

Biokenaf EU project: Industrial application of kenaf

Work Package 5: Utilisation of kenaf for
industrial products and energy.

S.J.J. Lips

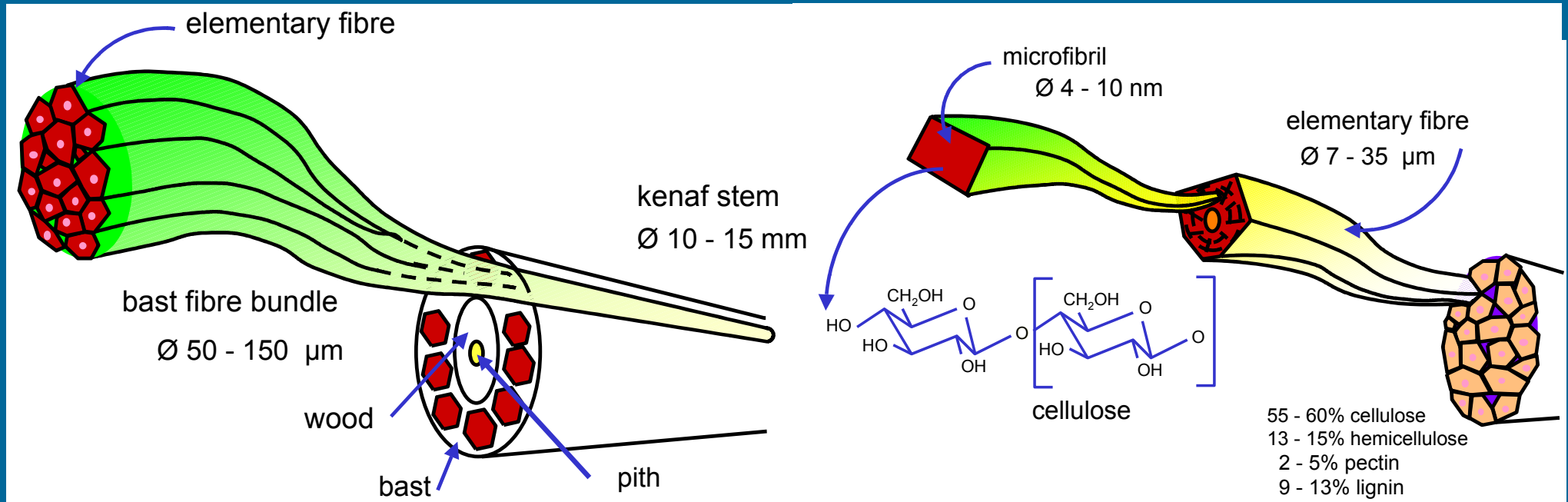
department Fibre & Paper technology

Bologna 9 May 2006

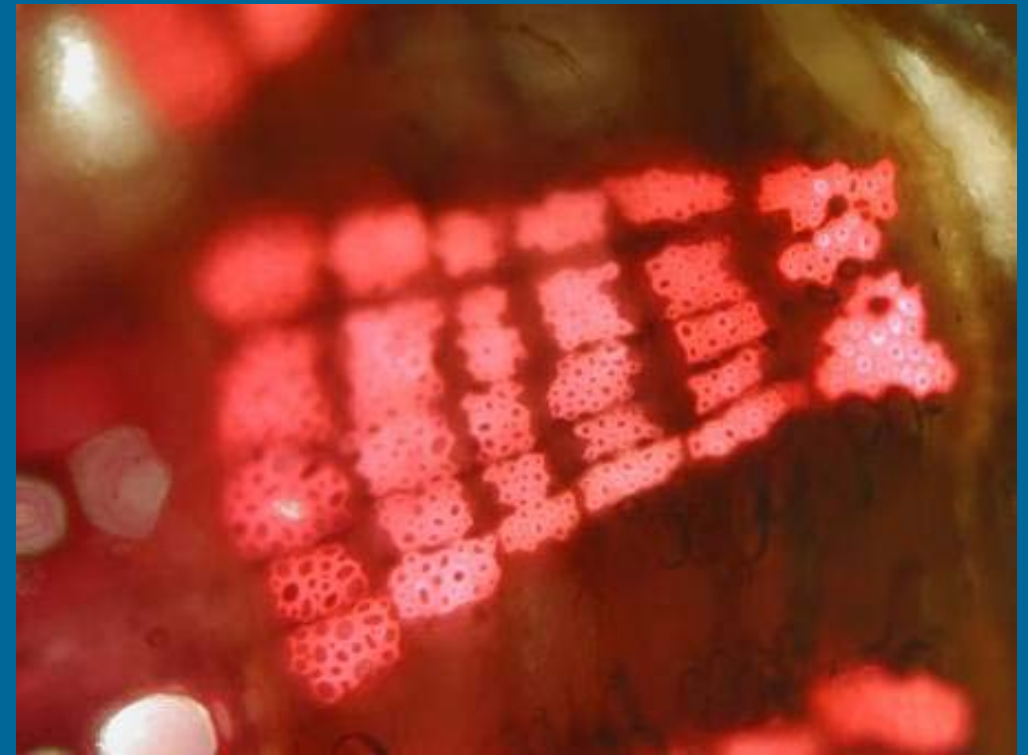
Work package 5

- **Task 5.1.1 Fractionating of kenaf stems (A&F)**
- **Task 5.1.2 Market and techno-economic feasibility studies for industrial application. Application tests on two or three selected areas (A&F)**
- **Task 5.2 Thermal conversion experiments with combustion, pyrolysis and gasifier equipment (BTG and CRES)**

Construction of the kenaf stem and fibre bundles



Structure of kenaf stem (Everglades 41)



Fibre production chain

Agricultural production

harvest / retting

Stems

Storage/transport

Fibre extraction

Decortication

scutching (cleaning)

hackling (combing)

Hurds

Short fibres

Fibres

Sliver

Textile processing

calendering

refining, drafting, and doubling

spinning

Yarn

weaving

Fabric

finishing and design

Marketable end-product

5.1.2: Market and techno-economic feasibility studies for industrial application

- Market and literature review
 - Composites
 - Building materials
 - Nonwovens
 - Paper & board
 - Absorption particles
- Testing of two or three applications selected from the market and literature review

Kenaf in composites

- Already applied in woven and nonwoven mats combined with plastics.
 - Strength of fibre bundle is important.
- Natural fibres in compounds for injection moulding is in it's commercialisation stage.
 - Weakened fibre bundles are possible but elementary fibres must have enough strength

Kenaf in composites

Kenaf-reinforced bioplastic strengthens cellphone handsets

Japanese companies NEC and Unitika have commercialized kenaf fibre-reinforced bioplastic for the NTT DoCo FOMO N701IECO cellphone handset that is manufactured by NEC.

According to NEC and Unitika, the kenaf fibre-reinforced bioplastic has high impact resistance when dropped and is highly mouldable - these are both necessary features for handset

cases. NEC first adopted the environmentally-friendly material for personal computers in late 2004.

