

Cascade valorization of spent coffee grounds

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Coffee's place in the world



More than **9.9 million tons** of coffee beans were **produced** between 2019 and 2020 in the **world**
2.4 million tons of coffee beans were **consumed** between 2019 and 2020 in **Europe**

[1]



3.2 billion cups of coffee were **consumed** everyday **worldwide** in 2018

[2]

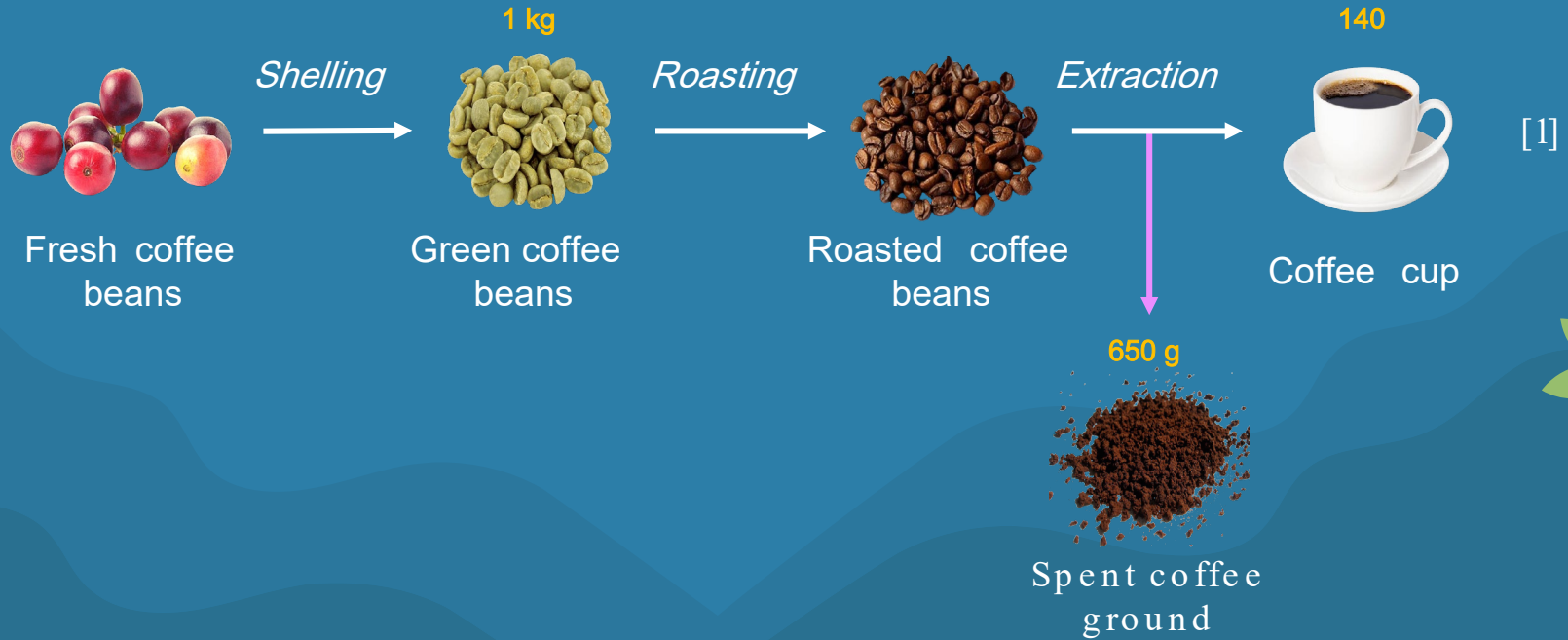
4 ways to consume coffee : capsules, grinded, soluble, beans



