Fibres Recherche Développement

Quality management of hemp straw / fibres used in agro-material

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RIGHTLAB Consortium:

Exploring lignocellulosic biomass
Challenges and opportunities for bioeconomy
26 - 29 June 2018 in Reims - France
FRD, a value creator

FRD pools the research of 11 shareholders

- Technical plant fibre producers (75% hemp, 25% linseed flax, 15% flax and wood)
- Producers of semi-finished products
- Plant chemistry players
- Investors

FRD makes plant fibres usable by the application industry

- An extraction laboratory for functionalization, technical plant fibre characterization: unique in Europe
- A national research network: 30 technical centres and laboratories

MARKETS

Application manufacturers

- Want to use plant fibres in their materials
- Want to have a clearly identified intermediary as an advisor (for range, quality, supply, material formulation, technical and economic feasibility)

RESOURCES

Plant fibre producers

- Have the resources
- Want to upgrade their fibres technically
- Want to develop ties with the application industries
Our innovation skills

- Markets, products, players, specifications, processes, the resource and biomass availability
- Fractionation and the functionalization of the fibres and preforms
- Characterization and quality management from field to final process
- Structuring and coordinating R&D projects

Studies
- Plant fibres
- Controlling variability
- Retting
- Extraction processes
- Functionalization processes
- Supply of European fibres
- Supply of foreign fibres
- Potential for upgrading miscanthus

Services / Advising

Innovation programme
Different funding (Region, ANR, FUI, BPI, ADEME…) according
- Partners
- Technology readiness level
- Funding option …
Our achievements/ongoing projects: from field to markets

- Lowering weight
- Polymer substitutes
- Controlled degradability
- Thermal insulation

Target applications:
- ENAFILIA
- SINFONI
- ISOL
- FINATHER

Mechanical properties:
- Fire resistance
Our achievements/ongoing projects: from field to markets

Assistance in creating supply chains

Quality control

Example from a single producer for the same year, showing retted straw from 2 different plots that were subjected to the same technical procedures

Studies
Some determinisms for fibre properties

**At the field**
- **Botanical/Biological**
  - Varieties / Physiology / Interactions between genes and environment…
- **Agronomy / Pedology / Climate**
  - Water supply availability / Fertilisation / Density of the seeding / Date of seeding…
- **Retting & Harvesting**
  - Retting quality / mode / Plant maturity / Harvesting system / Straw processing
- **Straw fractionation**
  - Process / Parameters

**At the factory**
- **Treatment of the products & coproducts**
  - Dusting / Cutting / Chemistry…
- **Processing of semi-finished products / finished products**

**Genetics & Agronomy**

**Retting**

**Fractionation**

**Functionalization**

**Processing**

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ELB – Reims - 2018
Genetics and agronomy

Effets on hemp straw / fibres – MAPROFI Project, 2009-2013

- On the morphological, chemical and mechanical properties
- On the quality of technical fibres
  - Presence more or less important of shorter and more lignified secondary fibres

Methodology

Crop
↓
Harvest
↓
Extraction process
↓
Compounding
↓
Final transformation
↓
- Variety
  - Seed rates
  - Nitrogen fertilization
  - Water supply
  - Harvesting time
↓
Impact measured over the entire downstream chain

MAPROFI Project, 2009-2013 - Thesis (E Fernandez)
Genetics and agronomy

**Effets on hemp straw / fibres – MAPROFI Project, 2009-2013**

- **On the morphological, chemical and mechanical properties**
- **On the quality of technical fibres**
  - Presence more or less important of shorter and more lignified secondary fibres
  - The maturity of fibres (i.e. cell wall thickness) can be affected by the culture conditions

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**Hemp fibres**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary fibres</td>
<td>Procambium</td>
</tr>
<tr>
<td>Secondary fibres</td>
<td>Cambium</td>
</tr>
<tr>
<td>Bast fibres</td>
<td></td>
</tr>
<tr>
<td>Xylem fibres</td>
<td>Cambium</td>
</tr>
</tbody>
</table>

