VALORISATION STRATEGIES OF SPENT COFFEE GROUND AS AN INGREDIENT FOR RUMINANTS

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NEW STRATEGIES FOR THE COFFEE BY-PRODUCTS RECOVERY AS A NEW RAW MATERIAL FOR ANIMAL FEED

PROJECT LOCATION: North of Spain (Basque Country and Navarre) and South of France (Aquitaine)

SCHEDULE: 01 / 09 / 2019 – 31 / 03 / 2024

CONSORTIUM:

Coordinator:

Partners:

OBJETIVES

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from coffee by-products to animal feed

General objective:

Develop, demonstrate and implement at real scale an **innovative and sustainable solution** for the recovery of **coffee by-products** and recovery for their use as an **ingredient in animal feed.**

Specific objectives:

1. Implement a value option for HORECA channel coffee grounds and Vending capsules as an ingredient for animal feed

   → **↑ sustainability and competitiveness of the coffee producer and consumer sector.**

2. Meet the growing demand for new raw materials for feed production and reduce dependence on the current market for raw materials.

   → **↑ sustainability and competitiveness of the feed sector**

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CHALLENGES

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Challenge 1:
Logistic

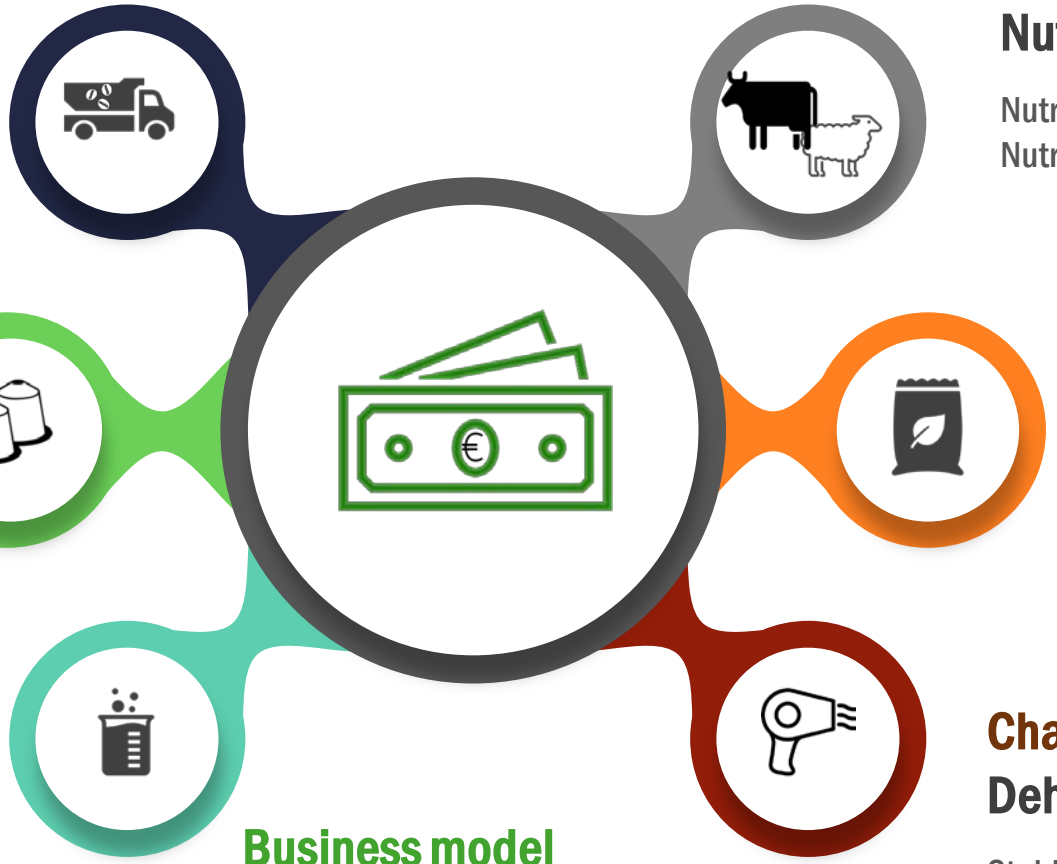
Management protocol in point generation
Grounds and capsules collection system
Coffee capsule collection systems
Synergies with other streams