Coffee's place in the world



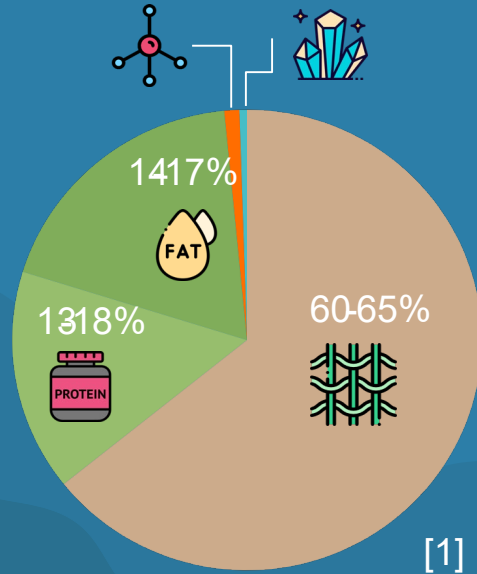
Coffee manufacturing process :



Spent coffee grounds and its applications



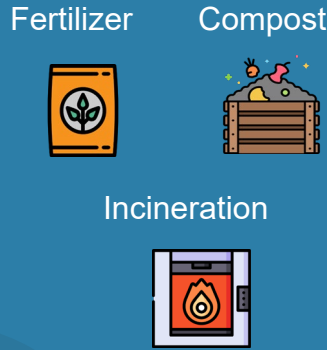
Spent coffee grounds composition



[1]

The main spent coffee grounds valorizations

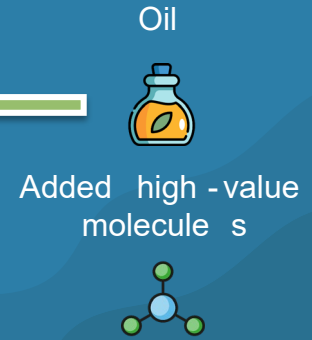
Direct applications



Processed products



Extractions



[2]

[1]: Al-Hamamre et al., 2012; Kulkarni and Dalai, 2006; Petrik et al., 2014; Ballesteros et al., 2014;

[2]: Galanakis C, 2017

Jimenez-Zamora et al., 2015

Cascade valorization applied to spent coffee de grounds

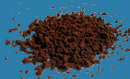
Roasted coffee beans



Coffee

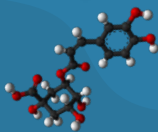


Extraction



Spent coffee grounds

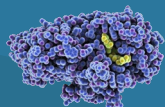
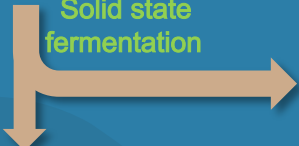
Eco-extraction



Polyphenols

Ressource exhaustion

Solid state fermentation



Enzymes

Thesis

Global project

Pyrolysis



Oil



Biochar



Biogas

Eco-extraction of antioxidant polyphenols



[1] Eco-extraction

Use of **innovative** processes



Reduction of **energy** impact



Use of **clean/ green** solvents



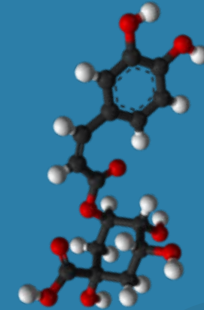
Reduction of process **times**



[2] Polyphenols

Main polyphenols in spent coffee grounds:

- **Chlorogenic** acids:
 - 5 CQA
 - 3 CQA
 - 3,5 diCQA
- **Ferulic** acid
- *p*-**Coumaric** acid
- **Gallic** acid
- **Caffeic** acid
- **Vanillic** acid



Antioxydant properties:

Application in cosmetic, food, pharmaceutical



[1]: Passos & Coimbra, 2013; Rocha and al., 2014; Michail and al., 2016; Pettinato and al., 2019