The companies explain that

kenaf fibre helps reinforce polylactic acid, largely improving the heat resistance of the plastic. The companies say that they have added a specific formula of vegetable softening agents and fillers for further reinforcement. The bioplastic contains around 90% vegetable-derived materials. The companies state that the material has achieved the highest level of performance attained by an electronic device bioplastic. NEC and Unitika add that they will continue to develop kenaf-reinforced bioplastic for electronic device applications.

Source: Plastic Additives and Compounding March/April 2006

Kenaf in building materials

- Particle boards (FAIR)
 - Bast fibre is less suitable and too expensive for any type of board.
 - Core fibre cannot fulfil the strength requirements and is not competitive with wood residues.
- MDF boards (FAIR)
 - Core fibre can be added to wood up to 10%, but has to be cheaper than wood.
 - Whole stem can be added to wood up to 30%, but has to be cheaper than wood.
 - Price of good quality wood chips is around €70 /ton.

Kenaf in building materials

Hard boards (FAIR)

- Whole stem gives a technically satisfying board.
 - Not competitive with rest wood fraction and woodcuttings.
-
- Binderless insulation boards
 - Under investigation in Japan by Xu and Okuda
 - Insulation mats
 - Interesting for further investigation

Kenaf in Paper and Board

- Technically possible but not competitive in most bulk papers.
 - Wood is cheaper
 - Phoenix mill in Thailand
- U.S.A.--- Whole kenaf for newsprint had good prospects --- a mill was never build
 - high investment costs and the need for reliable supplies of kenaf result in high risks.
 - 400.000 tons/y -----> 480 million € = €1200/ton/y

Kenaf in Paper and Board

- Can be used in specialty papers
 - bible, cigarette and security papers
 - small scale
 - competition with flax, hemp and jute
 - Import prices of jute in Spain € 280-350,- /ton
- U.S.A.---Vision Paper
 - chlorine free
 - tree free

Kenaf core absorption particles

- Cleaned core can be used as animal bedding
- Bedding material for horses around € 200 /ton
- High price, profits depends on distribution distance.



