scientific and technical center based in the Walloon region accredited ISO 17025 by BELAC . As an **SME**, CELABOR is offering scientific and technical support to companies involved in all sectors of the **circular-economy** and **bioeconomy** including agri-food, green processes, packaging, textile and environment.



Four departments in the heart of the bioeconomy sectors





Celabor : Walloon technological pilot platform for biomass refining and downstream processing

Flexible Pilot Platform for Biomass Valorisation



Green extraction & purification platform for biomolecules recovery

Our extraction & downstream processing team has a broad blend of skills and industrial backgrounds spanning the field of natural substances **extraction, fractionation and purification**. This breadth supports our ability to undertake lab- and pilot-scale development and validation of various feedstocks, e.g., woody & lignocellulosic residues, food and agri-residues, plants, microalgae, hemp, etc., for the recovery of high value biomolecules (antioxidants, antimicrobials, antiaging, proteins, pigments, etc.) and extracts rich in lignin, hemicellulose & cellulose, chitin & chitosan to be processed by our biopolymer team.



Advanced biopolymers production & green functionalization

We offer solutions for producing cellulose and chitin nanofibrils with controlled size by mechanical fibrillation combined to advanced pretreatments. We are developing industrially robust processes for polysaccharide and lignin-based materials **surface modification** by chemical and enzymatic routes to produce **highly reactive commercial products**. One of our core strengths is our expertise in the field of "green" production of advanced biopolymers and fibers and their conversion into **novel packaging, coating and textile end-products** e.g., **biocomposites**, paper, films, foams, aerogels, etc.



“Extraction” & “Sustainable Materials” departments



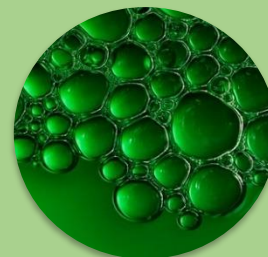
Green extraction & purification technologies



Bio-based lignocellulosic resources valorisation



Novel & low cost process: Nanofibres production & surface functionalisation



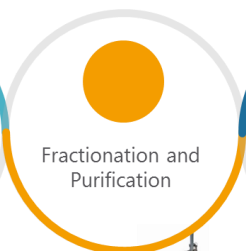
Algae and microalgae green refining & purification



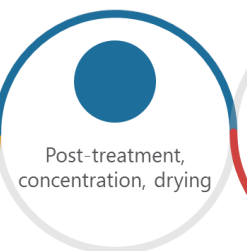
Microbial products & building-blocs recovery



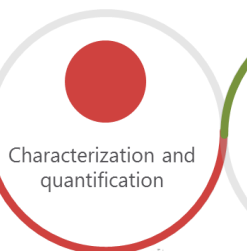
Pre-treatment and extraction of raw material