[2]: Scalbert et al., 2005; Samarin et al., 2012; Angeloni and al., 2020

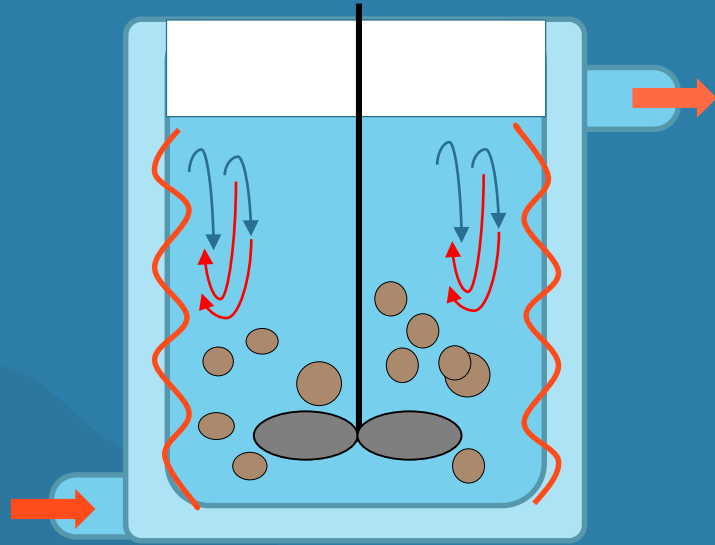
Eco-extraction of antioxidant polyphenols