Procotex



Hempflax

Hempflax

Stable bedding from flax and hemp core

Kenaf core absorption particles

- Applied methods are often very different
- Competition with other bedding materials like straw and wood shavings
- Comparison between kenaf and other bedding materials with the same method has to be made

Small-scale separation of kenaf

- A small- scale mill has better chances.
- Sales of bast and core for different applications.
- Smaller investment costs.
- Easier start.

Quality problem for some applications

- End of November the crop still contains 75% of moisture.
- Too wet for storage
- Drying during winter in field.
- Affection by micro-organisms

Affected kenaf stems



Unaffected



Affected during winter

Disappeared epidermis

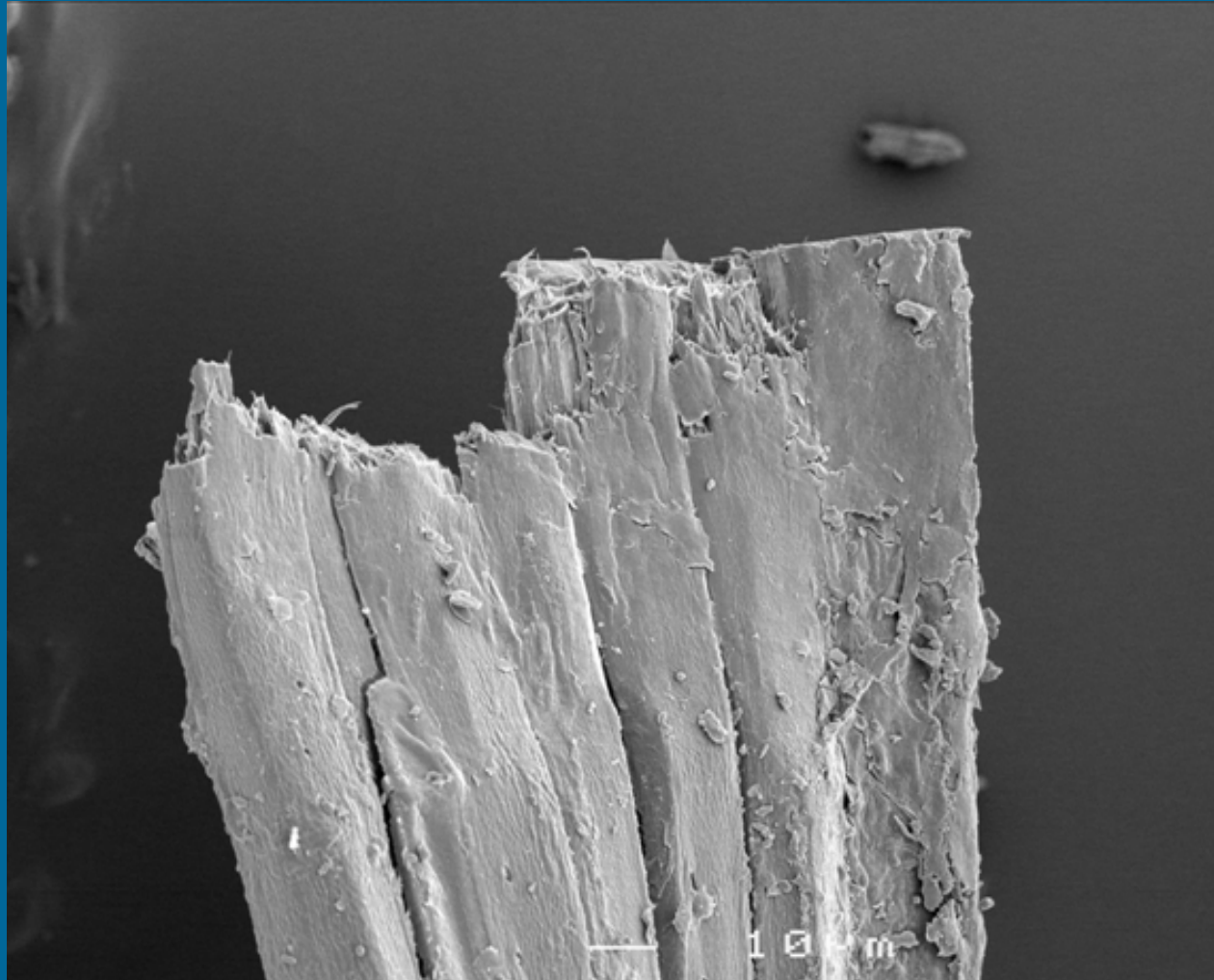


Fibre bundle strength

Sample	Tensile strength (Mpa)	Long fibres (%)
<i>BIOKENAF</i>		
harvest December	347	
harvest February	382	10.2
harvest February after storage*	443	
<i>FAIR</i>		
retted	556-682	21.6
green decorticated	276-435	

* stored in a pile of 10 mm chopped kenaf

Tensile fracture of a kenaf fibre bundle



Strength fibres bundles

- Weak fibre bundles limit the number of possible applications.
- Strong fibres make woven applications like for automobiles possible.
- For strong fibres a controlled retting process is essential.