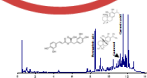
Fractionation and Purification



Post-treatment, concentration, drying



Characterization and quantification



Qualification and stability study





Supercritical Carbon Dioxide : Properties and Applications





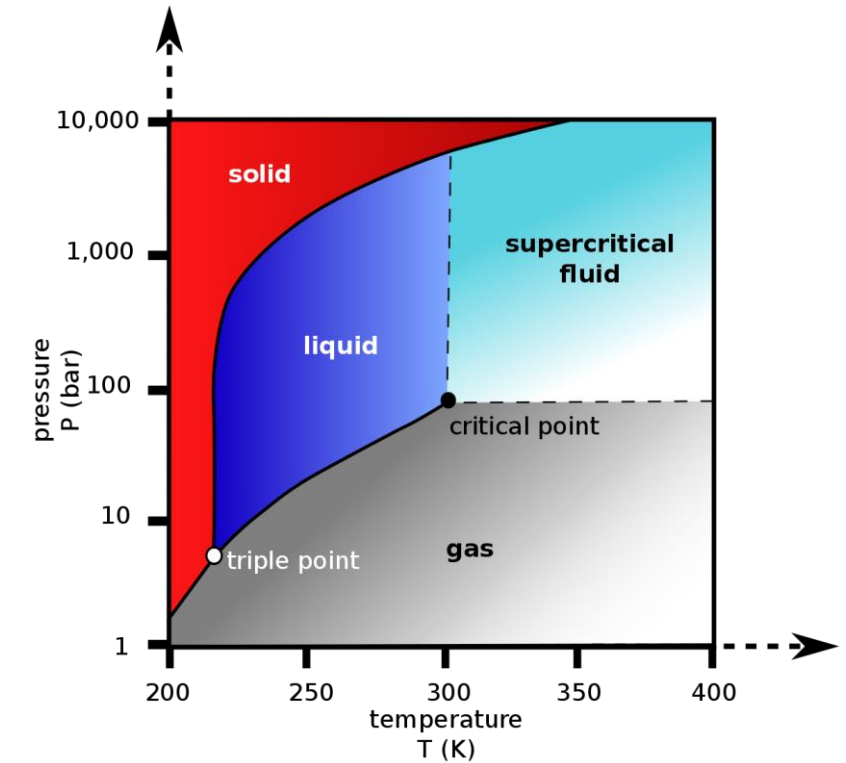
What is supercritical carbon dioxide ?

Supercritical fluids is a state beyond the critical point of a specific molecule, and has the behavior between a liquid and a gas.

Carbon dioxide

Critical point for CO₂: 31°C – 73 bars

- Easy to reach
- Nonflammable, nontoxic, biocompatible, cost-effective, and abundant
- Co-solvents use
- Industrial installations exist (TRL9)



Supercritical fluids

Low viscosity and high diffusivity (gas)

High density and high solvent power (liquid)

Solvent polarity changes with pressure and temperature : fractionation



Application of the supercritical carbon dioxide: Extraction

Supercritical carbon dioxide has many application in the field of natural substances. Especially for the extraction of non-polar bioactive compounds as well as volatiles fractions. The SFE-CO₂ aimed to provide extracts to sectors like cosmetics, nutraceutical or biobased materials

Applications
sc-CO₂

Defatting raw materials before extraction

Extraction of food ingredients (aromas, dyes, vitamin, specific lipids, ...)

Extraction of residual organic solvents or other impurities

Extraction of aroma from fermented and distilled beverages

Deodorisation/decoloration of natural extracts

Debacterization of beverages and fresh vegetables





Application of the supercritical carbon dioxide: Materials

Supercritical carbon dioxide as an alternative medium of organic solvents has been comprehensively explored in many industrial processes. It has been recognized as a non-toxic and environmental benign green solvent which could replace many solvents such as CCl_4 , benzene and chlorofluorocarbons (CFCs) used in traditional materials processing.

Applications
 sc-CO_2

Impregnation and dyeing of polymeric materials

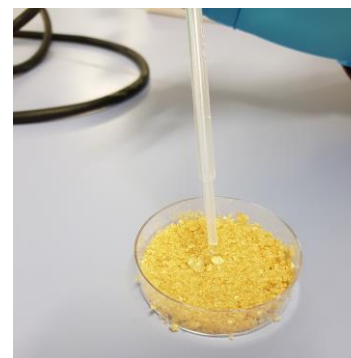
Controlled fabrication of biological active nanomaterials

Heterogenous chemical modification and surface functionalization

Coatings, exfoliation and intercalation of layered materials

Swelling and plasticizing of hydrophobic materials

Porous bio-based materials production: aerogels





Application to the ECOFUNCO project at Celabor : Equipment available

Celabor own a full equipment setup to perform extraction from lab-scale (10mL-2mL) to semi-pilot scale (2*5L) and have more than 20 years of experience in this field.