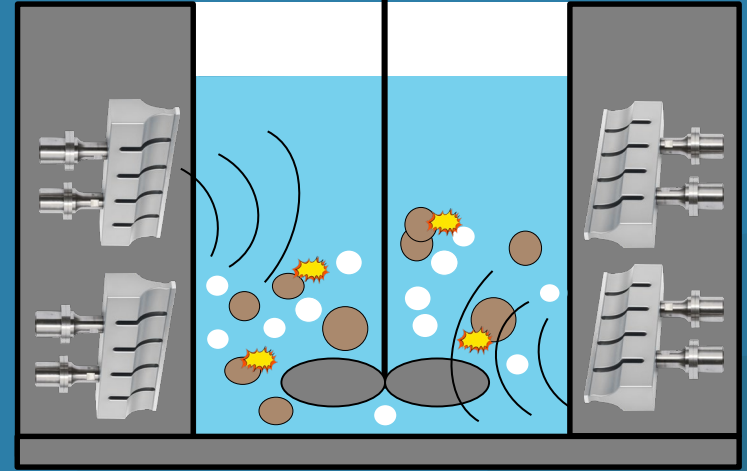
Conventional



Ultrasounds



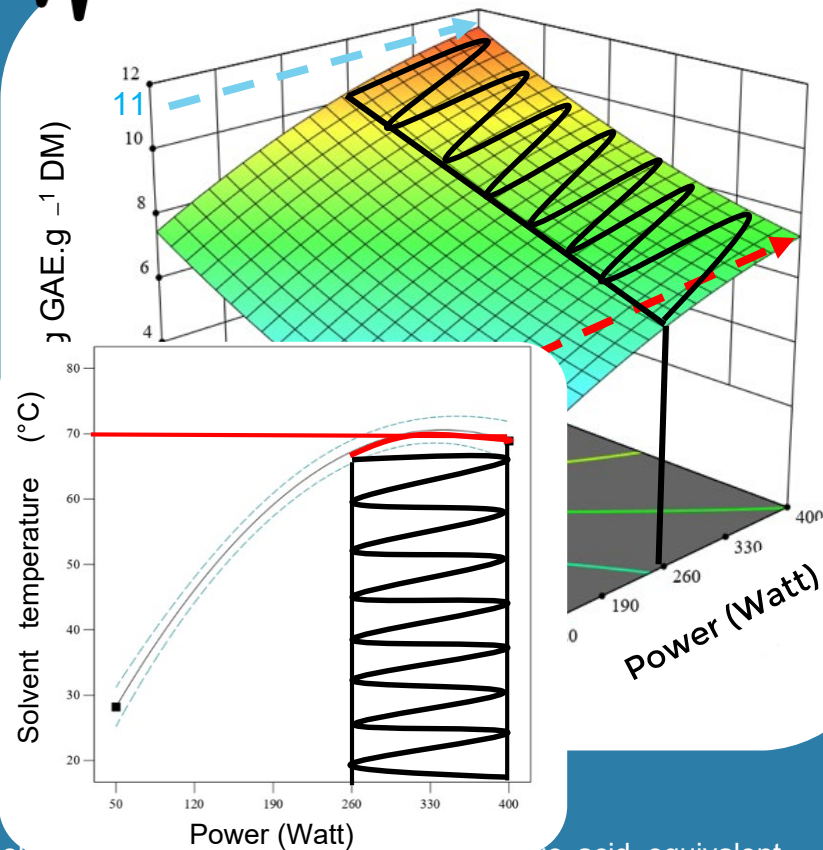
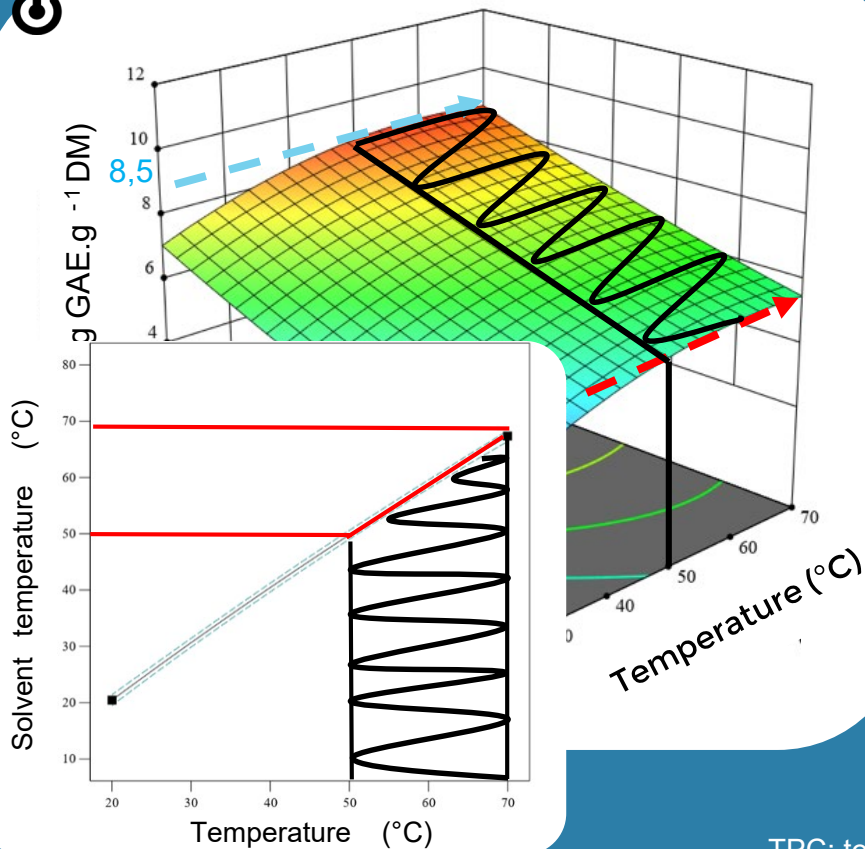
From 25 to 70°C