Challenge 2:
Decapsulation

Separation of fractions:
organic vs. inorganic

Challenge 3:
Enzymatic Hydrolysis

Increased fiber digestibility



Business model

Value proposal
Investor search
Roadmap

Challenge 6:
Nutritional efficiency

Nutritional value of coffee grounds
Nutritional efficiency tests: dairy cattle and sheep

Challenge 5:
Pellets

Energy optimization of the drying process using pellets from coffee grounds

Challenge 4:
Dehydration

Stabilization of the coffee grounds for its suitability as a feed ingredient

- Natural coffee grounds
- Hydrolyzed coffee grounds

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IMPLEMENTATION AT REAL SCALE

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1. **TECHNICAL SIZING**

   Sizing of the case study (north Spain - south France)

   Technical specifications of the necessary equipment

2. **ECONOMIC ASSESSMENT (LCC)**

   15-year financial balance; Financial indicators & Economic sensitivity analysis

3. **ENVIRONMENTAL ASSESSMENT (LCA)**

   Life Cycle Analysis → Acidification potential; Global warming, Eutrophication; Competition for land use

4. **SOCIAL ASSESSMENT**

   Job creation and maintenance; Industry and consumer awareness; Contribution to the sustainability of the primary sector

5. **BUSINESS MODEL**

   Value proposal; Investors; Road map; Replication to other EU regions

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CHALLENGE 3

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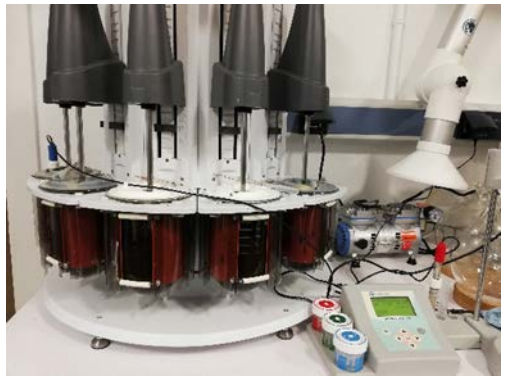
Enzymatic Hydrolysis ⟶ Increased fiber digestibility

- **Spent coffee ground** (SCG) has high potential to be reused **as secondary feedstuff for animal feed**.
- However, its **high lignin content** limits its inclusion percentage in diets to no more than 10 % due to a decrease in digestibility.

An **enzymatic hydrolysis** process is proposed to maintain its properties while increasing digestibility