Lab-scale batch mode
supercritical carbon dioxide
extractor (Pmax = 200 bar)

10 mL

Lab-scale percolation mode
supercritical carbon dioxide
(Pmax = 1000 bar)

100
mL

Semi-pilot extractor
equipped with a 5L
extractor vessel (Pmax =
250 bar)

5 L

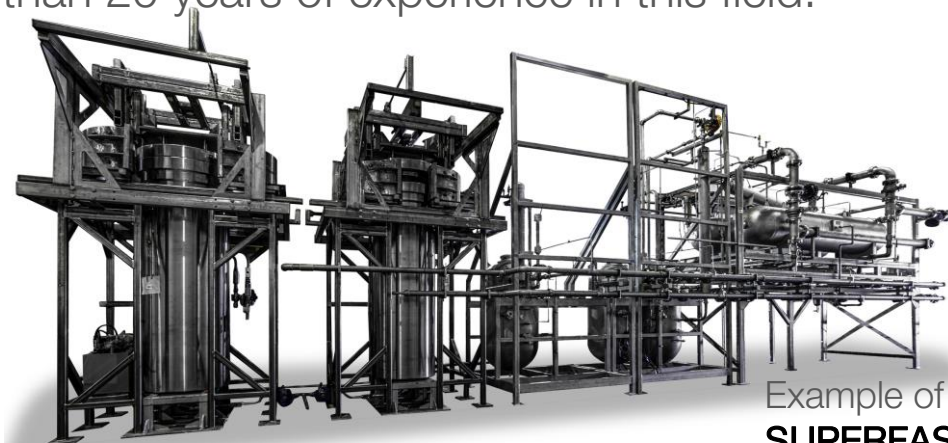
Semi-pilot extractor equipped
with two 6L extractor vessel
for large extraction campaign

2x6 L



Application to the ECOFUNCO project at Celabor : Equipment available

Celabor own a full equipment setup to perform extraction form lab-scale (10mL-2mL) to semi-pilot scale (2*5L) and have more than 20 years of experience in this field.



Full industrial scale extractor
equipped with two 1,65 T
extractor vessel for large
production

2x6 L

Example of Industrial equipment
SUPERFAST™ 2x1650 L from Thar Process



Semi-pilot extractor equipped
with two 6L extractor vessel
for large extraction campaign

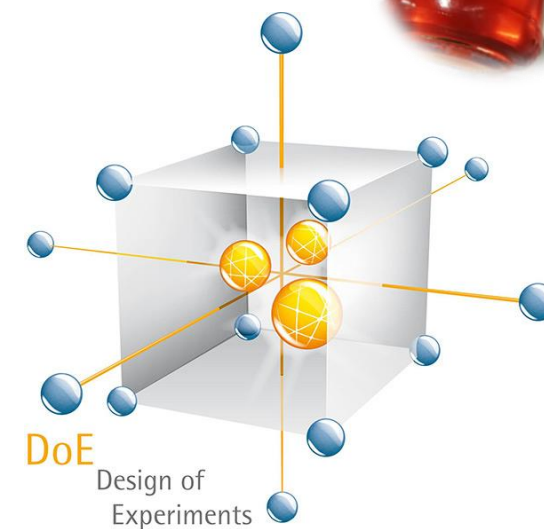
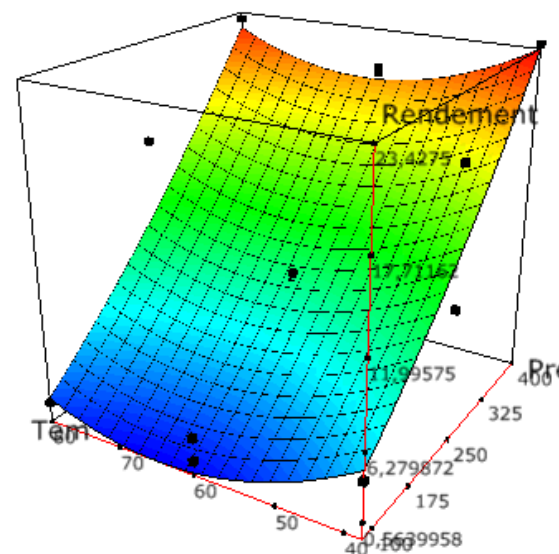
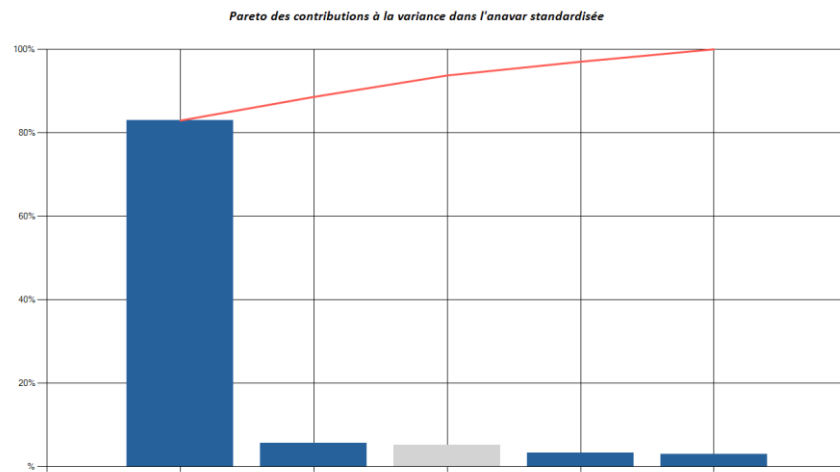
2x6 L