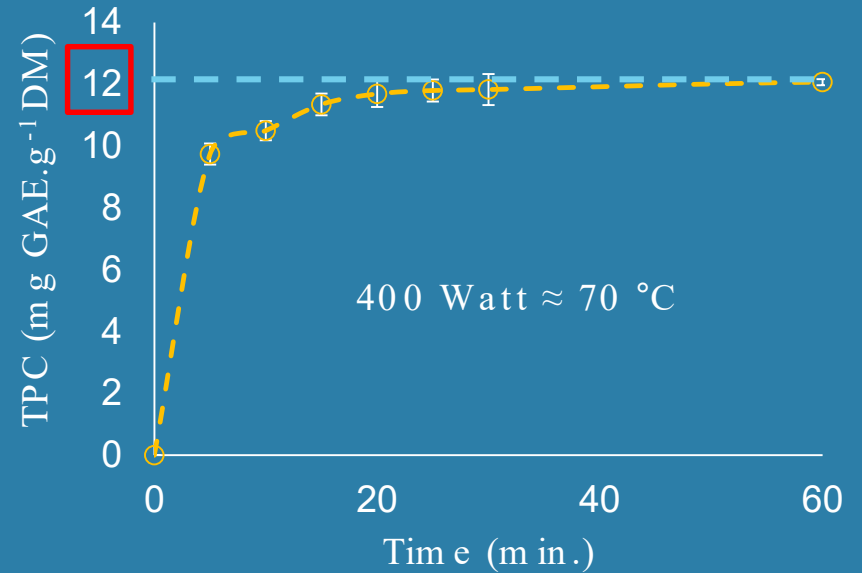
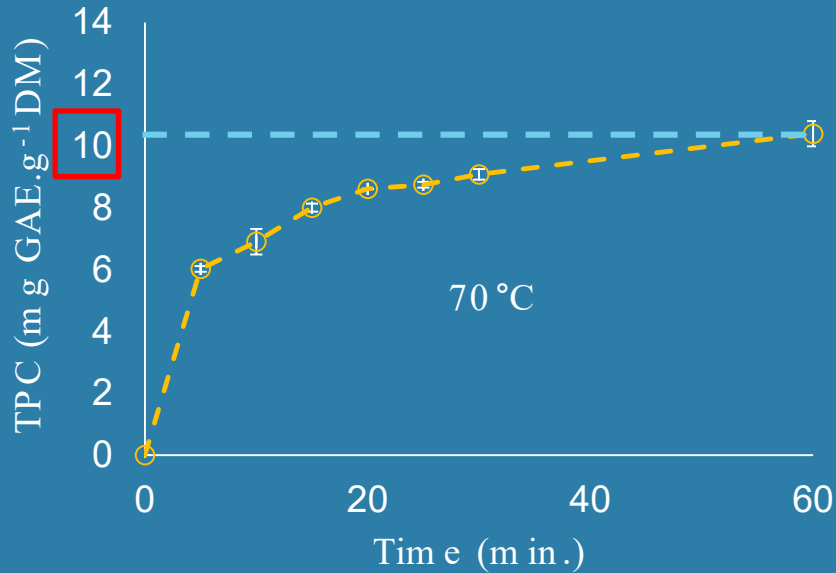
From 50 to 400 Watt

700 mL volume, From 0 to 50% ethanol in solvent, 150 rpm, solid to liquid ratio 1g : 40 mL