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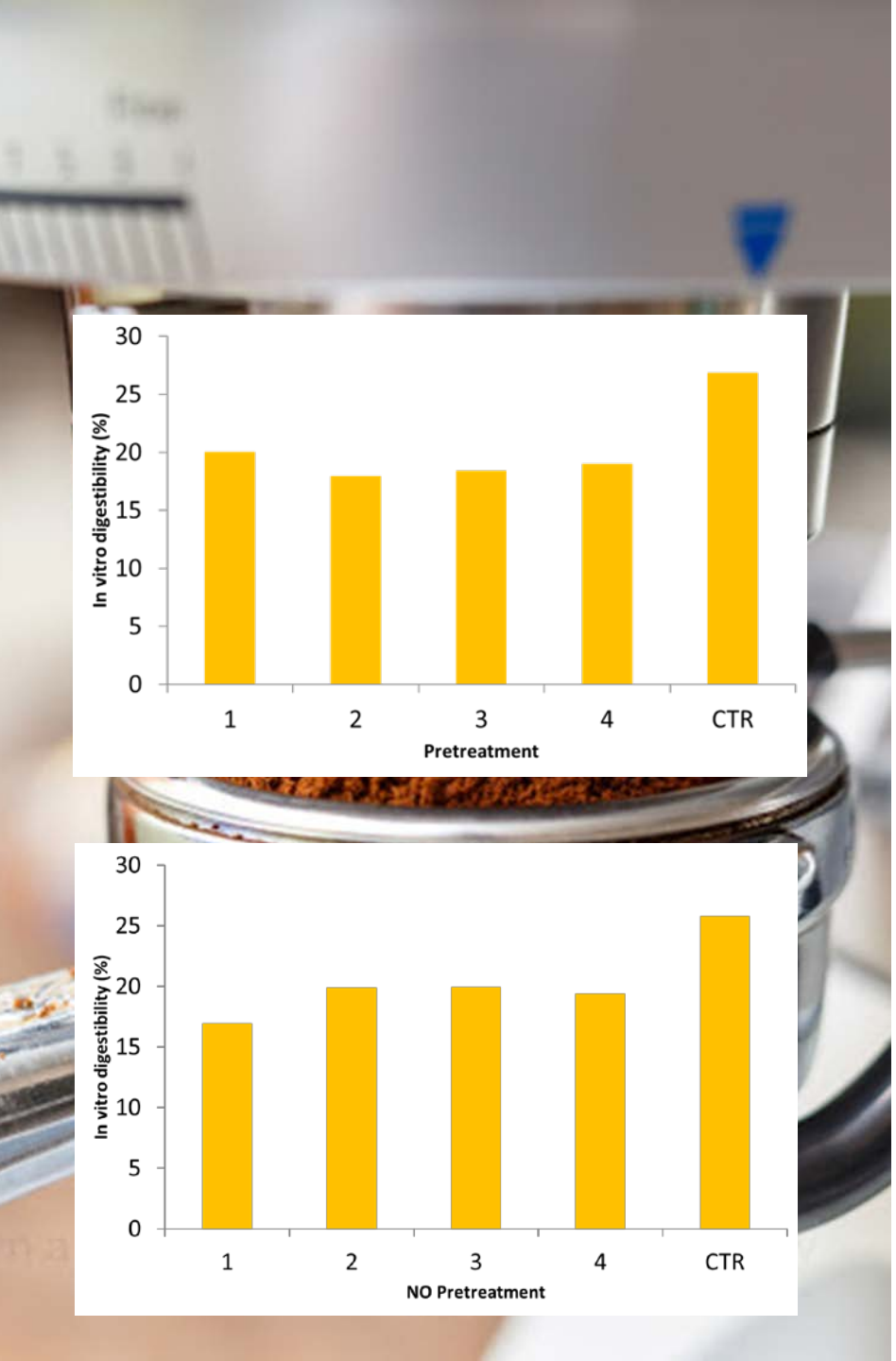

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Enzymatic Hydrolysis ⟶ Increased fiber digestibility

➢ 1st Experimental trial

Pretreatment (15 min 121 °C)	Enzymes
Yes	CTR - without enzyme
No	1- Celuclast
	2- Ultimase
	3- Viscozyme
	4- Ultraflo

OBJECTIVE

- ➢ Heat treatment for fibre degradation
- ➢ Cellulolytic enzyme treatment for fibre hydrolysis

RESULTS

1) PHYSICAL PRETREATMENT

- No significant effect of heat treatment in fibre degradation.

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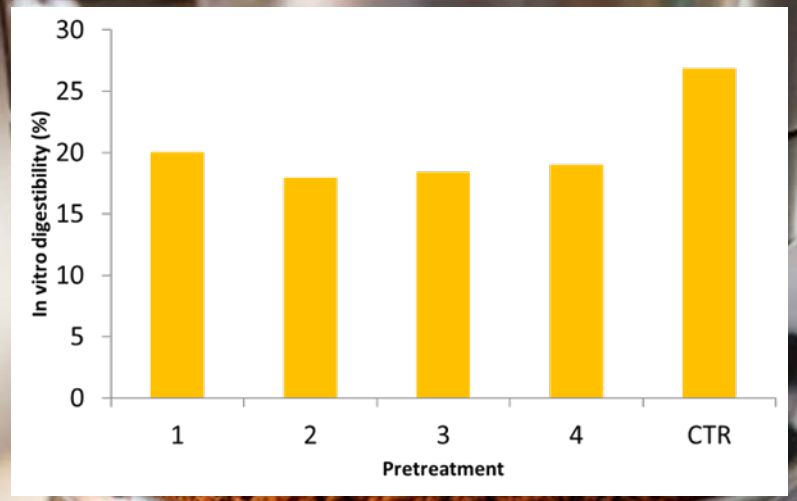