Fibre extraction- bast fraction

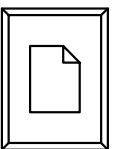


Fibre extraction - industrial separation

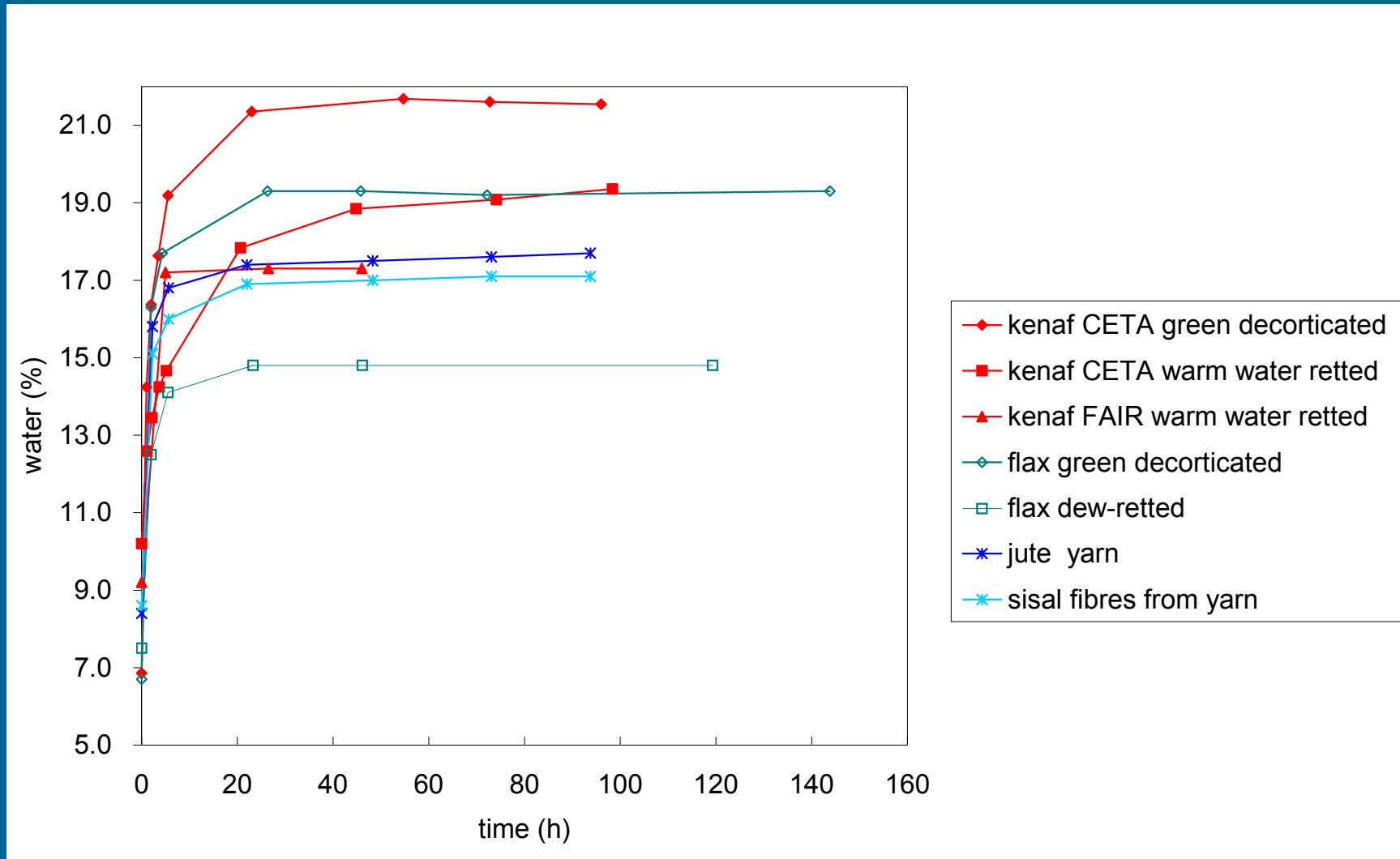