Results and comparison of a 30 minutes extraction

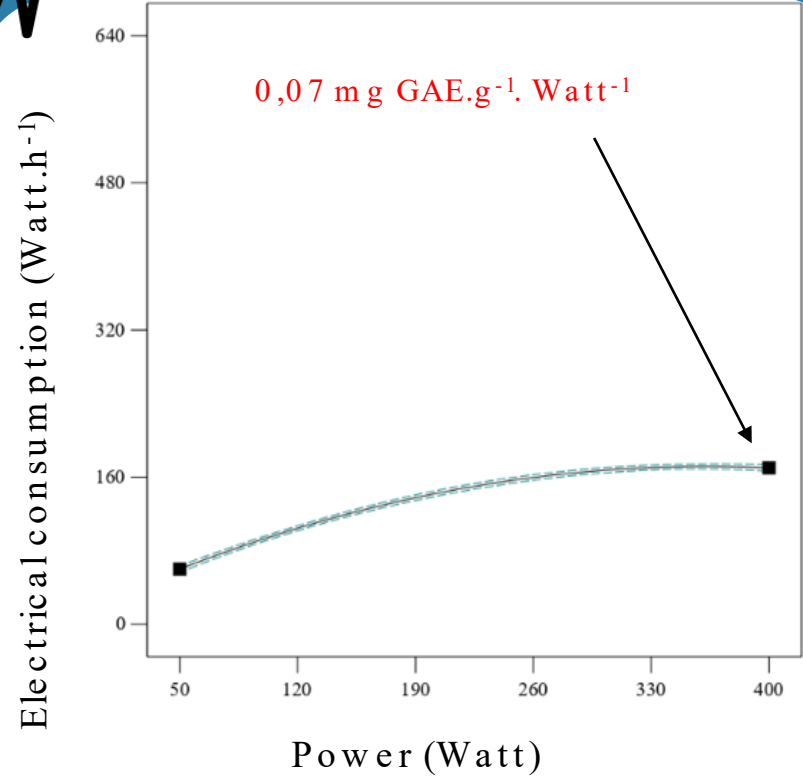
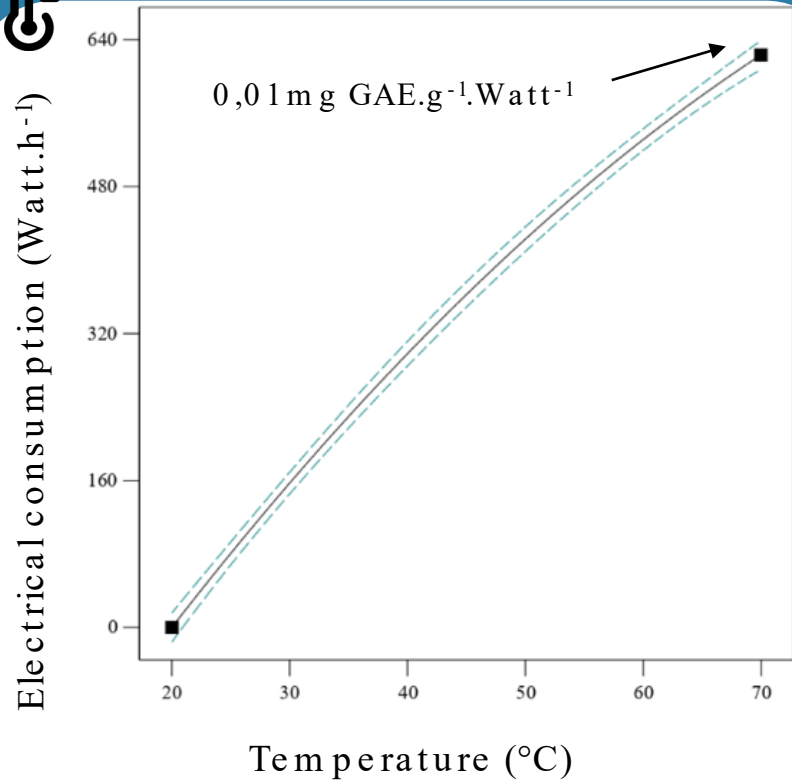


1hour extraction kinetics



700 mL volume, 50% ethanol in solvent, 150 rpm, solid to liquid ratio 1 g : 40 mL