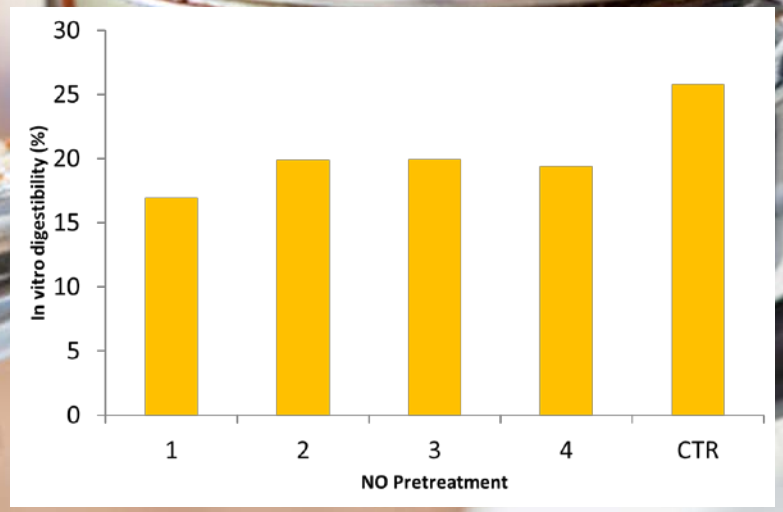

RESULTS

2) ENZYMES

- Viscozyme® and Celuclast ® show the highest fibre degradation.
- However, all enzymes reduce ($P<0.001$) in vitro digestibility by 27-30%. Hypothesis?

1. Hydrolysing solubilises nutritional compounds are lost when separating the liquid and solid fractions (necessary for cost-effective drying) → ↑ % fibre in the solid part.
2. The intensity of the effect of enzymes is substantially ↓ than the enzymatic action of animal rumen bacteria → No effective improvement on the digestibility of the ingredient in the animal.

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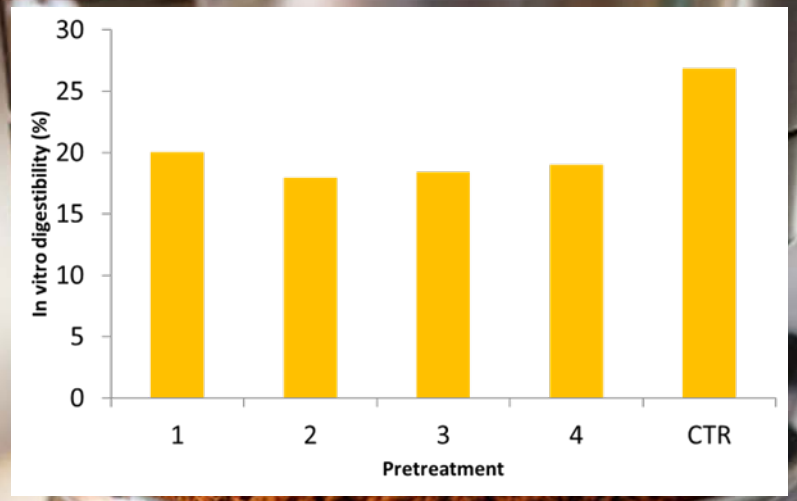

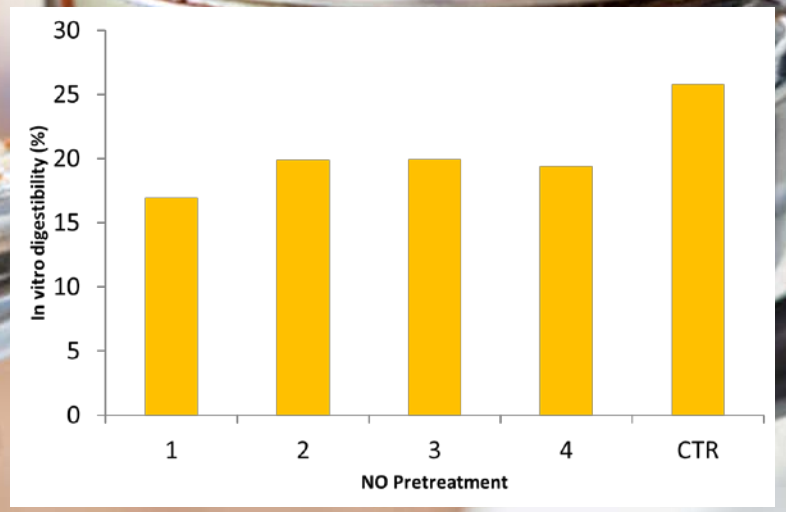

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OBJECTIVE

- ➢ Heat treatment for fibre degradation
- ➢ Cellulolytic enzyme treatment for fibre hydrolysis

CONCLUSIONS

- Inclusion of other physical treatments to improve the effectiveness of enzymes would be advisable.
- The effectiveness of other more effective enzymes in lignin digestion needs to be analysed.

