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:
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**
**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

**Challenge 4: Dehydration**
Energy optimization of the drying process using pellets from coffee grounds

**Challenge 5: Pellets**
Stabilization of the coffee grounds for its suitability as a feed ingredient
- Natural coffee grounds
- Hydrolyzed coffee grounds

**Challenge 6: Nutritional efficiency**
Nutritional value of coffee grounds
Nutritional efficiency tests: dairy cattle and sheep

**Business model**
Value proposal
Investor search
Roadmap

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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
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.
Enzymatic Hydrolysis → Increased fiber digestibility

1st Experimental trial

<table>
<thead>
<tr>
<th>Pretreatment (15 min 121 °C)</th>
<th>Enzymes</th>
<th>OBJECTIVE</th>
</tr>
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<tbody>
<tr>
<td>Yes</td>
<td>CTR - without enzyme</td>
<td>➢ Heat treatment for fibre degradation</td>
</tr>
<tr>
<td>No</td>
<td>1- Celuclast</td>
<td>➢ Cellulolytic enzyme treatment for fibre hydrolysis</td>
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<td></td>
<td>2- Ultimase</td>
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<td>3- Viscozyme</td>
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<td></td>
<td>4- Ultraflo</td>
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RESULTS

1) PHYSICAL PRETREATMENT

• No significant effect of heat treatment in fibre degradation.
Enzymatic Hydrolysis → Increased fiber digestibility

1st Experimental trial

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OBJECTIVE

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

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.
CHALLENGE 3

Enzymatic Hydrolysis → Increased fiber digestibility

1st Experimental trial

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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.
CHALLENGE 3

Enzymatic Hydrolysis → Increased fiber digestibility

2nd Experimental trial

### 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

### OBJECTIVE

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

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CHALLENGE 3

Enzymatic Hydrolysis → Increased fiber digestibility

2nd Experimental trial

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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
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

OBJECTIVE

• Heat treatment & Grinding for fibre degradation
• Cellulolytic enzyme treatment for fibre hydrolysis
• Lacasse® enzyme for lignin degradation
CHALLENGE 3

Enzymatic Hydrolysis → Increased fiber digestibility

3rd Experimental trial

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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)
Enzymatic Hydrolysis → Increased fiber digestibility

3rd Experimental trial

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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.
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 promotors**.

- 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.
Thank you for your attention

Any question?