- Small scale trial with about 50 kg of baled kenaf.
- Can the machinery handle the thick woody stems without problems?

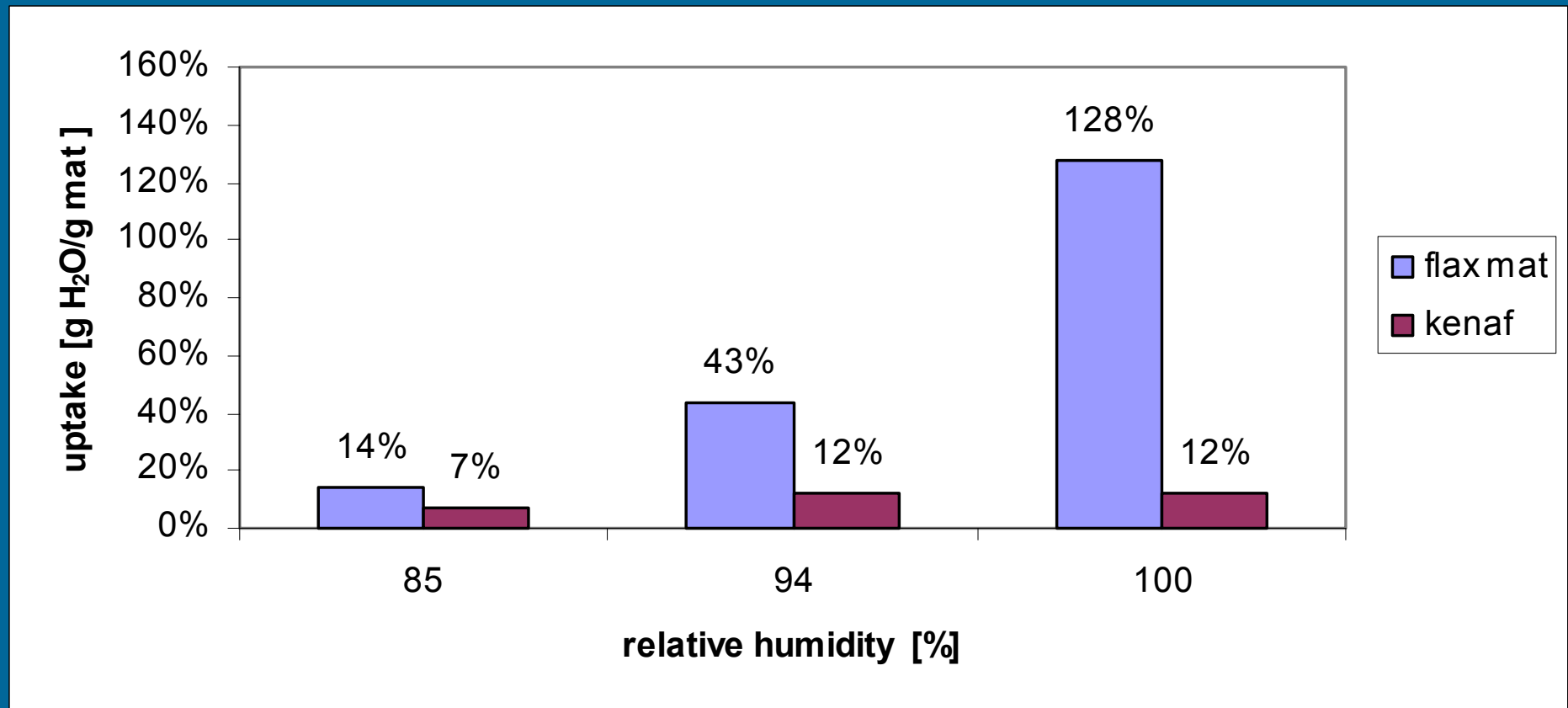
Fibre extraction - industrial separation