Application to the ECOFUNCO project at Celabor : Results

In the ECOFUNCO project, the SFE-CO₂ process was applied for the extraction and fractionation of lipids and fatty acids from tomato seeds. Optimization at lab scale by Box-benhken Design of Experiment with 3 parameters :

- Pressure
- Temperature
- Ethanol as co-solvent

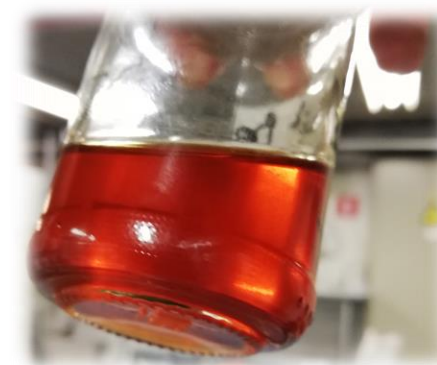


After the optimization study, the optimal SFE-CO₂ extraction parameters were tested and validated at lab-scale and semi-pilot scale at Celabor



Application to the ECOFUNCO project at Celabor : Results

A full process was successfully upscaled from lab to semi pilot scale with reproducible result. A focus was made for the extraction of lipids and fatty acids from tomato by-products. The main fatty acid found in the extract was linoleic acid and was used after for functionalization trials.