**Differences of cell wall architecture and composition between bast and xylem fibres**

**MAPROFI Project, 2009-2013 - Thesis** (E Fernandez)
Retting

Definition

- Complex processes (and dynamic)
- (1st) step of straw fractionation (stem fibres)
- Promote defibration process

Effects

- Well documented on flax
- **Major role on fiber economic values** with a ratio from 1 to 2.5 according the retting degree / homogeneity…
- **Strong impact** on fiber quality (chemical composition, mechanical properties...)
  - Cell walls = retting target
Fractionation

Definition

- Sequence of steps (usually mechanical ones) leading to the separation of fibrous elements from the other components of the stems

- Sequence of steps leading to the transformation of the fibres / aggregates previously obtained (cutting / fibrillation / micronisation…)

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Functionalization

Definition

- Give **materials** new **specific properties** through physical and/or chemical treatments

Effects

<table>
<thead>
<tr>
<th>Specific properties</th>
<th>Technological barriers</th>
<th>Main targeted markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre / matrix adhesion</td>
<td>Impact performance, resistance...</td>
<td>Transportation</td>
</tr>
<tr>
<td>Hydrophobic treatment</td>
<td>Humidity recovery, Aging...</td>
<td>Nautical</td>
</tr>
<tr>
<td>Fireproofing</td>
<td>Fire properties</td>
<td>Railroad</td>
</tr>
<tr>
<td>UV Stability</td>
<td>Aesthetics / Mechanical performance</td>
<td>Transportation</td>
</tr>
<tr>
<td>Coloring</td>
<td>Aesthetics</td>
<td>Transportation</td>
</tr>
<tr>
<td>Antibacterial / Fungicide</td>
<td>Durability</td>
<td>Construction</td>
</tr>
</tbody>
</table>
Processing

Strong link between fibers properties / their processing capacity and on final products qualities

- **Example**: fiber valorization in TP composite
  - Defibrex project (ANR 2012-2016):
    - Link between the morphological evolutions of the fibers during extrusion and their genetic origin, their morphology
    - Link between fiber fineness and fiber dispersion
    - Link between fibre / matrix adhesion and products properties
Retting : a key parameter for fiber quality

Requirements

- Provide plant fiber fractions with expected specificities in term of:
  - Fineness & morphology
  - Chemical composition
  - Surface properties
  - Mechanical properties
  - Specific properties (fire resistance, color...)

Some determinisms for fibre properties

Retting effect : a key parameters to control fiber qualities

- Intensity of the retting effects >> effect of the intraspecific variations and /or agronomic conditions
- Retting impact on fractionation process and fiber functionalization
Retting: a key parameter for fiber quality

Retting drawbacks:

- **Dew retting appears as the only economically efficient method**
  - compared to water / chemical or physical methods with high OPEX/CAPEX
- **No available indicator to measure the retting degree**
  - Risk for farmer to under / over retting
  - Highly heterogenous rotted straw quality
  - Non-conformances of fiber qualities
  - No market access: poor fiber valorization

**RIGHTLAB project (2016-2019)**

- Provide one/some retting level indicator(s) to manage / certified hemp straw/fiber qualities
- Field based methods
- 3 Markets: non woven / TP composite / textile
RIGHTLAB strategy

Dew retting:
- 4 field conditions at industrial scales
- Accurate monitoring of retting process

Multi approaches at different scales:
- from straw to cell wall
- Spectrometric / chemical / mechanical studies

Strong link with applicative markets:
- Markets specificities definition
- Industrials assays
RIGHTLAB strategy

Targeted output:

- Find a **low cost field method** to quantify the retting degree of hemp straw/fiber to **certify the straw/fiber quality** with a technical datasheet as manufacturers employed currently with synthetic fibers
  - The template of these data sheet was previously define in SINFONI project
Thank you for your attention ...

The Catalogue:
Natural fibres and reinforcement – Materials solutions is available at:
www.f-r-d.eu
www.agrobiobase.com

Thanks:
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B Kurek,