Electrical consumption at 30 minutes



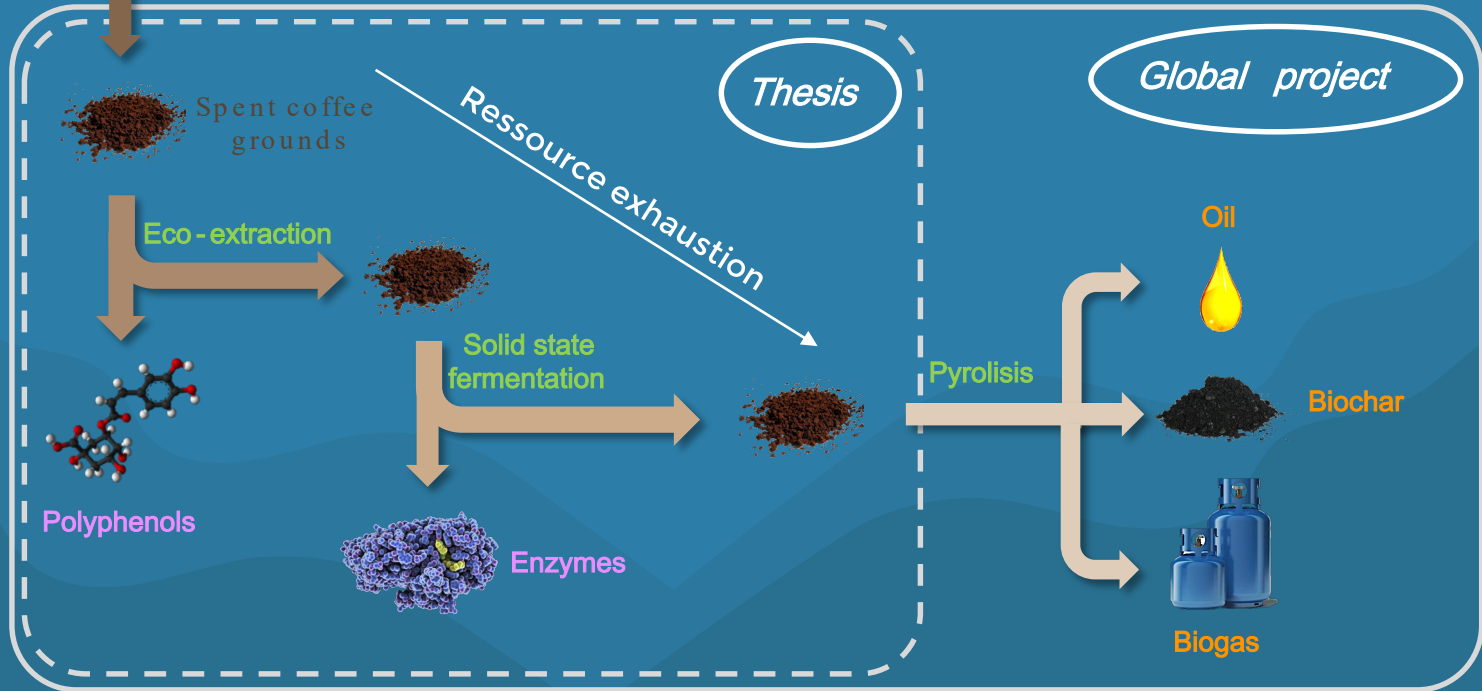
Cascade valorization applied to spent coffee de grounds

Roasted coffee beans



Extraction

Coffee



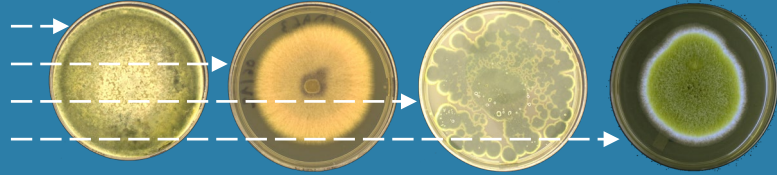
Solid fermentation for enzyme production

Fungi from spent coffee grounds isolation and identification



15 *Trichoderma*
4 *Fusarium*
4 *Penicillium*
3 *Aspergillus*
And others :

Pleurotus , *Acremonium* , *Paecilomyces* , *Talaromyces* , *Exophiala*



Solid state fermentation



Lipases → Biodiesel
Cellulases → Paper industry
Hemicellulases → Detergent
Proteases → Cosmetic