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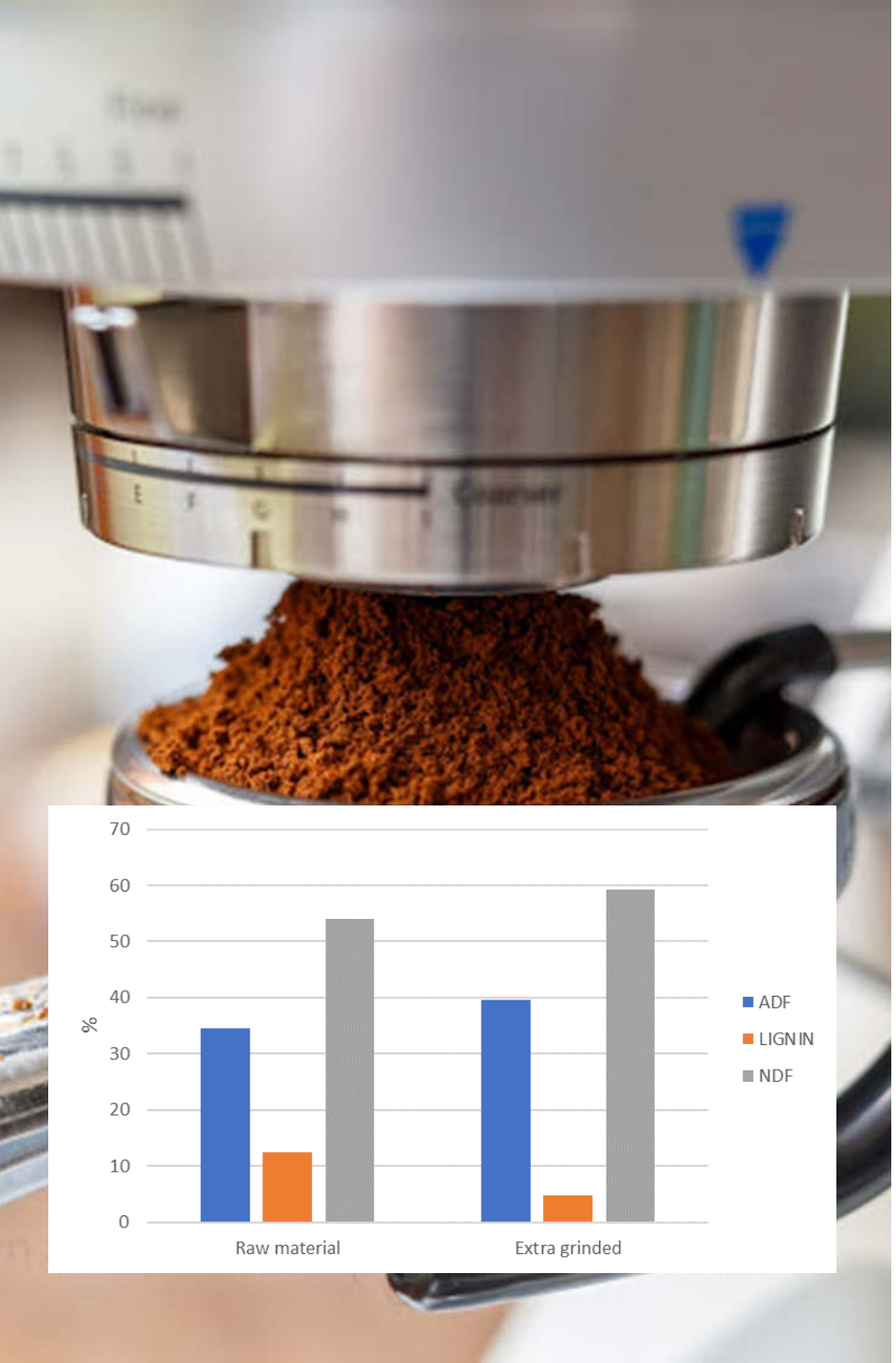

CHALLENGE 3

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Enzymatic Hydrolysis ⟶ Increased fiber digestibility