Moisture absorption of natural fibres at 90% RH



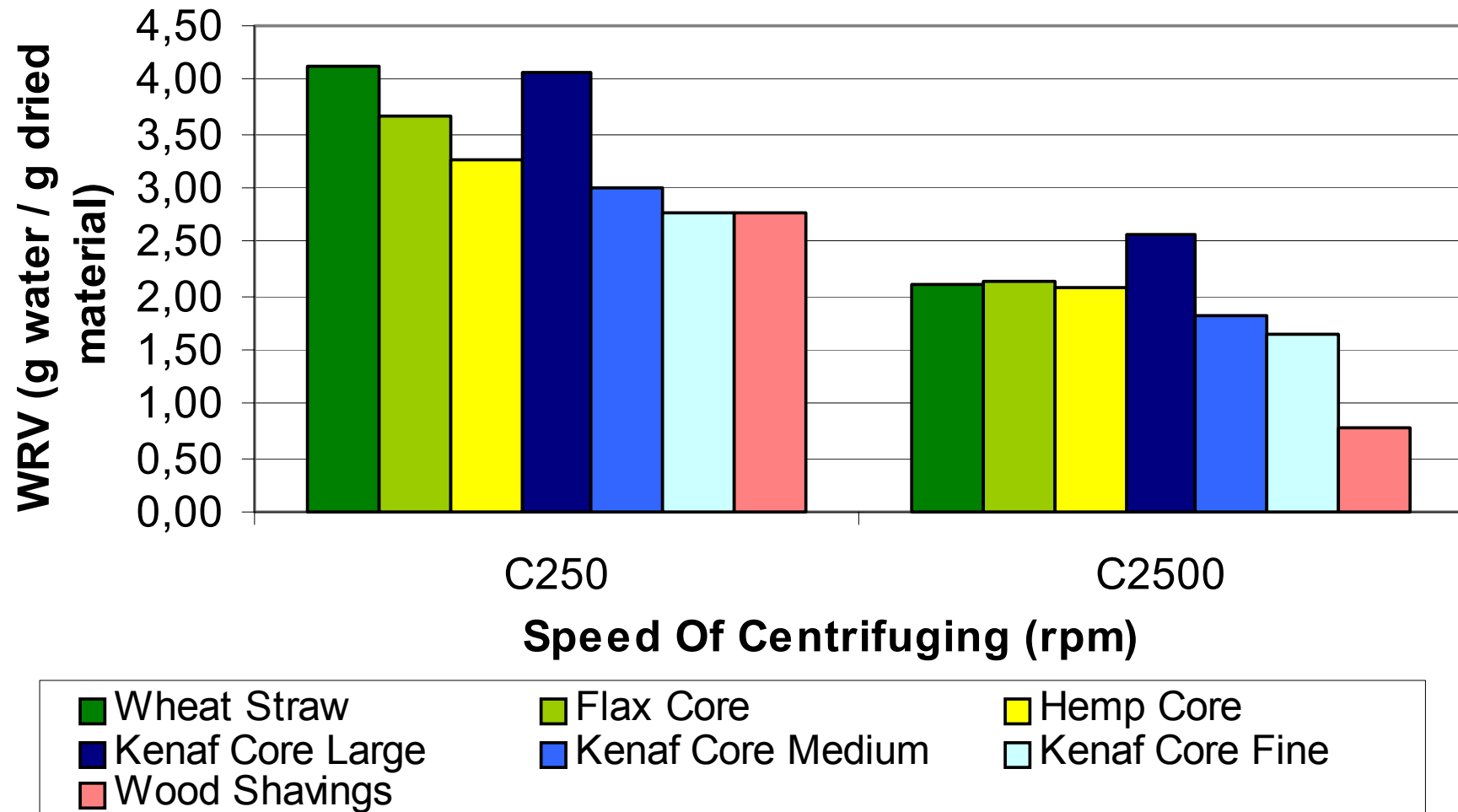
Moisture uptake of insulation mats



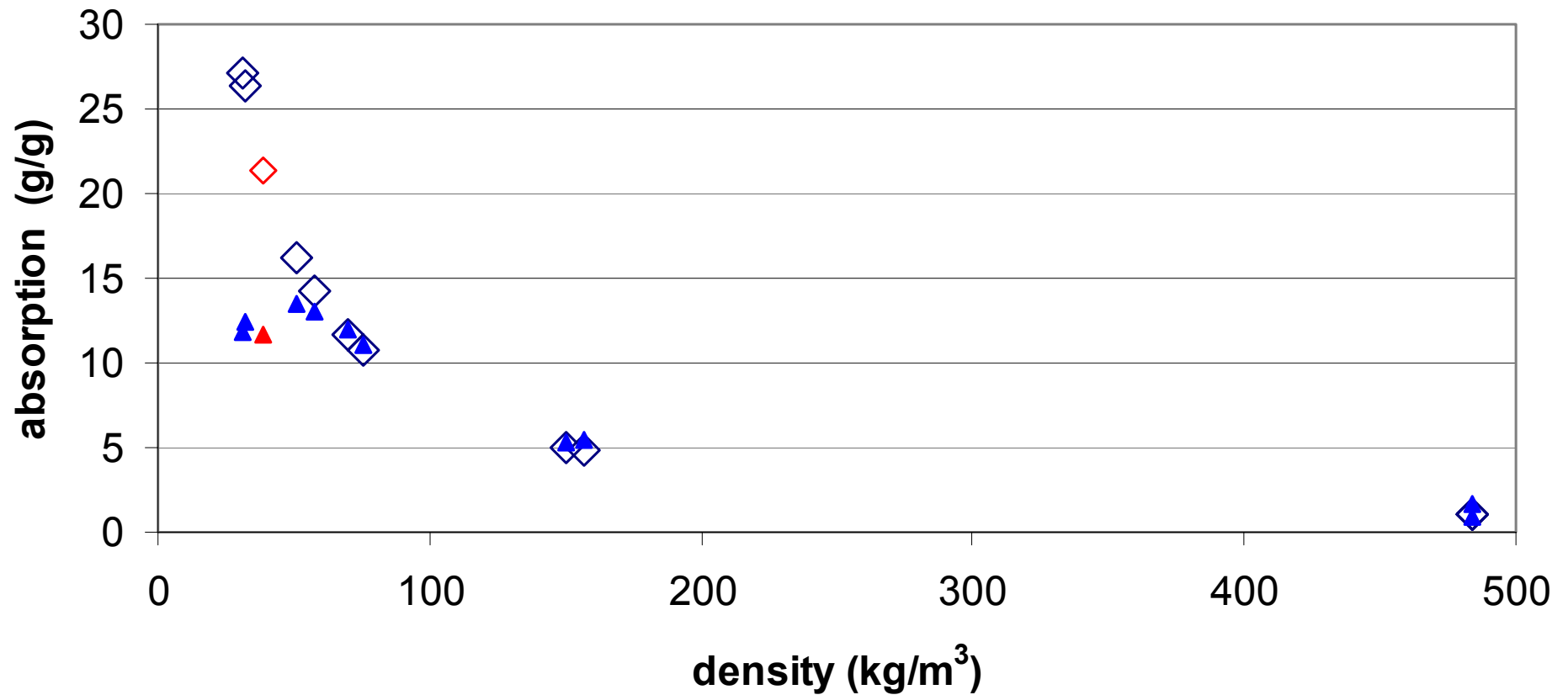
Kenaf no additives

Flax mat contains flame retardants and microbial inhibitors

Water retention of animal bedding materials



Oil absorption of kenaf fibre mats (K.E.F.I.)



◇ kenaf mat theory ▲ kenaf mat ▲ flax mat ◇ flax mat theory

Conclusions - fibres

- Easy fibre extraction
- weakened fibres - 60% of maximum
- Weakened fibres can be used insulation mats

Conclusions - core

- Large core fraction is the best water absorber of all the tested materials.
- Kenaf core medium and fine absorb
 - somewhat less than wheat straw and core of hemp and flax
 - more than wood shavings
- Kenaf pith is a very good absorber.

Conclusions - general

- Technically numerous applications are possible.
- Competitiveness with other materials or quality aspects limits the number of applications.
- To ensure high quality fibres another process route is necessary
- The de-gumming process as applied by Gruppo Fibranova in the HEMPSYS project might be a solution for this problem