Less energy and less water than liquid fermentation

Recycling co-products from the food industry

Solid fermentation for enzyme identification



FMS



Penicillium

Trichoderma

Water extraction

Enzyme cocktail

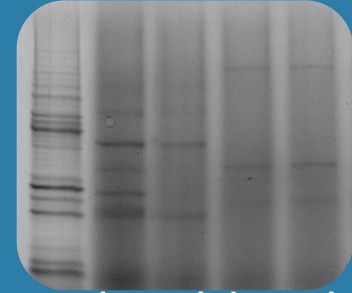


Denaturation

Precipitation
Digestion

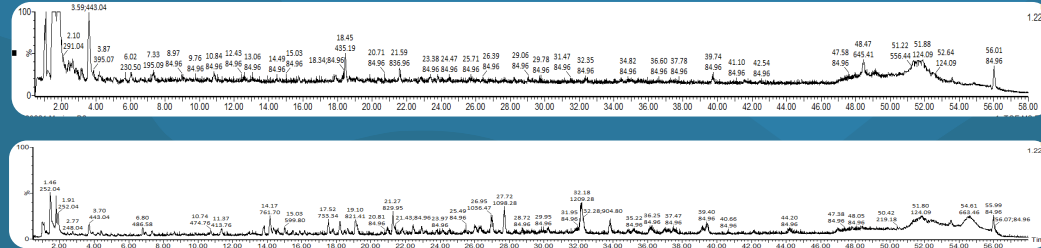
Nano LC-MS/MS

Electrophoresis SDS Page



Database comparison

900 peptides => 73 proteins
Proteases
Carboxylases
Others
800 peptides => 50 proteins



Solid fermentation for enzyme activity

FMS

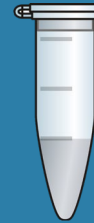


Penicilium

Trichoderma

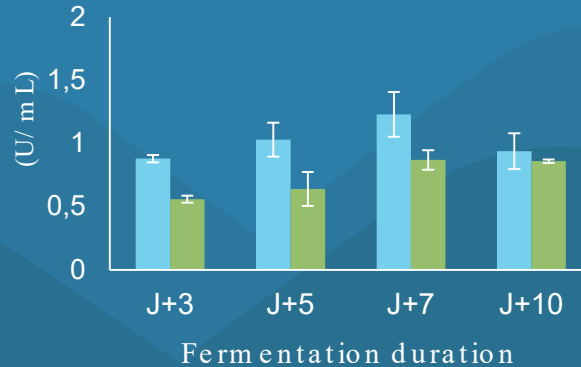
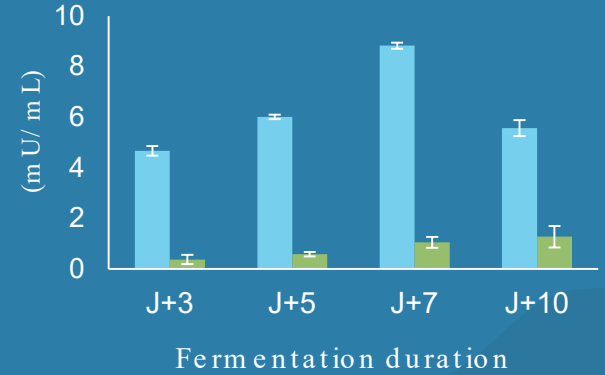
Water extraction

Enzyme cocktail



Lipase activity

Xylanase activity



Lipase activity:
P-Nitrophenyl butyrate

Xylanase activity:
Xylan birchwood – DNS

Conclusions



Extract polyphenols with a better efficiency while consuming less energy



Produce, identify and start to characterize enzymes produced from spent coffee grounds depleted in polyphenols

Perspectives



Purify the polyphenols extract



Continue the screening on the other strains



Couple steps of the cascade

Thank YOU
for
your attention



Région
Hauts-de-France