➢ 2nd Experimental trial

Pretreatment (15 min 121 °C)	Enzymas
Yes	Lacasse
No	Lacasse
Yes	Ultimase + Lacasse
Yes	Ultimase + Viscozyme
No	Without enzyme
Yes	Without enzyme

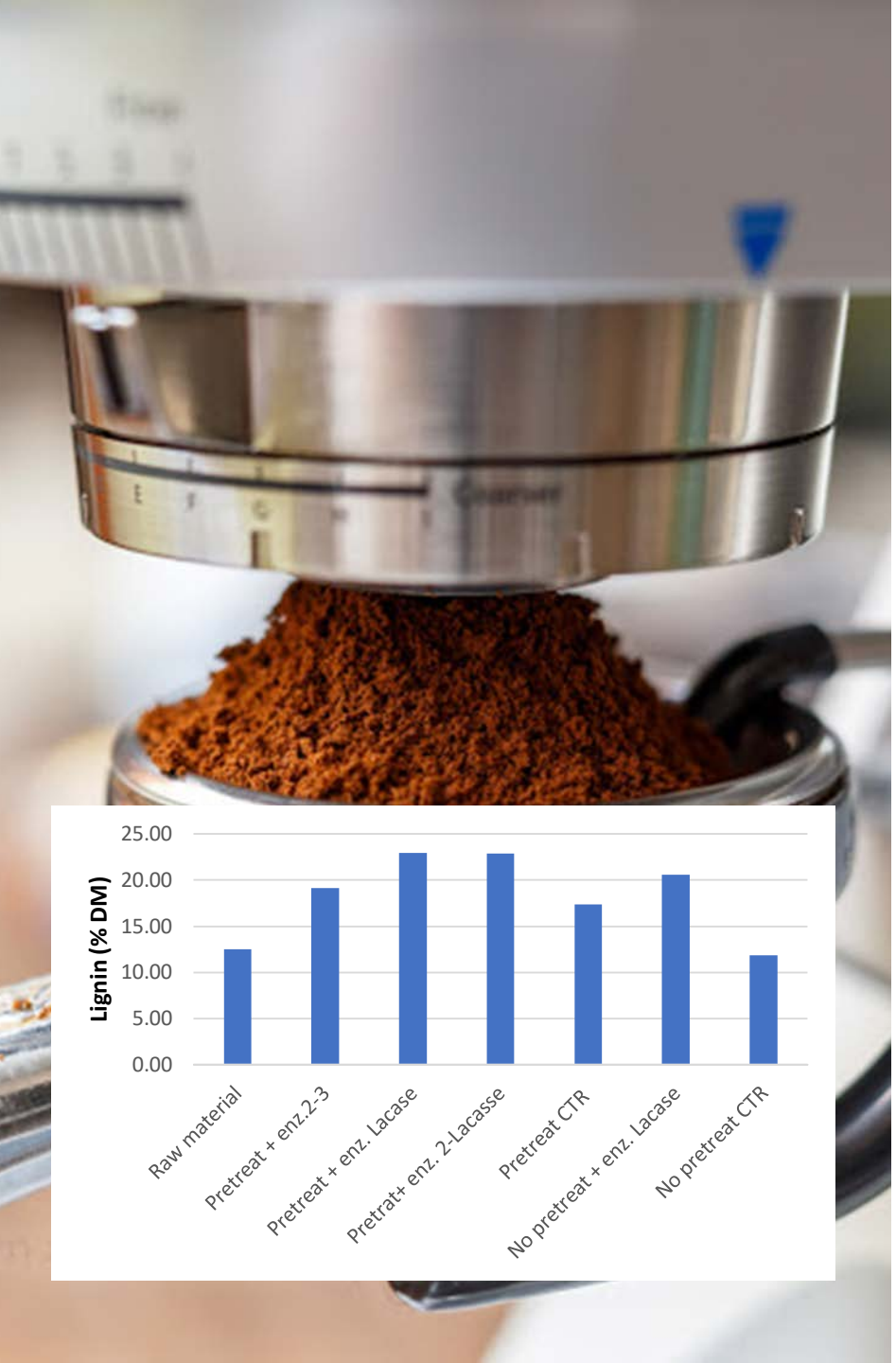
OBJECTIVE

- ➢ Heat treatment & Grinding for fibre degradation
- ➢ Cellulolytic enzyme treatment for fibre hydrolysis
- ➢ Lacasse® enzyme for lignin degradation