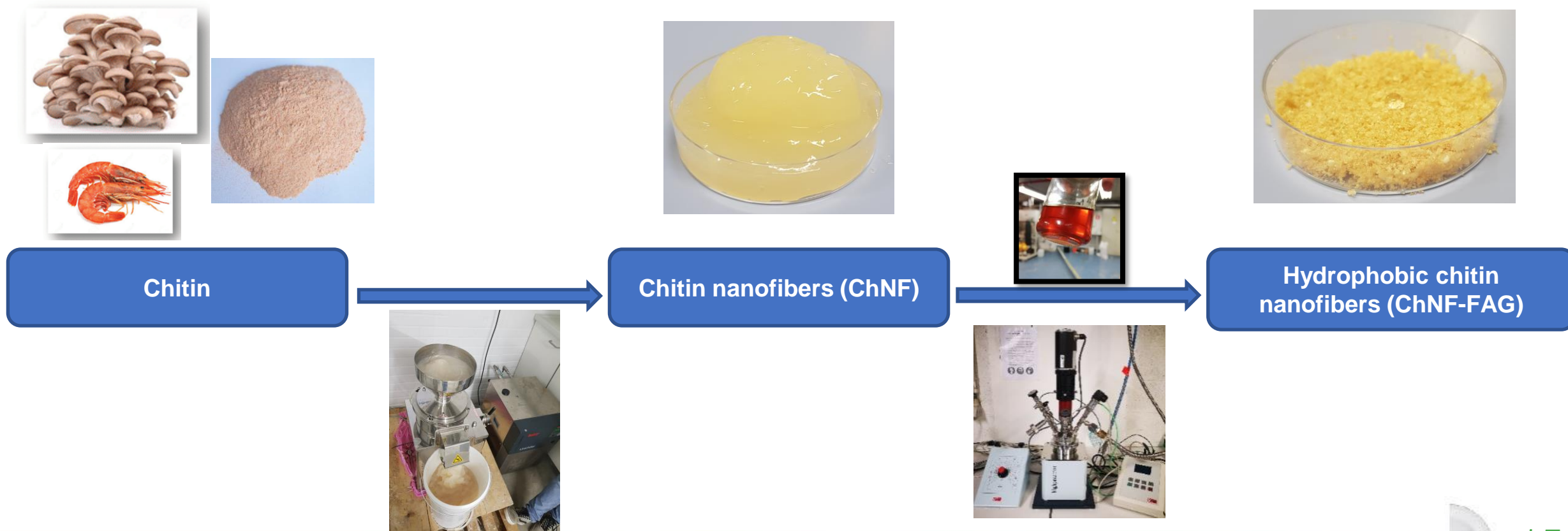


Extract	m _{MP} (g)	Yield (%)	Recovery (%)	%Fatty acid (%)	Linoleic acid (%)	Oleic acid (%)	Stearic acid (%)	Palmitic acid (%)
Lab scale	20,02	19,13	58,77	57,06	50,19	20,28	5,65	16,48
Pilot scale	960,00	19,63	60,30	58,65	51,90	19,93	5,53	14,79