RESULTS

1) PHYSICAL PRETREATMENT

- Heat treatment
  - ✓ Digestibility was not improved at any of the times tested
- Grinding
  - ✓ It improves in vitro digestibility by 25%, without increasing VFA production.
  - ✓ It would improve the ruminal fermentation process



CHALLENGE 3

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Enzymatic Hydrolysis ⟶ Increased fiber digestibility

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No	Without enzyme
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OBJECTIVE

- ➢ Heat treatment & Grinding for fibre degradation
- ➢ Cellulolytic enzyme treatment for fibre hydrolysis
- ➢ Lacasse® enzyme for lignin degradation

RESULTS

2) ENZYMES

- Ultimase® + Viscozyme® show increased release of sugars
- Lacasse® decreases Polyphenols (possible oxidation)
- None of the enzymes or combinations used:
  - ✓ Increases digestibility in vitro
  - ✓ Increases total VFA production
- All involve a loss of efficiency of the ruminal fermentative process

CHALLENGE 3

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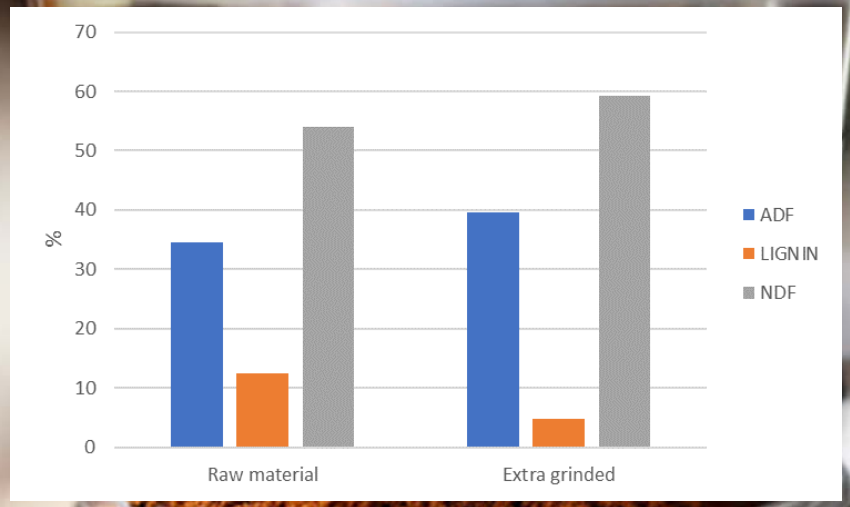
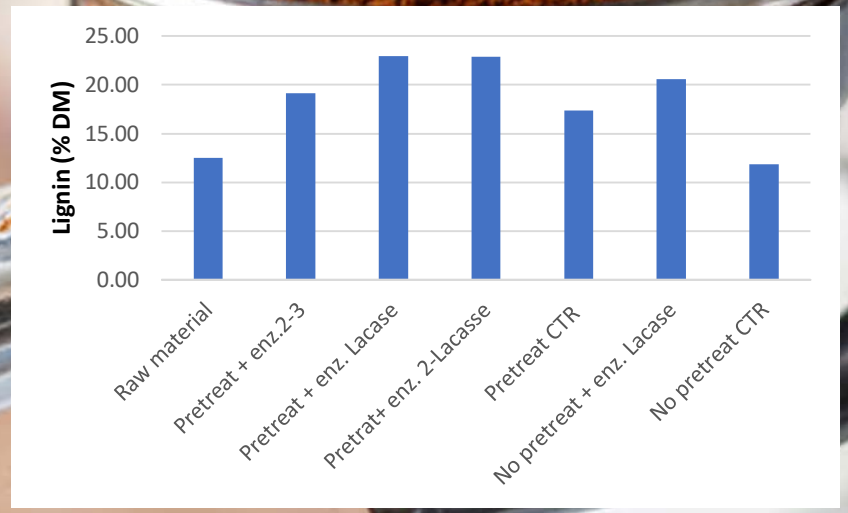
Enzymatic Hydrolysis ⟶ Increased fiber digestibility

➢ 2nd Experimental trial





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No	Lacasse
Yes	Ultimase + Lacasse
Yes	Ultimase + Viscozyme
No	Without enzyme
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OBJECTIVE

- ➢ Heat treatment & Grinding for fibre degradation
- ➢ Cellulolytic enzyme treatment for fibre hydrolysis
- ➢ Lacasse® enzyme for lignin degradation

CONCLUSIONS

- Grinding arises as an effective pretreatment to increase digestibility
- When coffee spent grounds are hydrolyzed, the liquid fraction is released when separating the liquid and solid fractions (necessary for cost-effective drying)
- Supplementing a typical dairy cattle ration with liquid fraction
  - ✓ Decreases the digestibility (70 vs. 48%) of such a ration without reducing VFA production
  - ✓ Improve the efficiency of the ruminal fermentation process and reduce protein degradation in the rumen
  - ✓ The liquid fraction can be an alternative to commercial growth promoters

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Enzymatic Hydrolysis ⟶ Increased fiber digestibility

➢ 3rd Experimental trial

Grinding	Hydrolysis
Original sample (about 500µm)	Without any treatment
Grinding 1 (about 250µm)	Reconstituted hydrolysate (solid + liquid fractions)
Grinding 2 (about 100µm)	Solid fraction
Flash dried sample	

OBJECTIVE

- ➢ Effect of grinding, since in the previous design it improved ruminal digestibility
- ➢ Effect of hydrolysis when reconstituting the hydrolyzed sample (recovering the liquid fraction)

RESULTS

1) PHYSICAL PRETREATMENT

- Grinding improves the digestibility of coffee grounds: up to 65% of the improvement (P3)

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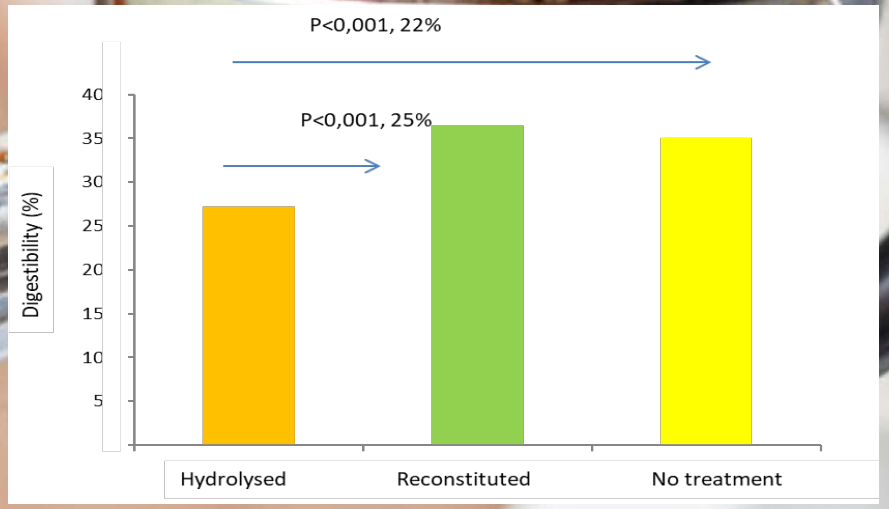

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Flash dried sample	

OBJECTIVE

- ➢ Effect of grinding, since in the previous design it improved ruminal digestibility
- ➢ Effect of hydrolysis when reconstituting the hydrolyzed sample (recovering the liquid fraction)

RESULTS

2) ENZYMES

- When we hydrolyze, we still see a loss of digestibility.
- If we reconstitute the liquid and solid part, we recover the digestibility.

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CHALLENGE 3

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➢ CONCLUSIONS

- **Spent Coffee Ground** is a by-product with a **high fibrous content** which makes it difficult to include as a digestible raw material in animal feed.
- The **hydrolysis process** could have been a **valuable strategy** to make the raw material components more accessible to the animals.
- However, the **effect of releasing compounds of interest** (sugars, polyphenols...) **into the liquid medium** during processing makes the resulting material less valuable.
- Furthermore, the **effect of enzymes** on the solid matter is **neutralized by the enzymatic action of the ruminal bacteria**.
- On the contrary, the **liquid fraction** can be an alternative to commercial **growth promoters**.
- The **heating pre-treatment is of no interest** for improving digestibility and therefore, increasing the percentage of inclusion of SCG in ruminant feeds.
- On the contrary, **grinding is presented as the best technological alternative to improve the digestibility** of spent coffee grounds in particular and the fermentative process in the rumen in general.

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