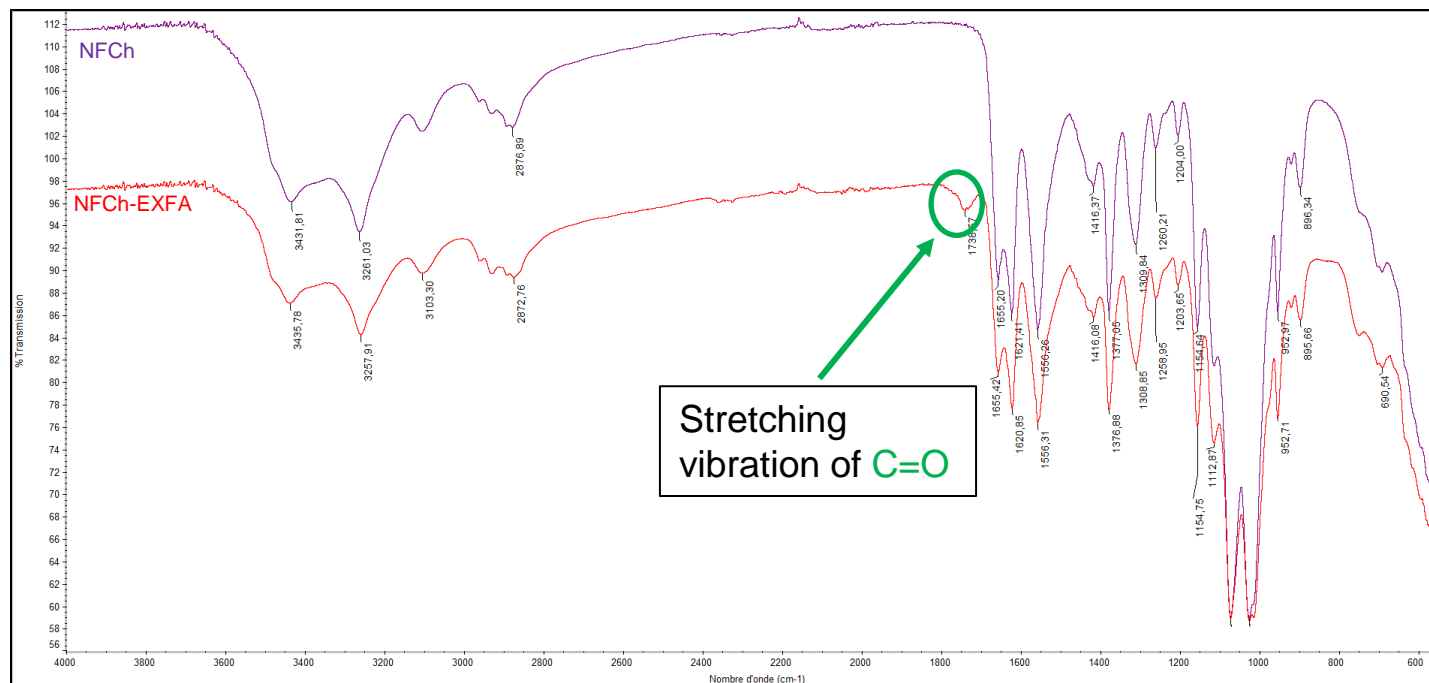
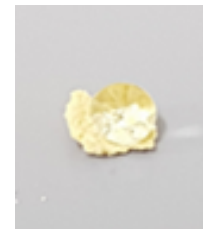
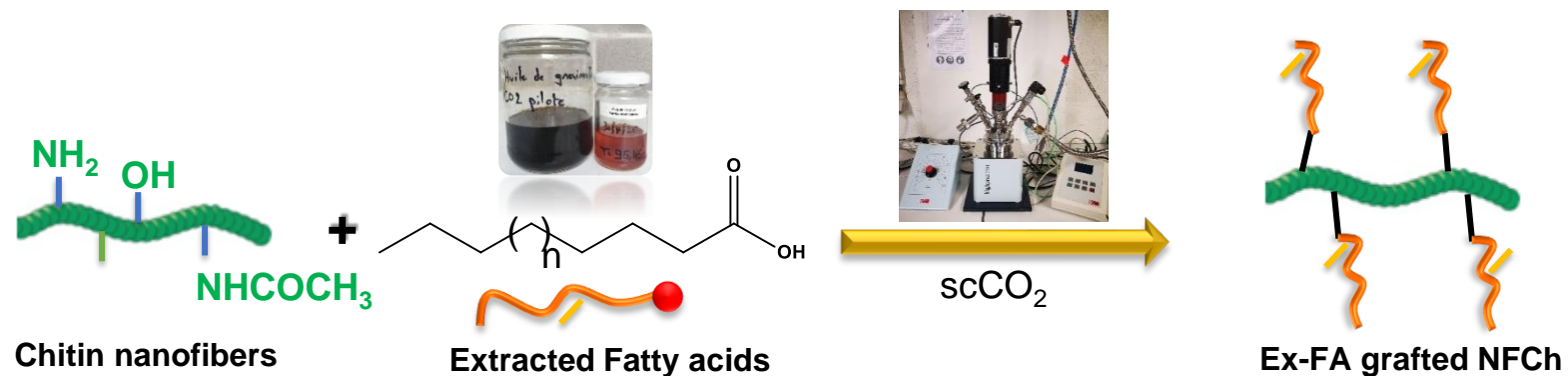
Application to the ECOFUNCO project at Celabor : Results

The extracted fatty acid by ScCO₂ were successfully grafted onto nanofibrillated chitin to enhance their barrier properties and compatibility with hydrophobic substrates. An innovative green process using again the ScCO₂ was developed and showed a good efficiency





Application to the ECOFUNCO project at Celabor : Results



Thank you!



Analyses - Conseils techniques - Expertises - R&D

Agroalimentaire - Emballage - Environnement - Textile

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